PROCEEDINGS

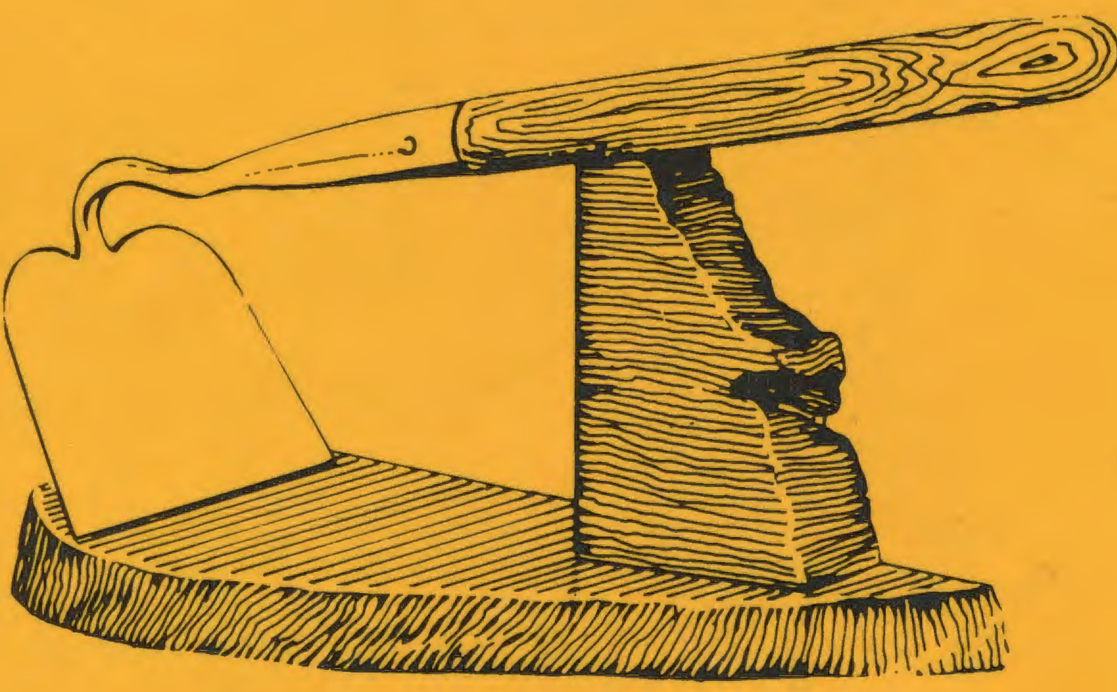
50th ANNUAL

CALIFORNIA
WEED SCIENCE SOCIETY

THEME:
FIFTY YEARS OF EXCELLENCE
FIFTY YEARS OF PROMISE

HYATT REGENCY
MONTEREY, CALIFORNIA

January 12, 13 and 14, 1998



1998

PROCEEDINGS

OF THE

CALIFORNIA WEED SCIENCE SOCIETY

VOLUME 50

PAPERS PRESENTED AT THE ANNUAL MEETING

JANUARY 12, 13, AND 14, 1998

HYATT REGENCY-MONTEREY

MONTEREY, CALIFORNIA

PREFACE

The Proceedings contain the written summary of the papers presented at the 1998 California Weed Science Society Annual Meeting as well as minutes of the annual business meeting, year-end financial statement and names, addresses and phone numbers of those attending the meeting.

TABLE OF CONTENTS

URBAN WEED SESSION - Moderators: Michelle Le Strange and Nancy Garrison

GENERAL SESSION - Moderator: Scott Johnson

CONCURRENT SESSIONS

SESSION A: Turf & Ornamentals - Moderators: Judy Letterman and Frank Ono

SESSION B: Trees and Vines - Moderators: Matt Elhardt and Roger Gast

SESSION C: Industrial and Aquatics - Moderators: Bob Brenton and Pamela Rener

SESSION D: Vegetable Crops - Moderators: Richard Smith and Carol Regusci

SESSION E: Agronomic Crops - Moderators: Mick Canevari and Ernie Roncoroni, Jr.

SESSION F: Forestry, Range & Wildlands - Moderators: Frank Aulgur & Nelsen Money

WEEDS OF THE YEAR - GORSE & BROOM SPECIES - Moderator: Joe DiTomaso

LAWS AND REGULATIONS - Moderators: Scott Johnson

POSTER SESSION: Chair - Tome' Martin-Duvall
Co-Chair - Manuel Jimenez, Jr.

1998 CWSS EXECUTIVE BOARD

Front Row:(L to R) Mick Canevari, Director; Ron Vargas, Past President Back Row: (L to R) Matt Elhardt, Secretary, Steve Wright, Program Chair, Louis Hearn, Director and Scott Johnson, President

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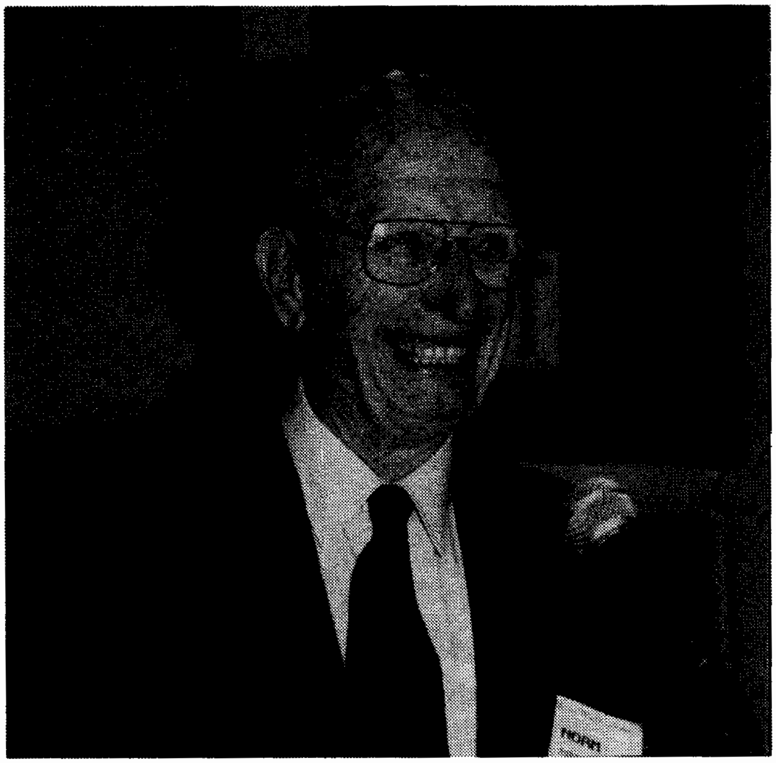
1998 HONORARY MEMBER



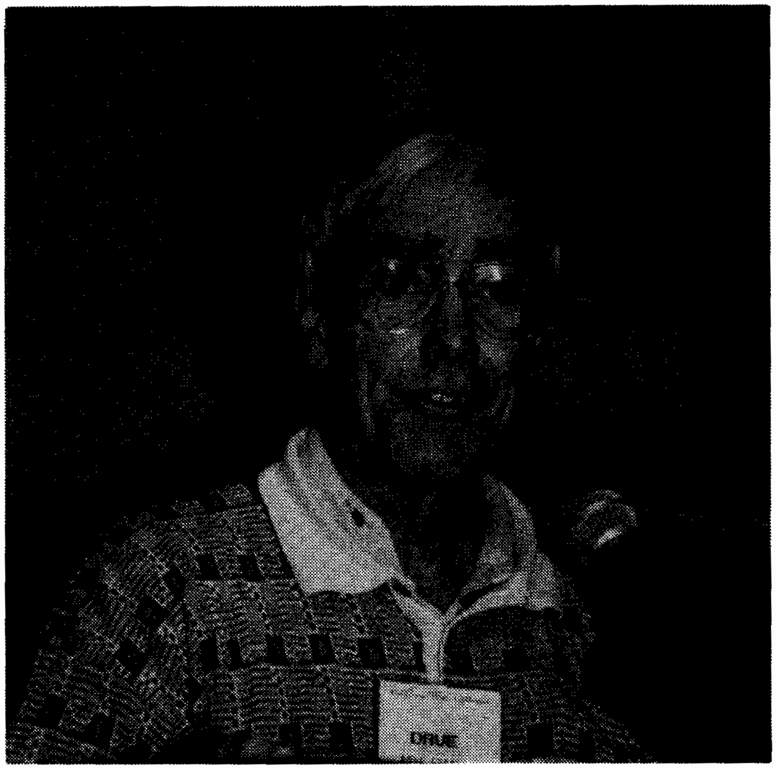
Norman Akesson

Professor Akesson is truly a pioneer when it comes to research and development of chemical weed control equipment. He joined the faculty of the University of California, Davis in 1947 with teaching and research responsibilities. His contributions to the discipline of Weed Science and to this organization began in 1949. Norm presented a paper on spraying systems at that first California Weed Conference. Since that time, he has presented numerous invited papers on herbicide spraying systems.

Norm's achievements are recognized worldwide and he has presented papers at meetings of the American Society of Agricultural Engineering Weed Science Society of America and the Food and Agriculture Organization of the United Nations. His list of publications is numerous, including a section in our textbook on aircraft spraying systems.

In our first conference in 1949, Norm served as the first chair of the nominations committee. He later served on several other committees and was elected Secretary in 1964. He became the 18th President of the conference in 1966. Professor Akesson continues to serve as an emeritus professor at UC Davis and is still active in the issue of pesticide drift.

1998 HONORARY MEMBER



Dave Cudney

Dave's contributions to the California Weed Science Society and to the discipline of Weed Science in general have been very impressive. He began his career as an agronomic and weed control Farm Advisor in Imperial County. He is presently an Extension Weed Scientist at University of California, Riverside where he has served for many years. Over the years, Dave has conducted intensive extension and research activities covering wild oat control in wheat, dodder and nutsedge control in alfalfa, kikuyugrass, bermuda grass, nutsedge, oxalis, crabgrass, smutgrass and dalasgrass control in turf, tolerance of turf to herbicides, weed seeds in dairy manure, symptoms of herbicide drift, and weed control in citrus orchards, to name a few. He has cooperated with numerous farm advisors and industry representatives over the years. His publication record is also very impressive.

Dave has served the CWSS in just about every capacity possible. He has served as a member of the Steering and Program Committees, presented numerous invited papers, and served as a section chair on many occasions. He has served on the CWSS Executive Board as Secretary, Vice President/Program Chair, President (1996) and Past President. Dave is also a co-author of the very successful book, "Weeds of the West".

1998 AWARD OF EXCELLENCE

Jim Helmer receiving award from Jesse Richardson

Jim began his career with Eli Lilly and Elanco in the Eastern U.S., but was eventually transferred to California in 1970. At that time, Jim was manager of the Elanco Field Station located at Fresno. In addition to those responsibilities, he was also Research Manager for the Western Region, overseeing all research in the Western United States. During this time, Jim was heavily involved in the development of Surflan on trees and vines, Treflan on cotton and a myriad of other crops, Balan on alfalfa and lettuce, and Sonalan on dry beans. Many of the present use patterns of these products in California were developed as a result of Jim's research at the station and cooperative projects with University researchers.

After ten years at the station, Jim was transferred out of California. He was transferred back to California in 1989 however, where he resumed herbicide research. During this time until his retirement he was involved in projects such as Treflan TR-10 on alfalfa, isoxaben in trees and vines, Grandstand on rice, Surflan and Gallery in turf and ornamentals, and Rubigan for annual bluegrass control in turf.

Jim has received a number of awards during his career. He received the California Distinguished Agriculturalist Award for 1978-1979 awarded by Cal Poly, San Luis Obispo. He also received the Elanco Charger Award in 1977. Jim also helped to establish the first undergraduate student internship program at Cal Poly in the early 1970's.

1998 AWARD OF EXCELLENCE

Jim Hill

Jim received a B.S. in Biochemistry and Crop Protection from Cal Poly, San Luis Obispo and a Ph.D. in Plant Physiology from University of California, Davis. After completing a Post-Doc at Davis in 1975, he was hired as an Extension Weed Scientist at the same institution. In 1978 he became Extension Agronomist with specific responsibilities in Rice Production and has held this post to the present day. In addition to these responsibilities, Jim has also held positions as Acting Program Director in the Agronomy and Vegetable Crops Program and as Vice Chair and Chair of the Department of Agronomy and Range Science at University of California, Davis. His publication record is also very impressive.

Jim has been involved in weed science research in rice for nearly two decades. Consequently, he has been involved in the characterization, development, and recommendation of virtually every weed management strategy in use in California rice today. His contributions have been felt by all rice producers in the state. Jim has also been heavily involved in the issue of rice straw burning and has been instrumental in developing strategies to help rice producers meet the requirements of AB 1378, the Rice Straw Burning Reduction Act of 1993.

HOME GARDEN WEED MANAGEMENT

Michelle Le Strange, Pam Elam, and Clyde Elmore
University of California Cooperative Extension

Introduction. Weeds exist in every garden site at times and, depending upon the gardener's management skills, may or may not be a serious problem. The goal with most modern weed management programs is not to eliminate weeds from every environment, but to reduce their impact. For example, a 100 percent weed-free lawn may be desirable, but it is not always practical. However, with good management skills, one's lawn can be nearly weed free without the extensive use of chemicals. Good turf management practices, such as selecting the best turf species and varieties for the site, proper mowing height and frequency, and adequate fertilization and irrigation, lead to a strong and competitive lawn where weeds cannot easily invade. Once turf is weakened, weeds are able to gain a foothold.

Weeds naturally invade garden sites. It is a part of the natural succession of plant ecosystems, even if they are man-made ecosystems. The goal of a gardener is to interrupt the natural succession and maintain a garden of ornamental plants. To do that, one must use a variety of weed control techniques over a long period of time. The following are a few of the methods home gardeners can use.

Prevention. If the garden is weed free now, be diligent in preventing weeds from coming in. Be aware of weeds when they emerge and clean them out before they flower and set seed. Avoid bringing in weed-infested plants from the nursery, or garden equipment that may have seeds or dirt on it with weed seeds present. Don't bring in soil that may contain weed seeds.

Keep Garden Plants Competitive. Provide conditions that favor the crop or plant and not the weed. For example, drip irrigation wets a small area and provides water to only the desired plants but not weeds. Fertilize at the right time and with the right amount for the garden planting.

Mechanical Control. Use tools, or hand pull weeds before they go to seed. Also consider mowing or rototilling them, or the "sprinkle-sprout-spade/spray" technique of weed removal prior to planting. Frequent hand removal of young plants will rapidly reduce annual weeds. Perennial weeds can be spread by cultivation and should be removed by other methods.

Smothering. Mulches can be very effective in reducing weed germination or in some cases eliminating it altogether. Organic or plastic mulches or a technique called soil solarization can be used. Organic mulches ("yard waste") must be 4 to 6 inches deep depending upon the fineness of the mulch to prevent weed seed germination. Plastic mulches should be black or dark colored (not clear) and exclude light and should also have UV light inhibitors to protect the plastic from rapid photodecomposition. There are also many landscape fabric products available.

Soil solarization is an effective technique to kill weed seeds and seedlings by heating the soil. Till the area to be solarized, rake it very smooth, irrigate it well, and then cover the area with a 2 to 4 mil clear plastic. Make sure the edges are well sealed with soil and that the area stays moist. Light and heat are transmitted through the plastic, and after 4 to 6 weeks in inland areas and 8 weeks in coastal regions, the soil becomes sufficiently heated to kill weed seeds and some soilborne pathogens.

Other weed control cultural techniques include flaming, flooding, and crop rotation with frequent tillage.

Biological Control. Using natural enemies to control weeds has been effective on a few species. For example, puncturevine (*Tribulus terrestris*) is a weed that has been significantly suppressed by the importation of two beneficial insects that feed on puncturevine: a puncturevine seed weevil and a stem weevil.

Chemical Control. In some cases, weeds can get the best of any gardener, and an herbicide may be the solution. There are many types of herbicides, and some work on some weeds and in some planting situations and not in others. It is important to read the label and follow the recommendations exactly. There are *preemergent* and *postemergent herbicides*, *contact* and *systemic herbicides*, and *selective* and *nonselective herbicides*. The following definitions will help:

First, an herbicide may be either preemergent or postemergent.

Preemergent. Applied before the weeds emerge from the soil. Damages young seedlings as they germinate and try to emerge.

Postemergent. Applied after the weeds have emerged from the soil. Damages actively growing weeds.

Then the herbicide may work either as a contact herbicide or a systemic herbicide.

Contact herbicide. The chemical causes localized injury where it has come in contact with the plant. Some examples include cacodylic acid, diquat, Finale® (glufosinate), and soap (fatty acid) herbicides, such as Scythe® (pelargonic acid).

Systemic herbicide. The chemical moves within the plant causing injury throughout the plant. Examples include Roundup® (glyphosate), 2,4-D, MCPP, dicamba mixtures, or Turflon® (triclopyr).

Lastly, herbicides may be selective or nonselective.

Selective. Toxic to only certain plants or weeds, such as 2,4-D, which is selective to kill only broadleaf weeds and not grasses, or pendimethalin, which controls crabgrass but does not injure established turfgrass.

Nonselective. Generally toxic to all plants. These chemicals may be rate (dose) dependent in terms of their toxicity.

Weed Identification. Prior to using any herbicide, it is important to identify the weeds needing control and know about their life cycle. Know if a weed is an annual or perennial. If it is an annual weed, then is it a summer or winter annual? Know if it is a grass or a broadleaf plant. Also know where the weed is a major problem. Is it in the lawn, along ditchbanks, or only in the flower beds?

Common weeds in landscapes and their life cycles

Annuals: *Grasses* - annual bluegrass, crabgrass (large and smooth), goosegrass, Italian ryegrass. *Broadleafs* - clovers (black medic and CA burclover), chickweed, field madder, filaree, common groundsel, henbit, knotweed, mayweed, nettle, pineappleweed, prickly lettuce, purslane, scarlet pimpernel, shepherdspurse, Southern brassbuttons, sowthistle, speedwell, spurge (petty, prostrate, and spotted), spurweed, and swinecress.

Biennials: Cheeseweed (mallow, malva), wild carrot.

Perennials: *Grasses* - bermudagrass, dallisgrass, German velvetgrass, kikuyugrass. *Narrowleaf* - nutsedge (purple and yellow). *Broadleafs* - clover (white), dandelion, English daisy, mouseear chickweed, oxalis (creeping woodsorrel and bermuda buttercup), pearlwort, perennial morningglory, plantain (broadleaf and narrowleaf), and yarrow.

If you cannot identify the weed, there are numerous references, or you may contact your local nursery, University of California Master Gardeners or Farm Advisors for assistance.

Group I: Selective herbicides for home gardeners

Common name	Trade name(s)	Pre/post-emergence	Contact/systemic	Weeds controlled (special)
benefin	Balan	pre		grasses
bensulide	Betasan (others)	pre		grasses (henbit)
metolachlor	Pennant	pre		grasses (nutsedge)
oryzalin	Weed Stopper (Surflan)	pre		grasses, some broadleafs
pendimethalin	Pendulum (PreM)	pre		grasses, some broadleafs
prodiamine	Barricade	pre		grasses, broadleafs
trifluralin	Treflan	pre		grasses, some broadleafs
clethodim	Select	*post*	systemic	grasses
fluazifop	Fusilade (Grassout)	*post*	systemic	grasses (except annual bluegrass)
halosulfuron	Manage	*post*	systemic	nutsedge in turfgrass
MSMA	Weedhoe 108 (others)	*post*	systemic	grasses (nutsedge) in turfgrass
sethoxydim	Poast	*post*	systemic	grasses (except annual bluegrass)
DCPA	Dacthal (Prevent)	pre		broadleafs, grasses (spurge, crab, annual bluegrass)
diclobenil	Casoron	pre		broadleafs, some grasses (horsetail)
isoxaben	Gallery (Portrait)	pre		broadleafs (oxalis)
napropamide	Devrinol	pre		broadleafs
2,4-D	Weed-B-Gon (others)	*post*	systemic	broadleafs (dandelion)
dicamba		*post*	systemic	broadleafs (clover, Eng. daisy)
Mecoprop		*post*		broadleafs (clover, chickweed)
2,4-D, dicamba, Mecoprop	Trimec	*post*	systemic	broadleafs
triclopyr	Turflon (Brush-B-Gon)	*post*	systemic	broadleafs (clover, oxalis)

Group II: Nonselective herbicides for home gardeners

Common name	Trade name	Pre/post-emergence	Contact/systemic	Weeds controlled (special)
cacodylic acid	Weed Ender (Montar)	*post*	*contact*	grasses, most broadleafs
diquat	Weed & Grass Killer (Reward)	*post*	*contact*	broadleafs, most grasses
pelargonic acid	Scythe	*post*	*contact*	broadleafs, most grasses
sodium chlorate	Grass, Weed & Vegetation Killer	*post*	*contact*	annual and perennial grasses and broadleafs
glufosinate-ammonium	Finale	*post*	systemic	many
glyphosate	Roundup (Kleenup)	*post*	systemic	many
oxyfluorfen/ imazapyr	Triox	*post*	systemic	all vegetation

Read and understand all label directions before using any chemicals.

To simplify information, trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products which are not mentioned.

FABRICS AND MULCHES FOR WEED MANAGEMENT IN THE LANDSCAPE

Cheryl Wilen, Area IPM Advisor, UCCE Statewide IPM Project

Landscape fabrics, or geotextiles, are opaque high-strength polypropylene or polyethylene materials which are either spun-bonded or woven. They are generally black but gray and white fabric are also available. These materials inhibit the germination and rooting of seeds as does black plastic but the have the added advantage of allowing air and water to diffuse through them. These fabrics are best utilized in permanent plantings such as shrub beds and around trees. As most are not UV resistant, they must be covered with another mulch to prevent photodegredation as well as improving the appearance. Common mulches used to cover landscape fabrics are wood chips and gravel.

Landscape fabrics may not control some perennials such as yellow nutsedge or bermudagrass. These weeds can penetrate some landscape fabrics. We have found that Washingtonia palm seedlings will penetrate spunbound polypropylene rated at a puncture strength of 40 lb.

Landscape fabrics are usually available in rolls 3 to 6 feet wide and 25 to 250 feet long. There are a number of manufacturers including:

1. Dewitt™, Dewitt Co., Sikeston, MO
2. Duon™, Blunks Wholesale Supply Inc., Bridgeview, IL
3. Typar™, Remay, Inc., Old Hickory, TN
   (This company also manufacturers Biobarrier II™)
4. Visqueen™, Visqueen Film Products, Richmond, VA
5. Exxon™, Landscape Supply Inc., Roanoke,VA

Organic mulches, such as bark or wood chips, will also limit weed growth. Advantages include reducing moisture loss and soil compaction. However, the microorganisms breaking down the mulch draw nitrogen away from the plant. Additional nitrogen may be needed if the plants or a soil test indicate nitrogen deficiency.

Because organic materials do break down, they need to be replenished periodically, usually yearly. Additional mulch to bring the depth to 2-4 inches is recommended. Lesser amounts are not adequate for weed control and greater depths limit gas and water exchange. Deep mulch applied right against the stem or trunk of woody landscape plants may increase the likelihood of collar rot or other disease.

Other landscape mulches:

Stone, pebbles, and gravel: Used to achieve color and texture changes. These materials are fire resistant and do not break down. Weed control is variable depending on the weed spectrum of the planting and the size of the material.

Plastic film: Not recommended for landscape use because of limited gas exchange and water movement. If plastic is used, it should be the type specified as needle-punched or perforated to allow aeration and moisture penetration.

Determining how much rock or organic mulch to apply:

Loose mulch is typically sold in bags or in bulk, and is measured in cubic feet or cubic yards. To figure out the number of cubic feet needed, determine the area in square feet. Multiply that number by the depth of the mulch layer (also in feet). For example, a 3 inch depth would be 3in X12in/ft =0.25ft. Therefore, a 250 square foot area would need 250 X 0.25 = 62.5 cubic feet of mulch. To convert to cubic yards, divide the result by 27 (62.5/27= 2.3 cubic yards).

In new plantings, soil levels should be 1-3 inches below the level of sidewalks to keep the mulches, particularly rocks, contained. An alternative would be to use an edging material. Slope the soil towards the plants to before covering with mulch to allow water to move towards the plant.

We currently are examining some landscape fabrics and herbicides for weed control in the landscape. Herbicides we are testing include Gallery, Surflan, and Snapshot (a granular formulation of Gallery plus Treflan). Landscape fabrics used in the studies are Typar 3201G, Typar 3401G, and Biobarrier II, a landscape fabric that has a root inhibiting herbicide (trifluralin) inside nodules attached to the fabric.

In this ongoing study, we used a chipped wood mulch to cover the fabrics and planted roses. All herbicides were applied to bare ground. Predominant weeds were spurge and puncturevine.

Of the herbicides tested the combinations provided greater weed control than that of the single herbicide treatments. No phytotoxicity of the roses was observed. Landscape fabrics provided excellent weed control in this study. Additionally, roses in the mulched treatments (with or without fabric) were noticeably more vigorous than those in the unmulched treatments (data not shown).

	Riverside 90 days after treatment			
Treatment	%Cover		% Control	
None	84.75	a*	0.00	a*
Mulch alone	26.25	c	68.75	cd
Fabric 3201	5.00	cd	92.50	e
Fabric 3401	5.00	cd	93.75	e
Biobarrier	0.00	d	100	e
Gallery 1 lb a.i./A	58.75	b	38.75	bc
Surflan 4 lb a.i./A	21.25	cd	78.75	cde
Gallery 1 lb + Suflan 3 lb a.i./A	10.00	cd	86.25	de
Gallery1 lb + Suflan 4 lb a.i./A	17.50	cd	81.25	de
Snapshot 5 lb a.i./A	35.00	b	58.75	c

*Means within a column followed by the same letter are not significantly different at the P=0.05 level by Fischer's Protected t-test.

WEED MANAGEMENT FOR ROSES IN LANDSCAPE PLANTINGS

John Karlik
University of California Cooperative Extension, Kern County

Roses have been used in landscape plantings since antiquity. The legends of Persia and India mention these plants, and they appear on coins of ancient Rhodes. The Romans made the rose a part of pageantry, perfumes and parties. At one occasion petals were so deep some guests suffocated, probably after drinking too much rose wine.

Roses are the most popular woody shrub in residential plantings in the U.S., present on the grounds of about 27% of households. In addition to their use in the garden, the ease of care, color and versatility of roses are strong recommendations for their use as flowering shrubs in landscape plantings. A wide range of colors and plant forms is available, and roses can contribute flowers to the landscape palette throughout the growing season. However, landscape managers may have reservations about using these plants more widely or in commercial settings because of a perceived need for frequent attention and pest control, including weed management.

It is possible to grow roses with a minimum of attention by following a systems approach. Variety selection is the first consideration in minimizing pest problems, including weeds, in a rose planting. Maintaining a suitable growing environment is the second consideration followed by appropriate treatment of pest problems, should they occur.

Variety Selection

Genetic improvement leading to the development of new varieties specifically for use in landscape plantings is reason to reconsider the place of roses. The heights, colors and forms now available suggest that roses be thought of as floriferous shrubs, with fits in the landscape palette surpassing their uses in garden settings.

Landscape roses refer to cultivars developed for use as floriferous shrubs and groundcovers. Landscape roses are sometimes called shrub roses, a term which refers to plants of intermediate size with an emphasis on constant flowering and attractive habit. The Meidiland Series of C.P. Meilland and the Florascape Series of Bear Creek Corp. contain examples of landscape roses. Rose varieties developed for landscape use usually require less maintenance, including weeding, than most garden varieties because their vigor and growing characteristics may help suppress weeds. Planting sites may have full sun to semi-shade but roses prefer four or more hours of sun. Spacing in the landscape will depend on mature size, but groundcover varieties can be planted 4-6 feet on-center, and hedge varieties 4-6 feet apart. Plant height and width will be affected by climate; roses in warmer climates will be taller and wider than those in cooler regions.

Because landscape varieties are own-root plants, they can resprout from the ground true-to-variety if tops are killed. There are selections available especially bred for cold hardiness, with the added benefit that cold hardy varieties often have outstanding disease resistance. Most landscape varieties are listed to -30°F, and therefore will be adaptable throughout California.

Colors and Forms of Landscape Varieties

Colors available in landscape varieties include red, fluorescent red, pink, white, orange, yellow, lavender and color blends and stripes. Forms available include uprights, mounding shrubs and groundcovers.

Upright plants grow as medium-to-large shrubs with uniform foliage and bloom. These varieties can be used as border plantings, screens, or for accents on vertical lines. Multiple plantings can be maintained as an informal hedge. Upright varieties include:

'Sevillana'--A variety five feet in height with a width of four feet. Orange-red flowers.

'Pink Meidiland'--Three to four feet in height. Single two-and-a-half inch salmon flowers.

'Simplicity'--Four to seven feet in height. Single pink two-to-three inch flowers.

Mounding shrub roses are more rambling than upright varieties. Uses include borders and mass plantings. Mounding shrubs include:

'Flutterbye'--Clusters of flowers on a vigorous plant. Canes may reach 10 feet in mild climates, four feet in the North. Flowers progress in color as they age, opening yellow, then peach, coral and pink.

'Lady of the Dawn'--Clusters of ruffled blooms in soft cream edged in pink. Plants reach four feet with an arching growth habit.

'Lavender Dream'--Single two-inch lavender flowers in loose clusters on a six-by-six foot plant, fine textured wood.

'Scarlet Meidiland'--Semi-double one-inch flowers in clusters on a three-to-four foot mounding plant.

Groundcovers are low-growing varieties useful in covering banks, along walkways, or as a cascade over walls. Some varieties reach two-and-a-half feet in height. Groundcover varieties include:

'Alba Meidiland'--Two-and-a-half feet in height, six foot spread. Small creamy-white clusters of semidouble slightly-fragrant flowers.

'Baby Blanket'--Light pink blooms. Plants are three feet tall with a five foot spread.

'Carefree Delight'--Two-and-a-half to three feet in height, spread of four to five-and-a-half feet. Medium-pink one-and-one-half inch single flowers.

'The Fairy'--One-and-one-half feet in height, three foot spread. Pink one-inch double flowers.

'Flower Carpet'--Perhaps one foot in height, two to three foot spread. Pink.

'Ralph's Creeper'--Three feet in height, five foot spread. Red-yellow bicolor semidouble flowers.

'Red Ribbons'--Four feet in height, two-and-a-half foot spread. Clusters of bright red, semidouble flowers.

'Red Meidiland'--Two feet in height with a spread of five feet. Single flowers two-and-a-half inches in diameter.

'Sea Foam'--Like 'The Fairy' but with white to cream flowers.

Environmental Management

The environment around rose plants will affect pest pressure. About two-thirds of the U.S. supply of rose plants is produced in the southern San Joaquin Valley, and it is obvious in the field that roses grow very well in full sun, with sufficient irrigation. However, roses do not grow well if over-irrigated. Too much water leads to chlorosis, leaf drop and sometimes marginal necrosis of leaves, and may favor shallow-rooted weeds. In the landscape, roses grow well when irrigated with drip systems, which, by limiting distribution of water tend to reduce summer weed populations.

Mulches may be used in rose plantings to suppress weed growth and have added benefits such as conserving soil moisture. Wood chips or bark are especially beneficial at depths of 2-4 inches. Rock mulches are less desirable because sunburn to canes may result from reflected solar radiation.

Herbicides For Use Around Landscape Roses

Many herbicides have been evaluated over the years for use in rose production fields. For landscape plantings, several herbicides may be used, if labels permit, to reduce weed populations around roses. In tests, the pre-emergent herbicides oryzalin (Surflan), pendimethalin (Pendulum), fluazifop-p-butyl (Fulisade, Ornamec), sethoxydim (Poast) and clethodim (Select) did not injure plants when applied at label rates over-the-top of plants just emerging from dormancy (early February). Similarly, when applied over-the-top of growing plants in early summer (late May), fluazifop-p-butyl, sethoxydim and clethodim did not injure rose plants.

However, injury occurred to growing rose plants from over-the-top applications of herbicides containing phenoxy herbicides or analogs (e.g. Trimec) or herbicides containing glyphosate (Roundup). Injury was moderate when application of phenoxy compounds or glyphosate was made over-the-top as roses began emerge from dormancy. Early summer application of these herbicides caused severe injury. Roses are quite sensitive to glyphosate, which may be absorbed through green stems in addition to leaves. Low rates of glyphosate may not kill plants immediately but injury may be apparent the following season.

Isoxaben (Gallery) may be useful because of its weed spectrum and is probably not phytotoxic if used at low rates, although isoxaben has not been evaluated by us in landscape rose plantings.

PREVENTING WEED INVASION IN LAWNS THROUGH CULTURAL MANAGEMENT

M. Ali Harivandi
University of California Cooperative Extension

Nearly all weeds which infest lawns in California can be controlled by currently-available herbicides. While chemical weed control should not be totally ruled out, proper lawn management can prevent a significant portion of weed problems and should be considered the foundation of weed control.

Weeds are generally defined as "plants growing where they are not wanted." Thus a tall fescue lawn is perfectly acceptable, while a few tall fescue plants growing in a bluegrass lawn will be objectionable weeds. Generally, weed growth in a lawn is encouraged by inadequate turf cover--i.e., a thin lawn with bare spots. Environmental conditions, including excessive traffic, and poor management practices are the primary causes of thin lawns. Long periods of drought, temperature extremes, over-irrigation, inadequate fertility, and poor mowing practices can all lead to thinning of a turf stand. Small animals, insects and turf diseases, misuse of herbicides, and heavy foot traffic can also destroy sufficient turf to leave a stand vulnerable to weed invasion.

The information most valuable for lawn weed control is knowledge of the most appropriate grass for a given situation, and the prevailing weed species found in the geographical area where this grass will be grown. Armed with such data, a turf manager/home owner can create an environment and a management program which favor the desired grass over the weeds.

Selecting a lawn grass adapted to one's locality is a good first step toward insuring a healthy, dense lawn which can resist weed invasion. Lawn grass selection should be based on cultivar evaluations conducted at local universities over a number of years. It is always advisable to use a blend of adapted cultivars rather than a single cultivar, since monostands (i.e., a turf stand composed of a single cultivar) are more limited in the range of conditions under which they perform well. At least three cultivars of one turf species should be used in a lawn grass blend.

Areas of lawn management which affect lawn performance are irrigation, fertilization, mowing and aeration.

Irrigation. Established lawns benefit from deep but infrequent watering. On clay soils in most areas of California, 1 to 1 ½ inch irrigation once a week is sufficient. If a lawn is sloped, or soil is too impermeable to accept this much water in one irrigation, applying half as much every three days should be considered. It is always best to let surface soil dry between irrigations; this practice helps reduce weed seed germination and survival.

Fertilization. Most California soils are deficient in nitrogen, the nutrient required in largest quantity by lawn grasses. Nitrogen fertilization is therefore necessary, and should occur during the optimum period for lawn grass growth: spring and fall for cool-season grasses like tall fescue; and monthly during the active growing period (mid-spring to mid-fall) for warm-season grasses like bermudagrass. Cool-season grasses need 4 to 6 pounds of nitrogen per 1000 ft^2 per year, while bermudagrass benefits from ½ to 1 pound of nitrogen per 1000 ft^2 per growing month. Both cool- and warm-season grasses benefit from annual application of 1 to 2 pounds per 1000 ft^2 of each of phosphorous and potassium. Irrigating after any fertilization is recommended to move nutrients into the grass rootzone for efficient uptake. Nitrogen should not be applied to cool-season grasses during hot summer months, or to warm-season grasses during cold winter months; applying nitrogen at these times will encourage weed growth.

Mowing. Mowing grasses to the correct height helps them compete against weeds. The recommended mowing height for Kentucky bluegrass and perennial ryegrass is between 1 ½ and 2 ½ inches. Tall fescue can be mowed to 1 ½ to 3 inches. Bermudagrass lawns should be mowed between 1 and 2 inches. Most annual weed seeds require considerable light to germinate. The above mowing heights allow each variety to maintain a dense canopy that restricts light penetration to the soil surface and thus inhibits weed germination. It is also important to mow weekly or even more frequently. Lawn scalping due to infrequent mowing is highly conducive to weed invasion.

Aeration. Highly trafficked lawns, especially those planted on clay soils, are prone to compaction. Soil compaction reduces air, water and nutrient penetration into the root zone, creating an unhealthy environment for lawn grass growth. Several weeds (e.g. goosegrass) actually thrive in such conditions. Core aeration once or twice per year will reduce the effects of compaction by increasing air and water movement into the rootzone. However, timing of core aeration is critical in terms of weed management. As mentioned above, a dense turf canopy is an effective barrier to weed seed germination. Because core aeration opens the canopy, it should be avoided when annual weeds are germinating. In most of California, late spring and early fall for cool-season grasses, and summer months for warm-season grasses, are the best times for core aeration. Although some weed seeds germinate at all times of the year, these periods coincide with the period of most vigorous lawn grass growth, and thereby offer the greatest likelihood that the grasses can win the competition with weeds.

In summary, the best lawn management program tailors irrigation, fertilization, mowing and core aeration to minimize weed germination and maximize the competitiveness of lawn grasses. Locally adapted lawn grass species and cultivars, sound cultural practices and a judicious use of herbicides will contribute to a clean environment and produce healthy, vibrant lawns for all to enjoy.

PRESIDENTIAL ADDRESS

Ron Vargas
University of California Cooperative Extension

It is indeed my pleasure to welcome each and every one of you to our 50th Annual California Weed Conference, truly a golden celebration as we commemorate 50 years of excellence and look forward to 50 years of promise. I especially want to welcome the students here with us today. They will be the ones that meet the challenges and chart the next 50 years for our society. I would like to encourage all the students to attend the student breakfast tomorrow morning from 7 - 8 a.m.

It has certainly been an exciting and productive year as your President and an honor to serve you alongside the many volunteers who support the California Weed Science Society with their time and talents.

Although time does not permit me to recognize you all by name, I would like to personally thank each individual who has served the society this year. Scott Johnson, your Vice President and Program Chair, along with his committee, has done an excellent job of putting together a 50th anniversary program focusing on "Fifty Years of Excellence - Fifty Years of Promise." Speakers will review weed science of the past and look at weed science into the 21st century.

The California Weed Science Society continues to grow as a result of your participation and attendance. Remember, as registered attendees, you are members of the society. Past board members have done an excellent job of maintaining and building the Society's financial assets, which are generated from the conference registration fees and sales of our textbook. Our financial situation now allows the Society to promote activities consistent with our research and educational objectives, which extends the Science of Weed Management on behalf of our membership. The Society has committed funds to the following activities and projects:

1. $45,000 - third revision of our textbook - "Principles of Weed Control in California" which will be titled "Weed Management." Jim Griel and Brenda Smith, project coordinators, have scheduled a completion date of January 1999.

2. $90,000 - sponsorship of a new weed identification manual titled "Weeds of California," that includes detailed descriptions of plant characteristics from seed and seedling to senescence of more than 600 weed species. Joe DiTomaso is the principal author and work has already begun with a planned completion date of 2001. The Society will receive royalties from the sale of each book and within a four to five-year period recoup its $90,000 investment. Future profits then can be used for new projects.

3. $20,000 - Scholarship Endowment Fund - interest from this fund will be used to provide $1,000.00 in college scholarships with plans to increase that amount in the future.

4. $10,000 - Educational Endowment Fund - interest to be used to fund special educational projects such as a weed loss and herbicide use study.

5. $2,500.00 - donated to the Stanley W. Strew Educational Fund Inc. for CAPCA's Plant Doctor program.

6. $1,500 - 2,000.00 - to support students that attend our conference and provide awards to student posters.

Besides these projects, the Board has committed to maintain a reserve of two ½ times our annual operating cost to insure the future of the Society. As your President, I am truly excited and proud of the commitments the Society has made to improve and further the Weed Science discipline.

As noted earlier, this year's conference theme is "Fifty Years of Excellence - Fifty Years of Promise." That excellence all began in 1949 when the first California Weed Conference was held in Sacramento in the Governor Hall at the State Fairgrounds. A small group of individuals including Walter Ball, Alden Crafts, Norm A. Kesson, Milton Miller, Loren Davis and Murry Pryor saw a need for weed control information and they began what has truly been 50 years of excellence in weed science. I am not going dwell on our history because I think we need to focus on the future and the promise of the next 50 years. But, during the past 50 years, there have been tremendous changes in the field of weed science and our organization. We have progressed from:

- focusing the control of a single weed species to integrated control systems,

- from herbicides applied in pounds per acre to oz per acre,
- from simple control to a fuller understanding of weed biology and weed/crop interaction,
- from less sophisticated cultivation equipment to precision cultivation equipment,
- from broad spectrum non selective herbicides to specific selective herbicides,
- from research to answer short term problems to long term, systems research requiring a full understanding of the entire agricultural ecosystem,
- from few regulations to seemingly burdensome regulations.

And as an organization, we have moved from a conference (CWC) to a society (CWSS) which allows us to better meet the needs of our membership in addressing ever-increasing challenges in the changing environment in which agriculture operates while maintaining the original objectives set forth by our constitution:

Let me give a few examples that illustrate the excellence of our past 50 years. These examples are a result of cooperative efforts between private sector, USDA, CDFA and the University of California. I know many can provide other examples and many more will be discussed during our concurrent sessions.

Annual and Perennial Grasses

During the 50s, 60s and 70s annual and perennial grasses competed heavily across all crop areas causing economic losses in agronomic, vegetable, fruit and nut crops, vineyards and turf and ornamentals. Options were quite limited including, MSMA, Dalapon and diesel oil with hand weeding and cultivation being essential. Johnsongrass caused severe economic losses in agronomic, vegetable and non-bearing tree and vine crops.

With the development of glyphosate, then post selective grass herbicides, Poast, Fusilade and Prism in the 80s, control of grasses entered a new era. Johnsongrass could be easily controlled with Roundup and now both annual and perennial grasses can be eliminated in most commodities by over the top applications of selective grass herbicides. And, whoever would have thought it possible to selectively remove wild oats from wheat or barley, as can now be done with Avenge?

Foxtail - Setaria sp.

By 1983 yellow and green foxtail had become the number one summer annual weed infesting thousands of acres of alfalfa hay in the Sacramento and San Joaquin Valleys. Foxtail was causing mouth ulcerations in animals, reducing feed palatability and decreasing milk production. To alfalfa hay producers, foxtail meant lower yields, shorter stand life, lower protein and discounted hay prices.

But today, yellow and green foxtail are no longer a problem. University and private company research resulted in the development of herbicides and an integrated control program that are still used today. With timely applications of Treflan TR-10 in the winter, before foxtail emergence, and followed by a post selective grass herbicide, yellow and green foxtail no longer cause million-dollar losses.

Nightshade

More recently, hairy and black nightshade have infested thousands of acres of both cotton and tomatoes in the Central Valley of California. Tolerant to DNA herbicides, growers were left with few alternatives beyond cultivations, and hand weeding and removal from fields. Hand labor costs were becoming prohibitive at $150-200 per acre.

Relief from these competitive weeds was first realized with the metham sodium applied preplant by sprinklers or with spray blades. The development of sulfonylurea herbicides Staple in cotton, and now Shadeout in tomatoes has almost entirely eliminated the need for hand hoeing, saving growers millions of dollars per year.

Orchard and Vineyards

Weed control programs for orchard and vineyards have moved from repeated cultivations and the use of soil sterilants such as sodium chlorate, borax and carbon bisulfide which were often injurious to the crop, to sophisticated weed management programs integrating cover crops, and mowing with weed free strips down the tree or vine row. Preemergence, and postemergence herbicides are available to taylor weed programs to field-specific problems in both bearing and non-bearing orchard and vineyards.

St. Johnswort/Klamath Weed

St. Johnswort or Klamath weed was found in northern California in the early 1900s and by 1944 thousands of acres of rangeland had been rendered useless for grazing by this invasive, poisonous weed. Borax or boric acid, either by itself, or in combination with sodium chlorate was used as a soil sterilant for control. But by 1950 the entire infested area in California was colonized by Klamath weed beetles and by 1956 dense, extensive stands of the weed were devastated and continue to be kept in check today, returning rangelands to their original productive state. This is probably one of the most successful cases of weed control through the use of plant feeding insects.

Hydrilla

The control and eradication branch of the California Department of Agriculture, have prevented the widespread distribution of noxious weeds. For example, hydrilla, a submersed aquatic plant listed on the federal and state noxious weed list, was first found in California in 1976. After this initial discovery, hydrilla was found in 18 counties and by 1985 over 900 miles of canals were infested in Imperial County and in 1989 Eastman Lake in Madera was closed to public use because of hydrilla infestation.

Today, due to the efforts of CDFA eradication programs, only 2 small sites remain in the Imperial County irrigation canal system and Eastman Lake is again open for recreational use. Hydrilla infestations are now only found in 7 of the 18 counties and occurrences and areas of infestations continue to decline.

Let me now turn your attention to the next 50 years and the new technology that is going to take us into the 21st century. As you know, accelerated population growth, urbanization of California, increased competition for land and other natural resources, efforts to protect the environment and rising public concern about food safety will have profound implications on weed science and production of food and fiber. Our very large and diverse agricultural system in California must coexist with an overwhelmingly urban population. Weed management in the next 50 years will certainly be a challenge. Those challenges will be met through research and new technology:

Biotechnology

Crop variety development and testing have entered into a new phase with the advent of transgenic varieties. Herbicide tolerant crops such as soybeans, cotton, corn and rice are becoming a reality across the US. Today in California, transgenic herbicide tolerant cotton varieties are being developed and tested and will be available to growers in the year 2000. Herbicide tolerant corn will be tested in 1998. Rice won't be far behind. The availability of herbicide tolerant crops will offer a valuable alternative strategy for weed management. But, as with any new technology, a number of issues and concerns are raised.

1. Effects on herbicide use? If a crop is tolerant to a non selective herbicide such as Roundup, can all other herbicides in the system by eliminated? Will it be necessary to use preplant, preemergence, post emergence or over the top selective herbicides? Will herbicide tolerant crops allow replacement of herbicides that are used in higher doses with those used at lower doses?

   Will herbicide tolerant crops cause growers to solely rely on herbicides for their weed problems, resulting in greater herbicide use?

2. Can cultivation and hand weeding be reduced or eliminated? With herbicide tolerant crops, will minimum or no till production systems be developed in California? Will herbicide tolerant crops allow the elimination of hand weeding and what will be the economic "trade off?"

3. Crop productivity, quality and safety? The implications of genetic engineering as a process in developing herbicide tolerant crops, raises the question of maintaining current yield and quality levels as well as food safety?

4. Weed Resistance - Will herbicide tolerant crops lead to weed species resistance or an increase in hard-to-control perennials?

5. Environmental Effects - What effect will herbicide tolerant crops have on air, water and soil quality? The San Joaquin Valley is a non attainment area for PM_{10} and ozone levels in the atmosphere. Will herbicide tolerant crops result in less cultivation, ultimately reducing the amount of dust and PM_{10}

particles released into the atmosphere. Will soil and water quality be effected by the elimination of residual herbicides in the soil which have a potential of effecting subsequent rotational crops and movement into the ground water supplies?

6. Economic effects - Will herbicide tolerant crops result in more economical weed strategies for growers? If cropping systems are developed that rely only on a few non selective herbicides; what effect will that have on the development and commercialization of new alternative herbicides? Will this technology lead to a complete restructuring of the ag chemical marketing system?

   As herbicide tolerant crops become available to California growers these and many other questions will be answered. It is certain that weed management systems will certainly evolve and change as growers integrate this technology into their production systems.

Application Technology & Equipment

Postemergent herbicides are applied to existing target weeds, but in most situations large areas are sprayed that have no weeds. Sprayers activated by lightwaves reflected from chlorophyll are now being used and will continue to be developed and perfected for weed management programs. Currently best suited to permanent tree and vine crops, this technology is starting to be adapted for use in field and row crops. Just imagine the reduction of herbicides applied to the environment and the reduced weed control cost with this system.

Mechanical cultivation, coupled with hand hoeing is an integral part of any weed management program. However, hand labor costs continue to increase, making hand hoeing cost prohibitive. The development of intelligent cultivation equipment (robotic cultivation) using advance machine vision made possible by the use of computers and computer imagery will provide automated cultivation systems that will not only efficiently remove weeds between rows, but also remove weeds within crop rows.

Precision or Site Specific Agriculture or Site-Specific Weed Management

The fundamental principle of precision farming is that this technology will provide us with ways to manage within field variability. A system of 24 satellites orbiting our planet make it possible to locate precise points on the earth's surface. When coupled with remote sensing growers will be able to develop weed control strategies not field by field as we do today, but for specific problem sites within fields. Weed infestations will be identified, mapped for future reference and control measures applied. Again, consider the cost savings and reduction in herbicides applied to our environment when only applied to specific targeted areas within a field, instead of the entire field.

Computer Technology

Of course computer technology will only continue to develop and change, improving precision agriculture, robotic cultivation as well as providing vital information, via the world wide web and the Internet, needed to maintain a viable agriculture.

Chemical Technology

Chemical technology has been extremely important to the success of agriculture and will be in the future. Targeted, more selective, and safer herbicides are being and will continue to be developed.

These are just a few of the technologies that will help us meet the challenges of the next 50 years. Another challenge will be helping the general public appreciate our bountiful and healthful food supply and the research that maintains it. So in closing I would propose the following challenges to each of you:

1. Fully recognize environmental concerns and address them in a professional manner.

2. Work cooperatively with urban and environmental groups to address problems and develop solutions.

3. Get involved at your local level with city councils, county planning commissions, and with public policy issues that deal with agriculture and pest management problems.

Most of all,

4. Become a spokesperson for agriculture and brag about what agriculture is doing to help conserve the environment and,

5. Be a creditable source of information to continue to advance weed science into the 21st century.

And lastly, I urge you to attend the meetings and educational posters and exhibits and invite you to become actively involved in your society. Our Society is now a half century old and I am confident the California Weed Science Society will meet whatever the future holds for us with the same enthusiasm, flexibility and professionalism of the past.

CROP PROTECTION IN THE FUTURE

JOSEPH CORNELIUS

MONSANTO COMPANY

By the year 2020, the global population is expected to increase by more than 40 percent, possibly surpassing the 8 billion mark. Feeding these additional billions, with a limited supply of suitable farmland, poses a dilemma of immense proportions. One answer may lie in agricultural biotechnology, which makes agricultural production more efficient.

As a world leader in plant and animal biotechnology research, Monsanto is finding new ways to protect crops, enhance yields and even improve the processing properties or flavor of foods.

The benefits of agricultural biotechnology are of particular importance to people living in developing nations. There, genetically improved seeds and other products will improve crop yields and quality and make farming possible in areas previously unsuitable for food production.

Among the current genetically improved, value-added products are:

Insect-protected cotton with the Bollgard® gene protects against cotton bollworms, pink bollworms and tobacco budworms. As a result, cotton growers can use significantly less chemical insecticides over their fields. NewLeaf® insect-protected potatoes offer protection against the Colorado potato beetle, the most damaging insect pest in potato crops. YieldGard® insect-protected corn protects against the European corn borer and related insect pests such as the Southwestern corn borer. Soybeans, cotton and canola with the Roundup Ready® gene are genetically improved for tolerance to Roundup® herbicide. These technologies let farmers use this environmentally responsible product for weed control during the growing season, resulting in savings and efficiency for growers. Posilac® bovine somatotropin helps dairy cows produce milk more efficiently, without any loss in quality or natural wholesomeness.

®Bollgard, NewLeaf, YieldGard, Roundup, Roundup Ready, and Posilac are trademarks of Monsanto Company.

Topdressing Compost on Turfgrass: Its Effect on Turf Quality and Weeds

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Roland D. Meyer, Extension Soils Scientist, U.C. Davis

Introduction

California's Integrated Waste Management Act (AB 939) requires California to reduce landfill waste by 50% by the year 2000. Since yard waste comprises approximately 25% of the solid waste sent to landfills, many municipalities have implemented a green waste pick-up and composting program. This has generated tons of compost, and ways to use it efficiently and effectively are now being sought. Possible applications of compost could include topdressings for school grounds, golf courses, community recreation fields, and parks.

Field studies were conducted from October 1994 to December 1997 in Fresno, CA to assess the feasibility of compost topdressing on turfgrass, compare compost topdressing with conventional fertilizer applications, determine optimum depth and timing of compost applications, and evaluate the benefits and risks of compost topdressings from cultural and financial perspectives.

The primary objective was to evaluate the utility of fall applications of varying depths of compost as compared to a check, conventional fertilizers, steer manure, and slow release fertilizer applications over a three year period, with and without aeration. Shifts in weed populations, turfgrass quality, density and color were evaluated regularly throughout the year. Preliminary reports presenting research results from 1994-95 and 1995-96 were published in the 48th and 49th Conference Proceedings of the CA Weed Science Society. This report summarizes some of the results obtained over the last three years.

Materials and Methods

The trial was initiated in October 1994 at California State University, Fresno. This site has overhead sprinklers and is uniformly irrigated. It consists of a well established common bermuda grass lawn planted in a sandy loam soil. The site is occasionally utilized as a practice band field. The field was uniform in weed population density and composition at the beginning of the trial. Plots were 10' X 18' and were arranged in a split plot design with four replications of each treatment. The main plots were either aerified or not. The subplots were either a fertilizer treatment, compost treatment, or an untreated check.

The fertilizer treatments were applied to yield 4 pounds of actual nitrogen per 1000 square feet per year. A single application of steer manure and slow release fertilizer (Once® by Sierra) were made in October of 1994, 1995, and 1996, while ammonium sulfate applications were made in October, April, July and September of each year. The compost treatments included single and multiple applications. The single application compost treatments were applied at 1/8, 1/4, ½ and 1 inch depths. It is estimated that a 1-inch topdressing equals 9.2 pounds nitrogen per 1000 square feet (1/2" = 4.6, 1/4 = 2.3 and 1/8"=1.2 pounds). Multiple applications were also applied two or four times per year to equal a total of 1 inch of compost applied annually. They were 1/2 inch applied 2 times per year in October and July, and 1/4 inch of compost applied 4 times per year in October, April, July, and September.

Results

Turf Color and Dormancy (Figure 1): All plots were visually evaluated on a scale of 1 to 9 (9 being the best) for green color throughout the year and for the onset of dormancy in the late fall. The three year average overall seasons revealed that all treated plots were greener color than the untreated check plots and that dormancy was delayed. The untreated check plots ranged from a winter low of 2.25 to a summer high of 3.5. The average of all fertilizer treatments (represented by the shaded area in the figure) ranged from a winter low of 3.5 to a summer high of 5.5. The 1/8" compost application closely resembled the fertilizer applications in the fall and winter, while the 1/4" compost application closely resembled the fertilized plots in the spring. As more compost topdressing was applied (1/4, ½, and 1") turf color improved and the onset of dormancy was delayed.

Turf Quality (Figures 2 & 3): Turf quality includes stand uniformity, density, turf color, and the presence/absence of weeds. The visual rating scale ranged from 1 to 9. (A rating of 9 is most desirable; 5 is considered marginally acceptable). Untreated check plots averaged a rating of 4 in quality over all seasons. Fertilized plots (represented by the shaded area on the figure) were higher in quality than the untreated check plots and averaged close to a rating of 5 with a slight decrease in winter. The 1/8", 1/4", and 1/2" compost applications were nearly equal in quality to the fertilizer treatments. All 1" compost plots were higher in quality than the check plots throughout the entire year except in winter, when there was a short term negative effect on density and stand uniformity. It was also observed that a weekly mow schedule was sometimes too infrequent in the 1/2" and 1" compost applications. Scalping resulted and turf quality declined. Shifting from a single 1" application to multiple (2 x 1/2" and 4 x 1/4") applications increased turf quality ratings over the year. (Figure 3). The most consistent and highest quality ratings were achieved with 4 X 1/4" compost applications.

Weed Populations (Figures 4-6): Two weed population peaks were observed per year. (Figure 4). These were associated with winter populations of annual bluegrass (*Poa annua*) and summer populations of crabgrass (*Digitaria spp.*) Weed populations were lowest in fall as this was the time between summer and winter annual growth cycles. The 1" and ½" compost plots had lower winter weed populations than the check, fertilizer treatments (shaded area in figure), and 1/8" and 1/4" compost applications. (Figure 5). All plots were abundant with crabgrass, however fertilizer treatments averaged significantly lower percentages than the check in summer. The lowest weed populations were observed in the 4 X 1/4" compost applications. (Figure 6). This treatment was optimal for keeping summer annual weed populations at 20% or less, winter weed populations at lower percentages than the check and fertilized plots, and simultaneously maintained the highest turf quality ratings.

Conclusions

It is feasible to apply compost topdressing on municipal turfgrass sites and experience a positive cultural effect. Compost applications of 1/4, 1/2, and 1" depths applied to turf in late fall resulted in an improvement of turf color throughout the year and delayed the onset of dormancy. Consistently high quality turfgrass ratings and low weed populations of annual bluegrass and crabgrass were obtained when 4 X 1/4" compost topdressings were applied throughout the year (October, April, June, and August).

Figure 1

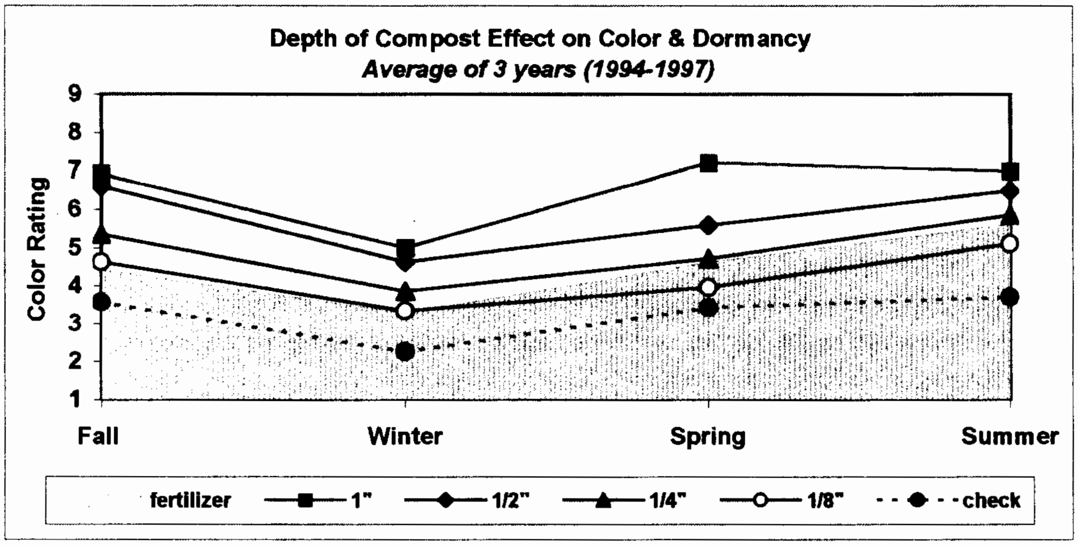


Figure 2

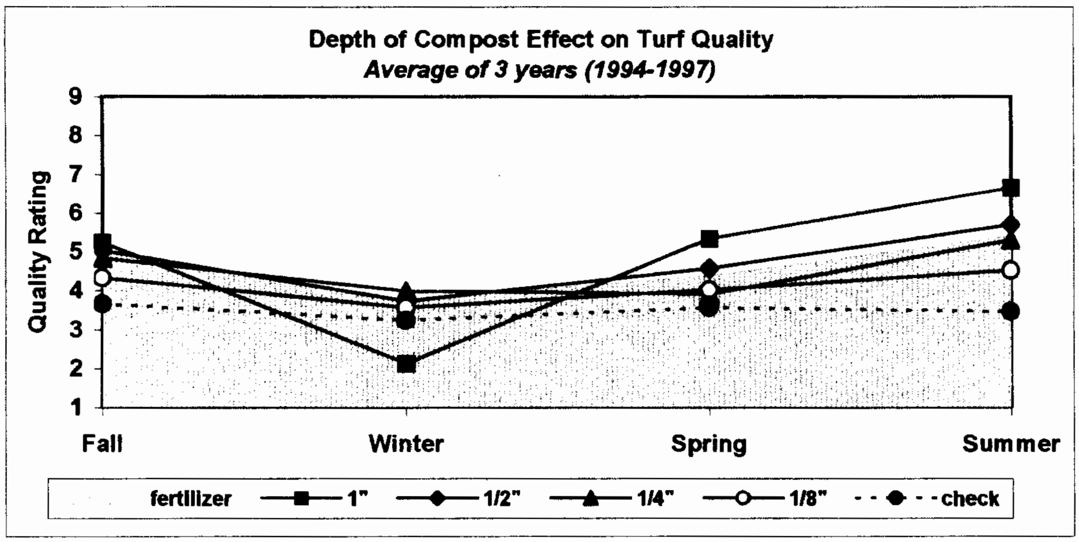


Figure 3

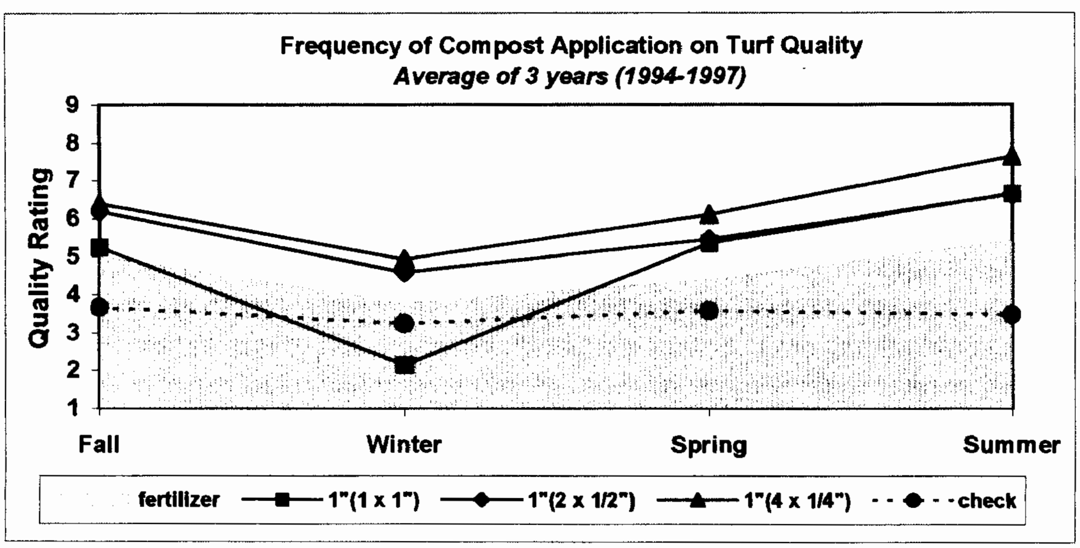


Figure 4

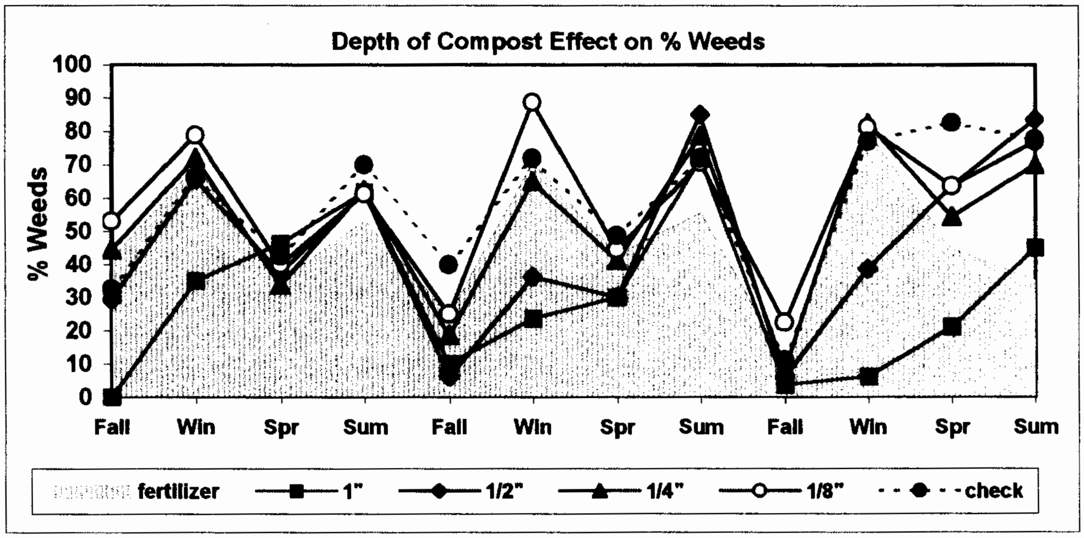


Figure 5

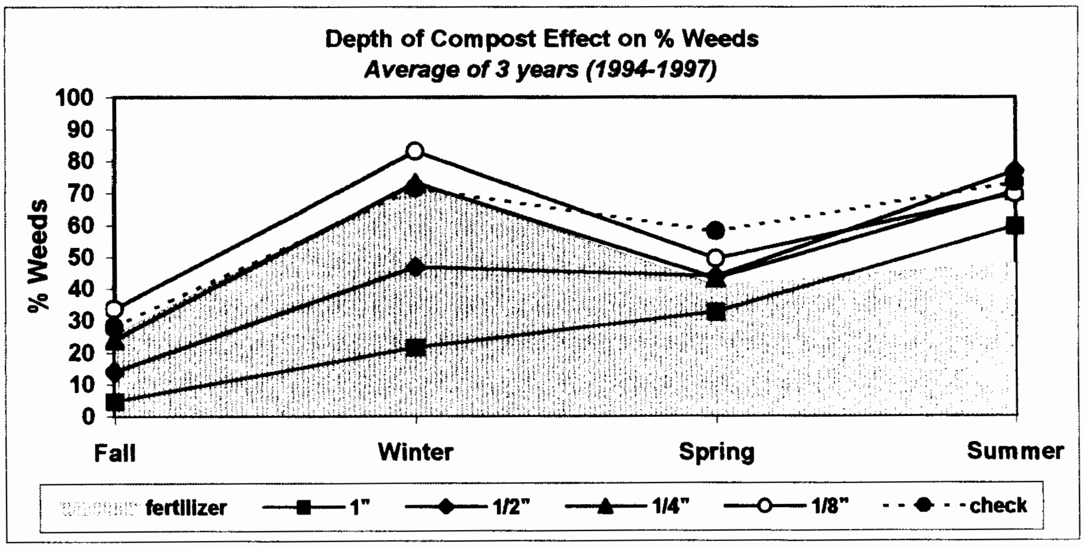
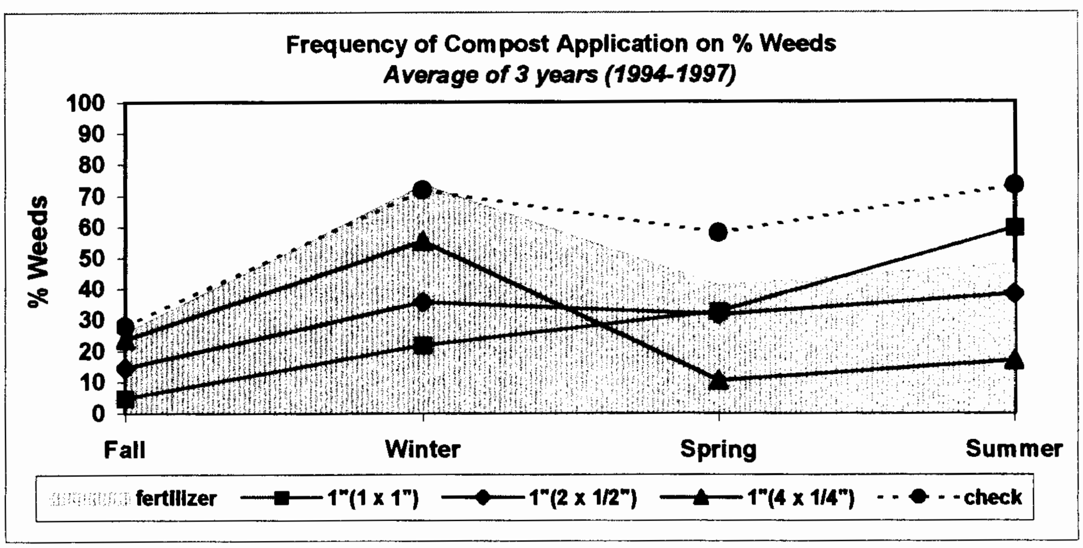


Figure 6



Control of English Lawn Daisy *(Bellis perennis)* in Cool Season Turf

Mark M. Mahady
Mark M. Mahady & Associates

Introduction

English lawn daisy or English daisy (*Bellis perennis L.*) is the most troublesome and difficult to control broadleaf turfgrass weed in California. English daisy continues to flourish in turf stands and frustrate turf managers due to its ability to adapt to a wide range of cultural practices, and to resist and tolerate many of the presently registered broadleaf herbicides.

English daisy is a fibrous rooted perennial with basal leaves and a prostrate, spreading growth habit. The leaves are nearly smooth or loosely hairy, entire margined or variably toothed, broad above, and narrowed at the base to a long stalk. Flower heads are white or pinkish with yellow centers. Flower stalks generally exceed the leaves in length.

This aggressive and troublesome weed spreads through a rapidly advancing rhizome system, and exhibits the potential to root and produce new plants at each node along individual rhizomes. English daisy also appears to be a prolific seed producer. Germinating seedlings have been observed at the Rancho Cañada Golf Club in Carmel Valley, CA from April until late September. Once established in turf this dual propagation system contributes to the rapid spread and invasion of English daisy in adjacent turfgrass areas.

English lawn daisy was introduced from Europe as a garden plant, and today there are approximately six species present in California.

Material and Methods

Field studies were conducted in rough and fairway setting at the Rancho Cañada Golf Club in Carmel, California during 1992-93, and Peter Hay Golf Course in Pebble Beach, California during 1997. These locations presents a specific California central coast micro-climate characterized by early morning fog, low clouds, and moderate temperatures (60-75° F) from April through August. Temperatures rarely exceed 85° F. Treatments were applied to representative stands of English daisy. Percent English daisy cover ratings were conducted on the day of initial treatment, and the randomization pattern established to reflect equal percentages of English daisy in each treatment. English daisy percent cover for each replication ranged from 34 to 64 percent with an average of 49 percent. The cool season grass rough area consisted of annual bluegrass (*Poa annua*), creeping bentgrass (*Agrostis palustris*), perennial ryegrass (*Lolium perenne*), and Kentucky bluegrass (*Poa pratensis*). Fairway areas consisted of perennial ryegrass and annual bluegrass. Rough areas were mowed at 1.5 inches and fairway areas at 0.625 inches, and were irrigated to prevent moisture stress.

In the rough field trial sequential applications of Confront* (triclopyr+clopyralid), Turflon Ester (triclopyr), and Trimec Amine Lawn Applicators Formula (2,4-D, MCPP, dicamba) were applied at four week intervals on April 30 and May 29, 1992. Single applications of Gallery 75 Dry Flowable (Isoxaben) were applied April 30 and November 13, 1992.

In the fairway field trial sequential applications of Confront, clopyralid, Turflon 4E, Dissolve, Triamine II, MCDA, DCDA, and Triplet were applied at the described rates and dates presented in Table 2. Two sequential applications of DOWXDE-565 at the described rates were applied on April 23 and May 14, 1997.

Treatments were applied using a CO2 propelled backpack sprayer equipped with a Tee-Jet 11004LP nozzle operating at 21 psi to deliver a spray volume of 1.5 gallons per thousand square feet. Field plots measured 5′ x 10′ with 2′ borders. Field plots were evaluated for turf injury, percent weed cover, and resulting percent weed control. Turf injury was rated on a 0 to 9 scale with 0 representing no injury, 3 minimally acceptable injury, and 9 dead turf. Percent weed control was computed by calculating the difference in weed cover on the day of application versus specific rating dates, dividing that difference by the percent cover day of application, and multiplying by 100.

Results of English Daisy Rough Trials

English daisy percent control ratings 45 weeks after the final sequential treatment are presented in Table 1.

Table 1. English daisy control in rough areas. Application dates 4/30 & 5/30/92. Rancho Canada Golf Club, Carmel, CA. MMM & Associates.

Treatments	Rate	45 WAT % Control
Confront/Gallery	0.5/0.75 lb AI/A	81.5
Confront	0.5 lb AI/A	71.2
Trimec Amine	1.0 lb/AI/A	48.8
Trimec/Gallery	1.0/0.75 AI/A	29.0
Turflon/Gallery	0.5/0.75 lb AI/A	16.3
Turflon 4E	0.5 lb AI/A	14.3
Gallery 75 DF	0.75 lb/AI/A	0.0
Check	*	0.0

Results of English Daisy Fairway Trials

Table 2. **English daisy fairway protocol. Peter Hay Golf Course. Pebble Beach, CA. 1997. MMM & Associates.**

	Treatments	Rate	Application
1)	Untreated Check	*	*
2)	Confront Liquid	2 pints/A	A: April 23, 1997
2)	Confront Liquid	2 pints/A	B: May 14, 1997
3)	Confront Granular	0.75 lb AI/A	A: April 23, 1997
3)	Confront Granular	0.75 lb AI/A	B: May 14, 1997
4)	Clopyralid	0.25 lb AI/A	A: April 23, 1997
4)	Clopyralid	0.25 lb AI/A	B: May 14, 1997
5)	Clopyralid	0.5 lb AI/A	A: April 23, 1997
6)	Dissolve + Turflon	40.0 oz/1.0 pints/A	A: April 23, 1997
6)	Dissolve + Turflon	40.0 oz/1.0 pints/A	B: May 14, 1997
6)	Triamine II + Turflon	4.0 pints/1.0 pints/A	C: June 4, 1997
7)	Triamine II + Turflon	4.0 pints/1.0 pints/A	A: April 23, 1997
7)	Triamine II + Turflon	4.0 pints/1.0 pints/A	B: May 14, 1997
7)	Triamine II + Turflon	4.0 pints/1.0 pints/A	C: June 4, 1997
8)	MCDA	2.66 pints/A	A: April 23, 1997
8)	MCDA	2.66 pints/A	B: May 14, 1997
8)	MCDA	2.66 pints/A	B: June 4, 1997
9)	DCDA	2.66 pints/A	A: April 23, 1997
9)	DCDA	2.66 pints/A	B: May 14, 1997
10)	Triplet + Turflon	4.0/1.0 pints/A	A: April 23, 1997
10)	Triplet + Turflon	4.0/1.0 pints/A	B: May 14, 1997
11)	DOW 565 + X-77	52.5 g/ha/0.25% VV	A: April 23, 1997
11)	DOW 565 + X-77	52.5 g/ha/0.25% VV	B: May 14, 1997

Sequential applications of Confront, clopyralid, Dissolve, Turflon, Triamine II, MCDA, DCDA, Triplet resulted in absolutely no control of English daisies under fairway settings. English daisy percent cover evaluations were actually greater at the end of the trial than on the first herbicide deployment date.

DowElanco XDE-565 eliminated flowering 7-14 DAT and induced a limp off color leaf tissue 21 DAT. At 21-28 DAT leaf necrosis appeared and plant tissue dissipated in the turf stand. Two sequential applications of XDE-565 (52.5 g/HA) resulted in 94% control of English daisy 63 days after treatment (DAT) and 77% control 120 DAT. Newly germinating English daisy seedlings were observed in treatment plots throughout the course of the field trial. To date DowElanco XDE-565 is the most promising postemergent herbicide ever reviewed for control of English daisy.

Take Home Message Rough Areas

- Maintain turf density.
- Utilize sequential spring applications of a three way herbicide mixture (eg. Trimec, Dissolve, Triplet + Turflon) when soil temperatures reach 55-60° F or utilize Confront when it receives registration in California.
- Utilize Dissolve when enhanced flower knockdown is desired.
- Spring applications appear to be more effective than fall applications.

Take Home Message Fairway Areas

- Maintain turf density.
- When plants first appear and plant populations are low physical removal is still the best control practice.
- Utilize Dissolve when enhanced flower knockdown is desired.
- With severe infestations herbicide performance in replicated field trials has been very poor. No herbicide programs with currently registered products can be recommended at this time.
- To date DowElanco XDE-565 is the most promising postemergent herbicide ever reviewed for control of English daisy. Research will continue with DowElanco XDE-565 during 1998.

* * *

ECOLOGICAL WEED CONTROL IN COOL SEASON SPORTS TURF

Todd C. Detzel
Laytonville Unified School District

Ecological weed control is dependent upon four factors; appropriate turf species and cultivars, field design, maintenance practices and, lastly, the rhizosphere. Failure to optimize any of these factors makes ecological weed control difficult, if not impossible. Based upon observation of turf/weed relationships in athletic fields and organic vegetable farms, it is theorized that the use of synthetic pesticides and fertilizers creates a syndrome that disrupts the rhizosphere and encourages weed colonization. Special emphasis is placed upon the role of vesicular-arbuscular mycorrhizal fungi (VAM).

Specific factors that influence ecological weed control are noted in the following table:

Turf	Field design	Maintenance	Rhizosphere
Species	Growing medium	Fertilization	VAM
Cultivar	Soil amendments	Nutrition	Diseases
Endophytes	Drainage	Mowing height	Misc. Micro
Insect resistance	CEC	Clippings	
Spreading ability	Organic matter	Aerification	
Germination temp.	Compaction resist.	Irrigation	
Usage		Compost	
Recovery potential		Overseeding	
Thatch potential		Herbicides	
Adaptation		Fungicides	
Turf density		Verticutting	
Clumping potential		Funding	

There is a great deal of published material relating to many of the factors. In general, basic preventative practices in fields maintained with synthetic or organic chemicals are the same. These include reducing compaction, mowing the turf as high as possible, maintaining a dense stand of turf by minimizing thatch and fungal diseases, over-seeding as necessary, assuring proper drainage, appropriate irrigation and providing adequate levels of nutrients.

However, there appears to be a marked difference in the ability of weeds to colonize synthetic and organic fields which is not due to the foregoing preventative practices.

This is clearly indicated when a field is moved from synthetic to organic maintenance. Weed pressures and colonization increase substantially during a transition period that may last several years. However, the ability of weeds to colonize, and the absolute numbers of weeds, eventually decreases to the point where it is possible to achieve turf with few noxious weeds.

It is theorized that a syndrome develops when synthetic pesticides and fertilizers are used. The theory is predicated upon the belief that there are species-specific ecotypes of VAM required to provide nutrients (mainly phosphorous, zinc and copper) and, further, that other micro-organisms in the rhizosphere act as predators against weed seeds or newly germinated weeds but not turf grass species. Since turf is a monoculture, it is reasonable to conclude that the majority of microorganisms in the rhizosphere will be dependent upon the turf plants as a host in some way.

Herbicides and fungicides are theorized to upset the rhizosphere by either killing or changing the balance of microorganisms in the rhizosphere to such an extent that it can no longer provide appropriate nutrition to the turf plants.

As the syndrome progresses, it becomes necessary to apply additional synthetic fertilizer. This in turn increases weed and fungal disease pressures which requires additional herbicide and fungicide use continuing the cycle.

Although there is a great deal of ongoing research related to mycorrhizal fungi in other crops, there has been little research and few papers on the impact of herbicides, fungicides or synthetic fertilizers upon weed colonization in turf or the importance of mycorrhizal fungi upon weed management.

There are ecto and endo mycorrhizae. Ectomycorrhizae form a mantle of hyphae over the root surface. These primarily infect *Pinacea*, *Betulacea* and *Lagaceae* species.

Endomycorrhizaes are ubiquitous in cultivated and native species. The spores of endomycorrhizae enter the root and the hyphae grows between the cortical cells while the extraradical hyphae (hypha) grows in the soil. It appears that the principal benefit to the plant is that the fungi increase phosphorous uptake. Studies also indicate that VAM may also increase uptake of zinc and copper.

The endomycorrhizae benefits by being provided with carbohydrate for metabolism and the completeion of its lifecycle.

The concept of species-specific ecotypes of mycorrhizaes is documented in other plant species such as the mycorrhizal relationship between Douglas fir and manzanita. Douglas fir does not invade areas which lack specific mycorrhizaes. Manzanita shares the same mycorrhizaes and, therefore, permits colonization. It has also been shown that pines planted in reclaimed areas exhibit superior survivability when specific mycorrhizal fungi are added to the root zone when planted.

Research has also indicated that there is a genetic component in the relationship between plants and ectomycorrhizal fungi. It is reasonable to assume that there would be similar relationships between plants and endomycorrhizal fungi. It has further been demonstrated that a plant's ability to use mycorrhizal fungi for nutritional purposes is an inherited trait.

It has been demonstrated that intensive synthetic fertilizer usage inhibits mycorrhizal fungi. Further, synthetic fertilizer directly impacts fungal diseases depending upon the lack or excess of nitrogen. Fungal diseases which kill the turf provide soil that can be colonized by weeds.

Synthetic fertilizer also provides readily available nutrients, without microbial intercession, to weeds that would otherwise not survive for a lack of a compatible VAM. This is especially true of phosphate which is, essentially, unavailable from soil without VAM intercession.

It was shown in one study that two of three organic farms had higher numbers of Trichoderma and Gliocladium. These species are known antagonists of pathogenic fungi and known biological control organisms. In the same study, it was also shown that pathogenic fungi (Pythium and Phytophthora) were greater in plots treated with inorganic fertilizers than in plots treated with organic fertilizers (composts).

Most organically maintained crops, including turf, rely upon compost for both weed and fungal disease control in addition to providing some nutrients. For many years it was believed that it was the added organic matter which was important. However, given the relatively low percentage of organic matter added to the soil, it is far more likely that the beneficial impact of compost is as a source of replacement bio-organisms. These would include not only mycorrhizal fungi but also other fungi, yeasts, algae, etc.

Being a monoculture, it is likely that microorganisms provided by the compost would be those which are compatible with turf and incompatible species would die off.

The viability of organically maintained athletic fields is shown in the following case study.

In September, 1992, the governing board of the Laytonville Unified School District, Laytonville, California, modified the existing grounds maintenance policy to prohibit the use of synthetic chemicals.

Laytonville is located in a rural area of the Coast range mountains of northern California at an elevation of 1,600 feet. The climate is transitional. It is typically arid in the summer months but has a winter rainfall of approximately 80 inches. The athletic fields encompass approximately 6 acres. The soils are clay loams. The fields were weed-free and college quality when the new policy took effect.

Prior to the change in policy, the fields were fertilized monthly using a synthetic fertilizer which provided 1.0# nitrogen, 0.38# phosphorous and 0.5# potassium per 1,000 square feet.

Trimec herbicide (2,4-D. MCPP and Dicamb) was applied every other year. Bayleton fungicide was applied to the fields when they were overseeded in the summer to prevent damping-off. In addition, the fungicide killed any *Poa annua* L.(annual blue grass).

The major weed species being chemically controlled with herbicides were: *Taraxacun officinale* (dandelion), *Plantago lanceolata* (Buckthorn plantain), M. *hispida* Gaertn. (California bur clover), *Erodium cictarium* L. (Redstem filaree), *Poa annua* L.(annual blue grass), *Isatis tinctoria* L. (Dyer's woad) and Dutch white clover. Minor weed species being controlled were: *Ranunculus acris* L. (Tall buttercup), *Centaurea solstitialis* L. (Yellow star thistle), *Dipsacus* fullonum L. (common teasel), *Cyperus esculentus* L. (Yellow nutsedge), *Cirsium arvense* (L.) Scop. (Canada thistle), *Daucus carota* L., (wild carrot), *Cichorium intybus* L. (Chicory) and *Convolvulus arvensis* L. (field bindweed).

Under the current organic policy, fields are fertilized three times per year using fish bone meal (8-3-2) at the rate of 30#/1,000 SF and compost applied at the rate of approximately 12 tons per acre once a year.

After five years, there are, essentially, only two weed species which are not controlled with compost and hand weeding; Dutch white clover and annual blue grass. Although corn gluten would control the clover and meets the definition as an organic herbicide, it is not yet approved for use in California. Additionally, budgetary constraints preclude its use.

In the case of annual blue grass, it has been noted that compost suppresses it for several months after application. It is likely that it could be totally suppressed with frequent applications. This suppression would be consistent with other research work in which it was shown that a strain of *Xanthomonas* showed promise in controlling annual blue grass.

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SPECIAL CHALLENGES OF WEED CONTROL IN MEDIANS

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Worker Safety

■Weed control at any application site requires compliance with worker safety regulations, however, pesticide application in medians has another layer of safety issues due to the working proximity to traffic. The narrow margin of protection between the applicator and moving vehicles compound the opportunities for injury to the applicator, particularly in areas where the design and size of the median do not accommodate the application equipment, necessitating equipment to be positioned in the traffic lane. Pesticide applicators, then, are protected only by the safety delineation, the applicator's ability to watch for oncoming traffic while applying, and the level of alertness of motor vehicle operators utilizing the roadway.

The mechanical removal of green waste weeds also necessitate the use of delineation. Equipment access for the weed removal also may require more man/equipment hours than applications at non-median sites. The additional set up, take down time, for delineation, the cost of delineation equipment, and the constraints for equipment access, lead to application costs being higher for weed control in medians.

Efficiency of Application

■Applicators performing operations in medians must take into consideration the standard environmental concerns about wind, rain, and inversion layers, but also must take into consideration, traffic pattern concerns. The efficiency of pesticide application on medians can be influenced not only by the normal wind velocity but can also be influenced by individual sporadic traffic generated wind bursts. This challenge can increase the potential of drift to non-target species, to off-site locations, and to the applicator himself. Frequently, lane closures are not possible when optimum environmental conditions exist, further narrowing the window for safe and efficient pesticide application.

The size and design of some medians may increase the opportunity for run off to occur. Medians that have berms or smaller planter cut outs, may experience run off when pre-emergent herbicides are applied and then deeply irrigated to activate the herbicide. In these situations, monitoring the application of short cycles of irrigation is crucial.

Addressing the Challenges-New Medians

■The greatest tool available for planning safe and efficient pesticide application in new medians is to actively participate in the design and plan review process. Frequently, aesthetics and cost factors are the primary factors in median design. Professionals knowledgeable of the special challenges of weed control in medians can assist in the development of a landscape plan which addresses practical solutions to issues of maintenance, including pesticide application.

Addressing the Challenges-Existing Medians

■The majority of the weed control challenges faced by pesticide application personnel, will be in existing medians which may not have been effectively designed to address maintenance issues. Addressing weed control in these areas may mean that options for changing design obstacles may be limited. To effectively control the weeds means that knowledge of the site's incumbent weed population is critical. This will determine the scheduling of regular, timely pre-emergent herbicide applications as well as any needed post- emergent applications.

In order to optimize the growing environment for the desired establish species, it is critical to monitor the irrigation schedule. Plants under stress from too much water or drought conditions, will be unable to be competitive with emerging weeds. Replanting of areas which fail to provide competition to weed populations may be required. At this time, groundcovers, and clean mulch materials may be installed. Composted green wastes are more frequently being used in established medians as weed barriers.

Summary

■Pesticide application in medians necessitate additional measures to protect the pesticide worker during application operations. Pesticide application in medians can require a greater time for the operation than areas outside traffic flow patterns. Run-off is frequently a greater issue in medians than at other sites. Overall costs for median applications are greater than for equivalent size non-median sites. The greatest tool we as pesticide professionals have is planning for limiting weeds on the new sites and providing applicator safe accessibility. On the established medians, our knowledge of plants and their ecology will help us to limit the need to future pesticide operations.

Attachment: City of Salinas Median Design Criteria

Starting with the basics of the soil, landscape architects must specify use of only high quality, weed free soil amendments. Specifications should require the use of pre-emergent herbicide applications in the amended native soil mix.

A plant pallet should be developed which can aggressively compete with weed populations known to be a problem near the new landscape median site. Plant materials that grow rapidly will get a head start on weed populations that may later come in though wind or incorporation by means external to the native soil or soil amendments. Groundcovers such as ice plant, ivy, gazanias, selected junipers, myoporum, and some newer varieties of bedding roses are some examples of aggressive plant materials capable of quick and efficient establishment. Their ability to compete for space, light, nutrients and water, are inconducive to weed population establishment. The installation of sod rather than seeded turf, can also be utilized to discourage weeds. Sod which has mesh backing material is thought to be somewhat more efficient for inhibition of some weed species. Aggressive grass species such as Kikuya and Bermuda can play a role in competition with weeds. However, some of these species, themselves, become the weed thus choosing these species require caution in placement near other desirable species, particularly if the adjacent desirable species are also monocotes. Placement of an aggressive grass species next to a less aggressive grass species will ultimately result in invasive weed control conflicts. Plants which provide shade or form allotrophic perimeters may be selected to inhibit weeds.

Weed barriers can be specified in new median designs. Used in conjunction with a pre-emergent herbicide, these can be some of the most effective means of limiting median weed problems. These weed barriers can be a variety of woven fibers, some of which are impregnated with herbicide. The plan can also utilize clean, organic mulch made of compost, bark, or other forms of recycled wood waste. Some inorganic barrier materials are effective. These products include decomposed granite, gravel, and decorative stones and boulders.

A median design which limits bare, open areas of ground will ultimately experience less need for weed control. Designs which utilize a mix of hardscape and planting areas can be both aesthetically pleasing and practical. A wide variety of materials, colors, and textures of hardscape, provide opportunities for planting medians and providing barriers to weed emergence. Cut out planter areas within hardscape islands have become common for median plantings. Larger islands with open planting areas alternating with bands of decorative paving materials also address aesthetics, traffic separation, and reduction of areas where weed control is required. Whatever paving/ planting design combination is utilized, the plan should have areas provided for equipment placement, and paved shoulders to accommodate maintenance operation personnel and equipment wherever possible. This can reduce some of the need for applicators to place equipment in traffic lanes during pesticide application operations and provide some measure of protection for workers.

WEED MANAGEMENT IN TURF—PAST, PRESENT AND FUTURE

Clyde L. Elmore, Extension Weed Specialist

Turf weed management could be said to have changed immensely or almost not at all over the last "100 years".

In the distant past, turf was the village square or resident vegetation that wasn't eaten by the livestock that grazed upon it. It was originally supported by the elite in China and was imported to Europe. In 1830, a mower was developed to periodically cut the turf to keep it shorter, to have a play field. When I visited China in 1988, many public parks were being cut with hand scythes and weeds were being pulled by hand in turf areas. There was a great interest in weed management and cultural practices for amenity turf.

Weed control methods.

Most all the weed control methods that we use today have been used for many years. Mowing, fertilizing and irrigation principals have not drastically changed. The turf types, and in particular varieties that have been selected increase the competition for water and nutrients against the weeds. Turf species have shifted from common bermudagrass or Kentucky bluegrass to more perennial ryegrass and turf-type tall fescue. These species have many new selections that are very competitive and can reduce weed invasion and establishment. There have never been more varieties available to choose a fine turfgrass.

Weed problems:

Weed problems have changed. In an extension paper for weed control in turfgrass in 1936 the principal weeds listed were divided into two categories, short stem types and spreading types. The short stem types included dandelion, plantains, shepherd's purse and chicory. The spreading types included crabgrass, bermudagrass, knotweed, chickweed, oxalis, speedwell and spotted spurge. Most of these sound very familiar today. In a paper presented to the California Weed Conference in 1959, Bill Bengyfield from the US Golf Association indicated that kikuyugrass, goosegrass, Dallisgrass, English daisy and annual bluegrass were five major weeds in California that needed additional work for control. Sound familiar? In 1963, V. Youngner, UCR indicated at the same conference that the major weeds were Dallisgrass, kikuyugrass, knotweed, burclover and black medic, Australian brass buttons, prostrate spurge, crabgrass and goosegrass were the major problems in turf. These weeds are still present and troublesome but now we also have other introduced species that are problems; notably green Kyllinga, Sporobolus, Setaria, etc. There are many species which have not been mentioned such as yellow and purple nutsedge, creeping woodsorrel, white clover, and broadleaf and narrowleaf plantain, to name a few. Are these all new weeds or are they being found more frequently now because there are more people looking at the turf? There are concerns about many of the same weeds as there were many years ago, such as crabgrass, annual bluegrass, plantains, dandelion, etc.

Current major turf weed problems:

Grasses:

Dallisgrass, kikuyugrass, bermudagrass, annual bluegrass, crabgrass, and goosegrass. Of lesser importance, but severe where they are found: Sporobolus, rescuegrass, knotgrass, velvetgrass, bentgrass.

Broadleaf weeds:

Dandelion, English daisy, creeping woodsorrel, plantains (broadleaf and narrowleaf), white clover, bur clover, black medic, knotweed, speedwell, brass buttons, spurweed, prostrate spurge, and wartcress. Of lesser importance, but severe where they are found: healall, cudweed, cheeseweed, henbit, sow thistle and prickly lettuce.

Herbicides:

The greatest change in weed management strategies has been the development of selective herbicides. This is not only for the control of broadleaf weeds in grasses but the selective control of grasses in grasses. Another aspect is the volume of herbicide used for the control of specific weeds. In 1971, Madison developed a list of herbicides and their rates of application (Table 1). I have modified this table to include herbicides in the 1980's and 1990's (Table 2). What will the rates and materials look like in the 2000's? I predict there will be fewer herbicides and less application of herbicides. Another area of change is that the characteristics of the herbicides have changed. When the arsenical herbicides were available (lead arsenate, calcium and tricalcium arsenate), these herbicides had multiple sites of action (competitive uptake and activity wherever phosphorus was used in the plant. With the introduction of 2,4-D, MCPP, MCPA, 2,4,5-T and Silvex, there was an introduction of multiple site of action materials. With an increase in regulatory action to "safen" materials and reduce herbicide use, there has been a major movement to "single site of action" herbicides and lower use rates, thus greater activity per unit of application. We are no longer using herbicides that require 10's or 100's of pounds per acre but are in ounces per acre. Specifically the ALS inhibitors are examples. During my career at the University we have had little concern about weed resistance to herbicides, because we had not been confronted with this problem. "It only was a problem with insecticides and fungicides." Today and in the future, it is a real concern with the introduction of single site of action herbicides.

Table 1

Herbicides, rates and timing of applications of herbicides used in turfgrass in the 1950 and 60's.

Herbicide	Rate (lb/A)	Timing	Weeds	Comments
lead arsenate	400-1000	annual/semi-annual	annual bluegrass, crabgrass	thins turf, may sterilize soil
calcium arsenate	375-550	annually	crabgrass, annual bluegrass	erratic control, thinning of turf
chlordane	60-340	annually	crabgrass, goosegrass	erratic control, not injurious to turf
bandane	17.5 -50	annually	crabgrass	some injury to turf
bensulide*	7.5 - 10	annually	crabgrass, annual bluegrass	safe on turf, "long residual"
terbutol	5 - 20	annually	crabgrass	injures bentgrass
siduron	5 - 20	annually	crabgrass	seedling turf tolerant
DCPA*	5 - 10	annually	crabgrass, Veronica,	safe to turf except bentgrass

* Herbicides with current labels.

Table 2. Current herbicides for weed control in turfgrass.

Herbicide	Rate (lb/A)	Timing	Weeds	Comments
pendimethalin	1.5 - 3	spring or fall	annual grasses and broadleaves	sometimes used twice per year
dithiopyr	0.25 - 0.5	spring or fall	annual grasses and broadleaves	pre or early postemergence
prodiamine	0.75 - 1.5	spring or fall	annual grasses and broadleaves	can thin some turf species under stress
fenoxaprop	0.25 -0.33	up to 2 tiller stage	crabgrass	stressed grass not controlled
halosulfuron	0.03 - 0.06	post emergence	nutsedge	two applications usually needed

In a presentation at the California Weed Conference in 1961, crabgrass materials listed consisted of chlordane, lead arsenate and calcium arsenate as the preemergence herbicides and dalapon and trichloroacetic acid (TCA) as the non-selective post emergence herbicides. Even today many may not remember DCPA for crabgrass, monuron for oxalis control and diphenamid for grass control in dichondra, or endothal for annual bluegrass control in grass turf.
Many weeds can now be controlled. With the introduction of glyphosate as a non-selective herbicide that would kill annual and perennial grasses, the potential for total renovation became a possibility. An herbicide could be used that would kill bermudagrass without leaving a residue in the soil that would affect subsequent planted turf, either from sod or seed. This was a major development in restoring weedy turf to a fine turf. There have also been methods developed to control crabgrass, goosegrass, kikuyugrass, Dallisgrass, dandelion, plantains and many other species.

Application Equipment:

Application equipment has changed. The changes may not have seemed great, except because of the type of application, application has had to change from large quantities of powder forms of lead arsenate or calcium arsenate at 100's of pounds per acre to spray applications of 0. 03 lb/A. Equipment for liquid and powder formulation application have improved to allow more uniform application. Light sprayers with booms and flat fan nozzles with low pressure are available to accurately apply very small quantities uniformly over large areas.

Changes in formulations

Early formulations were powders that were either applied by hand, or through a drop spreader. Powder formulations were changed to granular formulations to reduce or eliminate dust. Some powder formulations (wettable powder) have been reformulated to flowable (liquid) or to water dispersible granules (WDG) to further reduce dust and make it easier and safer for the worker to handle. Herbicides have been formulated with fertilizers. These formulations allow application of a herbicide for the control of the weed, and also a fertilizer that gives the turf some nutrients to increase vigor. With increased turf vigor, there is a reduction of weed encroachment and establishment.

Attitude change:

Is a weed still a weed? Are we reverting or progressing back to the future? There are more areas not being treated with herbicides thus there is a return to the sward or village green attitude in some areas. There is a divergence of attitudes between people who want a "well manicured", lawn with no weeds, and a uniform texture and surface and those who either don't care what it looks like, more the diversity of plants in the turf, or consciously decide they don't want pesticides used and there is no economic alternative to remove the weeds. There are even those that are choosing to find alternatives to grass as a lawn (even lawn is not the right word). They ask what to plant that doesn't require "pesticides and herbicides", doesn't need irrigation or fertilizer and will grow in a sunny location and take some traffic. What would your answer be?

Will this move continue, Yes! Will it last forever, No! At what time it will turn around, I don't know and also I don't have an idea what turn it will take. For a time there will be greater divergence with those who chose to use herbicides for weed management in turf and those who chose to try other means for turf management such as competitive varieties, mowing, etc. Eventually the amount and application of nitrogen will also have the same or more regulatory inspection.

Will turf management eventually move from current practices to "Mandatory IPM", or imposed "Best Management Practices"? This probably will occur first in all turf with public access, followed by homeowner turf? I see movement in that direction. There are those who would like to have the control to force all in that direction.

Maybe we are regressing or progressing to the aristocratic green of the Chinese or the square or village green of the Europeans. How we maintain them may not be that much different as well. I don't, however, see us going back to the scythe as the mowing tool.

Magnum Leap In Orchard Floor Management

Bill B. Fischer*

Fifty years ago it was not uncommon to see newly planted trees and vines smothered by unwanted competing vegetation. In fact in some newly planted orchards the young trees and vines could not be seen from the heavy infestation of weeds. And it was not uncommon to see well established orchards and vineyards heavily populated with numerous species of winter and summer annual weeds and perennials such as Bermudagrass, johnsongrass, field bindweed, Russian knapweed and nutsedge.

Orchardists and vineyardists were aware of the harmful effects these unwanted competing plants had on the growth and productivity of their crop. Therefore, they spent many hours and precious resources in controlling the weeds in their newly planted as well as in their established orchards and vineyards. They knew that weeds not only adversely effected the growth of the trees and vines, but they competed for water and nutrients, they harboured insects, diseases, nematodes and they interfered with essential cultural practices and reduced the efficiency of harvest.

To control weeds and minimize their detrimental effects they repeatedly cultivated the orchard and vineyard floor and employed costly hand labor. As early as 1919 noncultivation was tried as a method of orchard floor management especially in citrus orchards with its shallow root systems. In the mid 30's citrus growers began using oils to control the weeds and by 1950 about 50,000 acres of citrus were under noncultivation. With repeated applications of petroleum distillates and heavy oils they were able to minimize or eliminate cultivation and reduce the need for hand weeding and the handling of orchard heaters.

In the early 50's, Boysie Day at U.C. Riverside successfully demonstrated the effective and safe use of substituted urea herbicides (monuron and diuron) for weed control in citrus orchards. A single application during the winter months provided effective seasonal control of most annual weeds. Needless to say, growers were very interested and many of them rapidly converted their orchards to complete nontillage management.

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In deciduous orchards and vineyards the task was somewhat more difficult, but during the past fifty years with the sue of selective herbicides we made significant progress in developing new techniques and methods in the management of orchards and vineyards. We evaluated many herbicides in a large number of different varieties of fruit and nut crops under varied irrigation and management practices. U.C.Extension workers like Art Lange, Clyde Elmore, Harold Kempen, Harry Agamalian and I conducted many applied research studies and field meetings showing farmers and pest control advisers the performance and selectivity of herbicides that today are widely used in orchard floor management.

With the intelligent use of herbicides orchard floor management practices have significantly changed during the past 50 years. You may not remember the time when the orchard middles had to be disked in one direction and a second time in the other direction to control the weeds in the tree row and often hand weeding was required to control the weeds around the base of the trunk. In vineyards French (Kirpy) plows were used to plow the weeds from the vine-row and later the soil had to be thrown back with a disk and in many vineyards, especially those infested with crabgrass and bermudagrass, costly hand weeding was required around the trunk. Repeated disking, harrowing and hand weeding were required to keep the unwanted vegetation under control to enhance the economical harvest of the crop.

Here is what we accomplished: With the use of herbicides in a narrow strip in the tree and vine rows we were able to reduce the need for cultivation by 50% and do away with costly hand weeding. By eliminating the need for cross cultivation growers were able to increase the fruiting branches on the trees, quadruple the number of trees planted per acre, reduce the need for the use of heavy tractors and utilize low volume emitters for irrigation.

Today, with the use of selective herbicides, fruit and nut growers have many options in managing the orchard floor. They have the option of using strip nontillage by applying herbicides in the tree row and disking the centers, or they can mow the resident vegetation (remember we used to call them weeds) and practice complete nontillage. Another option is to use herbicides in the tree or vine row and to plant a cover crop between the rows. A fourth option would be to treat the entire orchard floor with herbicides. They can use any one or a combination of these methods to reduce soil compaction, improve water penetration and enhance all other needed cultural operations to achieve an integrated system of orchard management.

On the way we encountered many problems studying rates and proper timing of application and learning how to use these new chemical tools safely and effectively. We were able to accomplish this while complying with the requirements imposed by the EPA, CDFA and OSHA. We learned to knuckle under and comply with the myriads of permits, notifications, tests and licences that are required to enable us to apply a few pounds of herbicides per acre.

One of the early setback was presented by Rachel Carson in her well written popular book Silent Spring. She expressed some concerns that were justified and should have received more open-minded professional response from the scientific community.

What was more difficult and costly to live with were the protestations of some attractive looking people who knew nothing about agriculture and even less about the use of pesticides but their ignorance did not inhibit them from spreading half truths and often outright lies. Even worse were some tabloids using any means to attract attention to their misinformation.

Inspite of misguided and prevaricated protestations, we have made great progress during the past 50 years that we can justifiably call a **magnum leap in orchard floor management**. This is irrefutably evident when we compare orchard floor management practices pursued in the 50's and 60's with the ones practiced today. This is undoubtedly reflected in the quality and quantity of fruits and nuts we produce in California.

I don't want to leave you with the impression that all our problems are solved. There are many weed problems that require more effective control. Although we have demonstrated that nearly all unwanted vegetation can be controlled with the available tools (chemical and mechanical), we need to learn how to use them more effectively and more economically.

Growers and their pest control advisers are not doing an adequate job of properly identifying the weeds infesting their orchards and vineyards. And they are not keeping adequate records of their distribution. The consequences of poor herbicide selection can be costly and result in inadequate or no weed control. This can be illustrated by the grower who used oryzalin and wound up with a solid infestation of willow herb, or the one using simazine repeatedly and found his vineyard infested with bedstraw. The importance of knowing the weed infestation can not be over emphasised. California's orchards and vineyards are infested with a broad spectrum of weeds. Without their proper identification it is not possible to select the most effective tools for their economical management.

We have made great progress in integrating the use of cultural, mechanical and chemical practices. We have developed better techniques and tools for the safe and effective use of herbicides. We have controlled droplet applicators and more recently so called "smart sprayers". What we need is smarter applicators to use these tools effectively. When you think of it a "smart sprayer" is pretty dumb unless someone can properly identify the weeds, know their susceptibility to herbicides and select the most effective one to put into the tank.

We need better understanding of weed physiology, study their habit of growth, their distribution and their economic influence on crop production. There is great concern that the recently passed Food Quality Protection Act may result in the loss of widely used herbicides. To maintain their availability in the next 50 years we need to continue pursuing aggressive applied research studies of vegetation management. This challenging task is up to my younger colleagues and Clyde Elmore will look ahead and tell us what we can expect during the next fifty years.

MANAGING WEEDS IN NEWLY PLANTED ORCHARDS AND VINEYARDS

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Controlling unwanted vegetation (weeds) in newly planted orchards and vineyards is important to ensure proper development and maturity. When trees and vines are first planted, competition from undesirable vegetation is high, robbing the crop of vital water and nutrients. Shallow-rooted trees (e.g., citrus) are especially sensitive to early weed competition. Because there are many types of tree and vines grown on wide variety of soil types, weed management decisions vary greatly.

Developing a weed management strategy should begin before the trees or vines are planted. An accurate record of the field's weed history will help to define the approach needed. Avoiding fields with a history of problem perennial weeds (i.e., nutsedge, johnsongrass, bermudagrass, etc.) may be easier if one first knows they are a problem prior to planting. Prior to planting, an application of trifluralin disk incorporated four inches deep within the planted row will provide control of several annual broadleaves and grasses. Escaped weeds can then be controlled with postemergence herbicides while they are small. Where yellow or purple nutsedge is a problem, deep plowing with a moldboard plow (e.g., Kverneland, Wilcox, etc.) can help bury the reproductive tubers deep into the soil profile. Done properly, this preplant option can reduce early nutsedge competition. While preplant options may add costs to the crop up front, it can ensure a more desirable environment that favors early tree and vine growth.

There are three basic methods of managing vegetation in trees and vines: mechanical, cultural and physical, and chemical. Because many of the herbicides labeled for use in California are limited based on soil type and/or age of the crop, a combination of approaches often provides the most cost-effective control. Young trees and vines in California are managed by complete tillage, strip-nontillage, trunk-to-trunk, or with a combination of chemical and mechanical.

In complete tillage systems, fields are typically disked in two directions to destroy 90 to 95% of the vegetation. However, since it is essential to remove weeds growing near the trunk, additional hand hoeing crews are required. Using power mulchers in-row equipped with tripping mechanisms may clean up weeds close to the trunks as well, but will not be 100% effective. Only when soils are dry enough to support heavy equipment and prevent compaction can they be used. Therefore, cultivation is done in the spring to reduce weed growth and to prepare a firm surface wherever frost may present problems. This is typically done several weeks prior to bloom in most deciduous orchards and prior to leafing in grapes. The French plow is an effective tool for managing weeds within staked grape vine rows. Problem weeds, like johnsongrass, nutsedge, and others, can be brought to the middles where they are dehydrated through disking. Care should be taken when using the equipment to prevent mechanical injury to the trees or vines. In most cases staked crops are needed for this equipment. Because many growers have switched to low-volume irrigation, in-row cultivation is not used.

One of the most common methods of managing weeds in orchards and vineyards is using strip-nontillage or strip-minimum tillage. In the fall or winter during dormancy, preemergence herbicides are applied to a narrow (2-8') strip down the planted row to control weeds not yet emerged. Winter rains are used to incorporate and activate the chemical. Herbicide selection and rate will depend on several factors, primarily: weed species, crop age and, soil type. Understanding the weeds present and correctly identifying them will help one to select the appropriate chemical(s). A postemergence herbicide is usually added if susceptible weeds are present at the time of application. Glyphosate or paraquat are typically added in these cases. Applying herbicides in this manner reduces the total herbicide amount needed by 70% or more, improves management of time, and generally provides a higher return on investments. Middles are then either repeatedly disked or mowed during the growing season. Sod cultures (planted species or resident vegetation) can be maintained in the middles, which can allow for entering the field under wet conditions, especially with light equipment. Where mowers are used, the plants are not allowed to set seed. Because plants are actively growing they do compete for water and nutrients. However, because young trees or vines may have limited root systems, competition may be low as long as the tree planted row is kept clean.

Selecting the proper herbicide is important to increase control and reduce costs and potential injury to the crop. The type of irrigation system used also has an influence on herbicide performance. Under frequent drip irrigation, herbicides like simazine, diuron, napropamide, etc., are broken down rapidly through hydrolysis and microbiological degradation. As a result repeated directed or spot treatments of postemergence herbicides will be needed. Soil type can also influence leachability of the chemical, causing injury to the crop. Less mobile herbicides like oxyfluorfen may be desirable where drip irrigation is used. Herbicide persistence is increased under furrow or basin-flood irrigation, but it is more difficult to apply water to the top of the berms.

Herbicides can be applied trunk-to-trunk during the winter to provide a weed-free soil surface. The advantages of this method are maximum frost protection, labor and equipment savings, improved water and nutrient utilization, and earlier orchard maturity. While the costs at the outset may be higher than other methods, the benefits often outweigh the disadvantages. Citrus, because of their shallow roots and need for sufficient frost protection, are often treated in this manner. Soils high in silt, that may crust, can reduce water infiltration under this regime. Periodic or light cultivations may be needed to reduce the problem. This method has a significant potential for improved orchard management practices.

During the first few years of a new tree or vine crop it is important to protect the plant from injury caused by postemergence herbicides. Treating weeds when they are small and conducive to directed sprays is helpful. Using shielded sprayer under minimal windy conditions is also helpful. Although dormant, new plantings are still susceptible to injury through the young bark. This means applying postemergence herbicides on time, before weeds get large and difficult to spray. Controlling new infestations of perennial weeds (like bermudagrass) is important before their stolons become entangled in the tree or vine, after which control is difficult and potential injury to the crop increased. Spot spraying early repeatedly with postemergence herbicides will ensure the infestation does not spread.

While there are different methods of management tools available to control weeds in tree and vine crops, each should be tailored for the particular crop and soil. Because weeds can offer high levels of competition for essential water and nutrients, it is critical that some form of control be utilized that reduces weed growth, while stimulating healthy tree and vine development.

VISOR HERBICIDE IN THE REAL WORLD; THE TREE NUT CROP EUP PROGRAM IN CALIFORNIA

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Introduction

Field research in California since 1994 has shown that Visor 2E (thiazopyr) provides excellent preemergence control of many weed species as well as showing outstanding crop safety in trees and vines. These trials were established as replicated small plot experiments designed to understand the activity of Visor 2E based on rate, moisture requirements, soil type, weed spectrum, residual activity, and crop tolerance. These small plot trials were conducted under very controlled conditions to insure accuracy and reduce as many variables as possible. The early trials were small for another important reason; there was no crop tolerance established by the EPA, and all harvested crops treated with Visor 2E had to be destroyed.

The Federal Environmental Protection Agency approved a temporary tolerance for Visor 2E in tree nut crops and issued an Experimental Use Permit on July 25, 1996. This 2-year EUP allows Rohm and Haas Company to conduct grower-applied Visor 2E trials in almonds, pecans, pistachios and walnuts totaling 100 acres/year for each of these crops in California.

Between November 15, 1996 and February 26, 1997, 24 Visor 2E EUP trials were established in California. These trials were conducted in almonds (7), pecans (2), pistachios (7), and walnuts (8) and were spread throughout the nut crop growing regions of California. In these trials, 4 Visor 2E rates were evaluated; 0.375, 0.5, 0.75 and 1.0 LB ai/Acre. Comparisons were made with the grower's standard preemergence herbicides which included Surflan AS (oryzalin) at 3.0-4.0 LB ai/A (28% of the trials), Princep Caliber 90 (simazine) at 1.0-2.25 LB ai/A (20%), Solicam DF (norflurazon) at 2.0-4.0 LB ai/A (16%), Prowl 3.3EC (pendimethalin) in nonbearing nut crops at 2.5-3.3 LB ai/A (16%), Karmex DF (diuron) at 3.2 LB ai/A (12%), and Devrinol 50DF (napropamide) at 4.0 LB ai/A (8%). Since no single preemergence herbicide generally controls all weeds in an orchard, all grower programs in these 24 EUP trials included tankmixing Goal 2XL (oxyfluorfen) at 0.75-1.5 LB ai/A. Therefore the same rate of Goal 2XL was tankmixed with Visor 2E and the respective grower standard at each of the trial locations. If weeds were present at application, Roundup (glyphosate) at 1.0 LB ai/A or Gramoxone Extra (paraquat) at 0.625 LB ai/A was also used.

Most of these trials were established prior to the winter rains which totaled 6-13". This resulted in excellent incorporation of the herbicides at most locations. The trials were equally split between light and heavy soils providing Visor 2E good representation in the various soils from sandy loam to clay.

The grower's application equipment varied as much as their individual herbicide programs. Spray volumes were from 20GPA to 75GPA. Prior to the establishment of each trial, the sprayers were calibrated, assuring the greatest accuracy possible with all herbicide applications.

The growers did allow small untreated areas within the trial sites, usually 2 rows by 10 trees. This generally gave a good representation of the weed spectrum and made meaningful evaluations possible. Forty-two weed species were evaluated in these EUP trials. Table 1 shows the weeds that were found within the trials and their frequency of occurrence.

Table 1. Weed Species Evaluated In The 1997 Visor 2E EUP Trials.

Broadleaf Weeds (30):

		# Of Trials			# Of Trials
Annual Sowthistle	(Sonchus oleraceus)	9	Pineappleweed	(Matricaria matricarioides)	3
Black Mustard	(Brassica nigra)	2	Prickly Lettuce	(Lacuca serriola)	3
Brassbuttons	(Cotula australis)	1	Prostrate Knotweed	(Polygonum aviculaire)	2
California Burclover	(Medicago polymorpha)	2	Prostrate Pigweed	(Amaranthus blitoides)	1
Chickweed	(Stellaria media)	6	Puncturevine	(Tribulus terrestris)	1
Common Groundsel	(Senecio vulgaris)	3	Redroot Pigweed	(Amaranthus retroflexus)	2
Common Purselane	(Portulaca oeracea)	5	Russian Thistle	(Salsola kali)	1
Fiddleneck	(Amsinckia intermedia)	2	Scented Mayweed	(Matricaria chamomilla)	1
Flaxleaf Fleabane	(Conyza bonariensis)	6	Shepherdspurse	(Capsella bursa-pastoris)	6
Green Amaranth	(Amaranthus hybridus)	1	Smooth Cat's Ear	(Hypochoeris glabra)	1
Lambsquarters	(Chenopodium album)	2	Spiny Sowthistle	(Sonchus asper)	2
Little Mallow	(Malva parviflora)	4	Spotted Spurge	(Euphorbia maculata)	10
London Rocket	(Sisymbrium irio)	2	Strawberry Clover	(Trifolium fragiferum)	1
Marestail	(Conyza canadensis)	9	Tumbling Pigweed	(Amaranthus albus)	1
Pannicled Willowherb	(Epilobium paniculatum)	3	Whitestem Filaree	(Erodium moschalum)	2

Grasses (10):

		# Of Trials			# Of Trials
Annual Bluegrass	(Poa annua)	4	Johnsongrass	(Sorghum halepense)	1
Barnyardgrass	(Echinochloa crus-galli)	5	Junglerice Grass	(Echinochloa colonum)	3
Bearded Sprangletop	(Leptochloa fascicularis)	1	Large Crabgrass	(Digitaria sanguinalis)	3
Diffuse Lovegrass	(Eragrostis diffusa)	1	Orchardgrass	(Dactylis glomerata)	1
Foxtail Barley	(Hordeum jubatum)	4	Southwest Cupgrass	(Eriochloa gracilis)	2

Sedges (2):

		# Of Trials			# Of Trials
Purple Nutsedge	(Cyperus halepense)	3	Yellow Nutsedge	(Cyperus esculentus)	11

Results And Discussion

Visor 2E provided excellent residual weed control with all rates and was still 75-90% effective 8-9 months after application. Table 2 shows the overall weed control with Visor 2E compared to the grower standard herbicides. Generally, there was a rate response with Visor 2E; however, even the 0.375 LB ai/A rate demonstrated more effective control than the average activity of the commercial standard herbicides.

Table 2. Overall Preemergence Weed Control Activity Of Visor 2E Compared To The Commercial Standards In Nutcrops.

		% Preemergence Weed Control			
Treatment*	LB ai/ Acre	2-3 Months	4-5 Months	6-7 Months	8-9 Months
Visor 2E	0.375	96	87	78	81
Visor 2E	0.5	87	91	78	75
Visor 2E	0.75	96	95	88	90
Visor 2E	1.0	91	96	93	87
Commercial Standard**		88	79	69	62

*Goal 2XL at 0.75-1.5LB ai/Acre added to all treatments including commercial standards.

**Depending on trial location, commercial standard was Surflan, Prowl, Solicam, Princep, Karmex, or Devrinol.

To better understand the activity of Visor 2E, comparisons were made based on the strengths of the grower's preferred choice for their herbicide program. For example, Surflan AS (all nutcrops) and Prowl 3.3E (currently only labeled for nonbearing nutcrops) are usually selected for their good residual activity on annual grasses and many broadleaf weeds (excluding marestail and flaxleaf fleabane). The results in Table 3 show that Visor 2E was as effective as Surflan AS in providing excellent grass control up to 8-9 months after application. For broadleaf weed control, Visor 2E was considerably more effective than Surflan AS at both 4-5 months and 8-9 months.

Table 3. The Preemergence Activity Of Visor 2E Compared To Surflan For The Control Of Annual Grasses And Broadleaf Weeds.

		% Preemergence Weed Control			
	LB ai/	Grasses		Broadleaves**	
Treatment*	Acre	4-5 Months	8-9 Months	4-5 Months	8-9 Months
Visor 2E	0.375	----	---	89	75
Visor 2E	0.5	100	85	94	81
Visor 2E	0.75	100	88	97	81
Visor 2E	1.0	100	85	97	80
Surflan AS	3.0-4.0	100	84	82	63

*Goal 2XL at 0.75-1.5LB ai/Acre added to all 5 treatments.

**Broadleaf weeds do not include marestail or flaxleaf fleabane.

Visor 2E provided even greater differences in activity when compared to Prowl 3.3E, as shown in Table 4. The evaluations after 8-9 months show that the residual activity of Prowl 3.3E was considerably less than the activity of Visor 2E, especially on the grasses where Visor 2E was 61-93% effective, compared to only 38% control with Prowl 3.3E. Even the Prowl 3.3E activity on broadleaf weeds (64%) was much less than the 88-94% control with Visor 2E.

Table 4. The Preemergence Activity Of Visor 2E Compared To Prowl For The Control Of Annual Grasses And Broadleaf Weeds.

		% Preemergence Weed Control			
	LB ai/	Grasses		Broadleaves**	
Treatment*	Acre	4-5 Months	8-9 Months	4-5 Months	8-9 Months
Visor 2E	0.375	83	61	80	88
Visor 2E	0.5	93	85	89	90
Visor 2E	0.75	93	91	92	91
Visor 2E	1.0	96	93	94	94
Prowl 3.3E	2.5-3.3	83	38	72	64

*Goal 2XL at 0.75-1.5LB ai/Acre added to all 5 treatments.

**Broadleaf weeds do not include marestail or flaxleaf fleabane.

For control of nutsedge, marestail, and flaxleaf fleabane, Solicam DF is the only preemergence herbicide that offers fairly good suppression of those weeds. However, Solicam DF is often not used due to grower concerns over crop injury. Table 5 shows the results when Visor 2E was compared to Solicam DF in controlling nutsedge and the marestail/flaxleaf fleabane complex. For nutsedge control, Visor 2E at rates of at least 0.75 LB ai/Acre was slightly more effective than Solicam DF. After 4-5 months, Visor 2E was providing 90-99% marestail/ flaxleaf fleabane control compared to only 80% control with Solicam DF.

Table 5. The Preemergence Activity Of Visor 2E Compared To Solicam For The Control Of Nutsedge And Marestail/Flaxleaf Fleabane.

		% Preemergence Weed Control		
	LB ai/	Nutsedge		Marestail/FLF
Treatment*	Acre	4-5 Months	8-9 Months	4-5 Months
Visor 2E	0.375	80	70	95
Visor 2E	0.5	53	70	98
Visor 2E	0.75	78	90	90
Visor 2E	1.0	80	85	99
Solicam DF	2.0-4.0	63	73	80

*Goal 2XL at 0.75-1.5LB ai/Acre added to all 5 treatments.

Summary And Conclusions

Although the overall activity of Visor 2E showed excellent broadspectrum preemergence weed control compared to the current standard herbicides in nutcrops, there were some areas of potential "weaknesses" with the Visor 2E + Goal 2XL tankmixes that were evident in the 1997 EUP program. For optimum nutsedge control, the rate of Visor 2E should be greater than 0.5 LB ai/A. The spotted spurge control with Visor 2E, although not specifically mentioned in this paper, dropped off after 6-9 months when rates were equal or less than 0.5 LB ai/A. Finally, also not specifically mentioned, the annual sowthistle control dropped off after 8-9 months. This was probably related to the Goal 2XL rate in the Visor 2E + Goal 2XL tankmix where growers decided on a rate that did not give sufficient long-term residual sowthistle control (0.75-1.0 LB ai/A instead of 1.5-2.0 LB ai/A).

The highlight of the 1997 research was undoubtedly the excellent residual activity of Visor 2E compared to the commercial standards. Table 6 shows that the longer the time between application and evaluation, Visor 2E increases the difference in activity compared to current preemergence herbicides.

Table 6. Residual Weed Control Activity Of Visor 2E Compared To The Grower's Commercial Standards.

Residual Time	Visor 2E Less Active	Equal Activity	Visor 2E More Active
2-3 Months	10%	69%	21%
4-5 Months	15%	37%	48%
6-7 Months	25%	15%	60%
8-9 Months	8%	13%	79%

The 1997-98 field trials for the second year of the Visor 2E EUP program in nutcrops will be even more ambitious than the work conducted during this past year in anticipation of a registration in the near future.

Using Degree Days to Predict Weed Growth.

Timothy S. Prather, IPM Weed Ecologist, Statewide IPM Project, UCCE.

Scheduling weed control measures to phenological stages is important for control of most species. Critical stages of plant development for several important weed species are often missed, rendering control less effective. Critical stages for control include delaying control of yellow nutsedge past the 5 leaf stage will allow plants to produce new tubers. Cultivating later than the 2 leaf stage with flex-tined cultivators will reduce control of many species. Our ability to predict emergence and development of weed species can improve our efficacy of weed control.

Increasing our understanding of species that emerge and growth during similar time periods would allow us to time our control to a phenological stage of the last member of a species assembly. Identifying species assemblies would allow us to time postemergent berm sprays to a specific leaf stage of the last species of the assembly, allowing for control of all species and precluding the need for a second application. Degree day models also allow us to schedule control activities by providing us a greater understanding of how fast weeds attain the same phenological stage during different time periods. Intuitively we know that common lambsquarters will grow slower in March than it will in June. Knowing the speed of development allows planning to make sure that labor shortages or irrigation schedules do not prevent control of weeds during the control window. Our ability to identify species assemblies and to identify control windows can improve the efficiency of weed control.

Methods

Weed species were planted at 4 equal intervals through out the year. Each species emergence and growth were recorded up until fruit maturation. Emergence and growth of each species were related to degree day accumulation using regression analysis. Historical air temperature weather data were acquired from UCIPM and two years from a ten year selection of temperature data were selected because of the difference in temperature patterns between the two years. Degree day models were run for each of those two years to find differences between years in plant development and to find differences in plant development with selected emergence dates with each year.

Results

Weed species did grow predictably according to accumulated degree days. Some species such as common lambsquarters did not grow at the same accumulated degree rate in each season (Figure 1). Different models may be required for some seasons but part of the difference in models may be a result of fewer stages of growth achieved in winter versus summer.

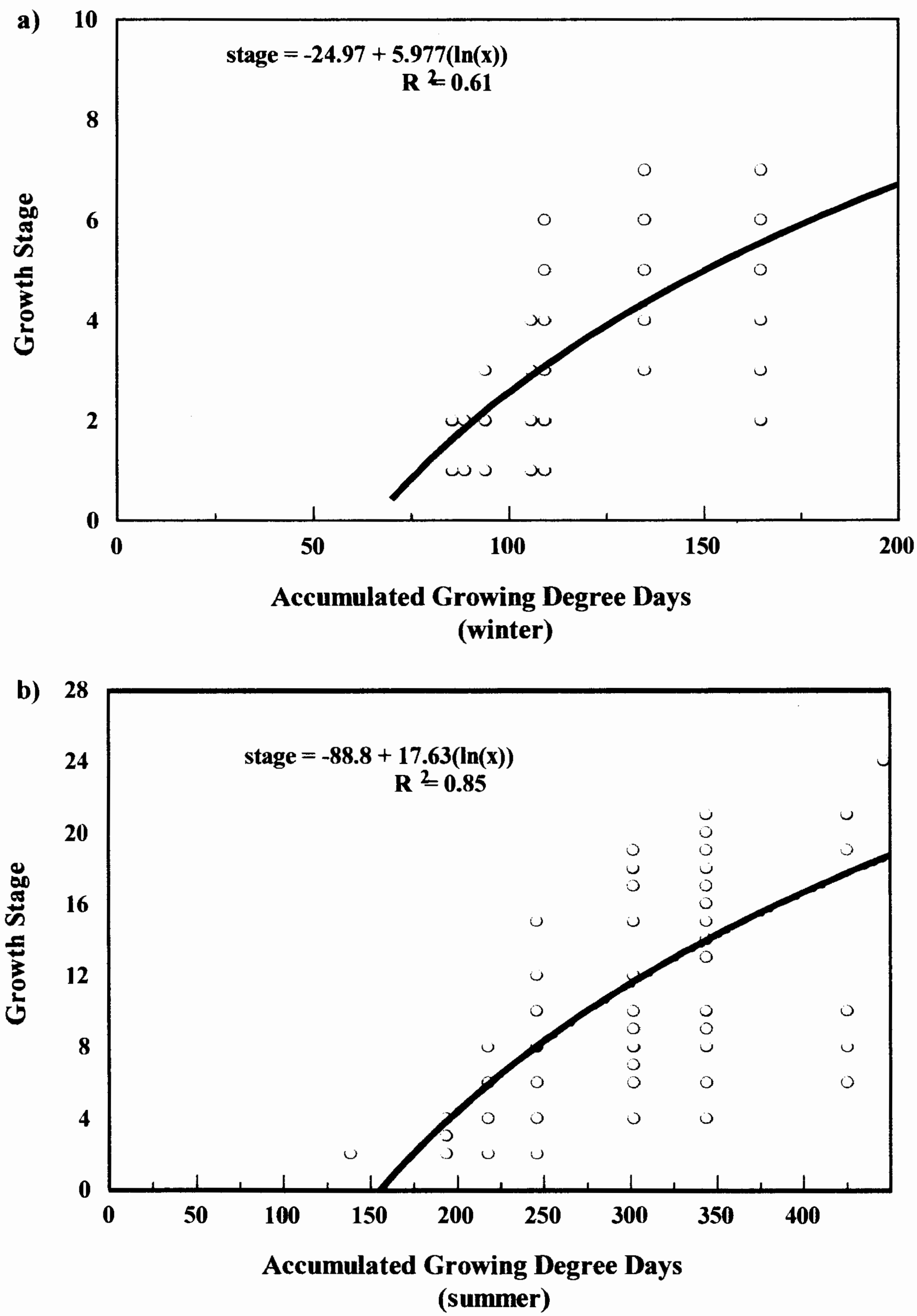

Figure 1. Accumulated growing degree day models for common lambsquarters grown in winter and summer. Growth in winter stopped at stage 10 (9 leaf stage) by frost.

Models may change with season but their utility for predicting phenological development is apparent when looking at how plant development changes with different germination and emergence dates through the year (Figure 2). Wild radish that initiates growth in October required only 8 calendar days to achieve the 2 leaf stage but a wild radish that initiated growth in January required 56 days to achieve the 2 leaf stage (Figure 2). Seasonal differences in phenological development could be manipulated when timing cover crop plantings to minimize competitiveness of weedy species. Understanding the seasonal differences in phenological development also allows the farmer or PCA to allocate labor efficiently to control weeds within a reasonable control window.

Weed species may respond differently to temperature between species but some species will have similar emergence and phenological development. Grouping of species into species assemblies requires that the most developed species must still be at a controllable stage at the time when the last species in the assembly emerges. If a technique such as flame cultivation requires flaming prior to the 12 leaf stage for a particular weed species (for example common lambsquarters) then the last member of that assembly must emerge prior to the 12 leaf stage of common lambsquarters. The assemblies also must reflect irrigation schedules. If control is delayed for a newly emerged member of an assembly and the field is too wet, then the oldest species may be past the phenological stage for control.

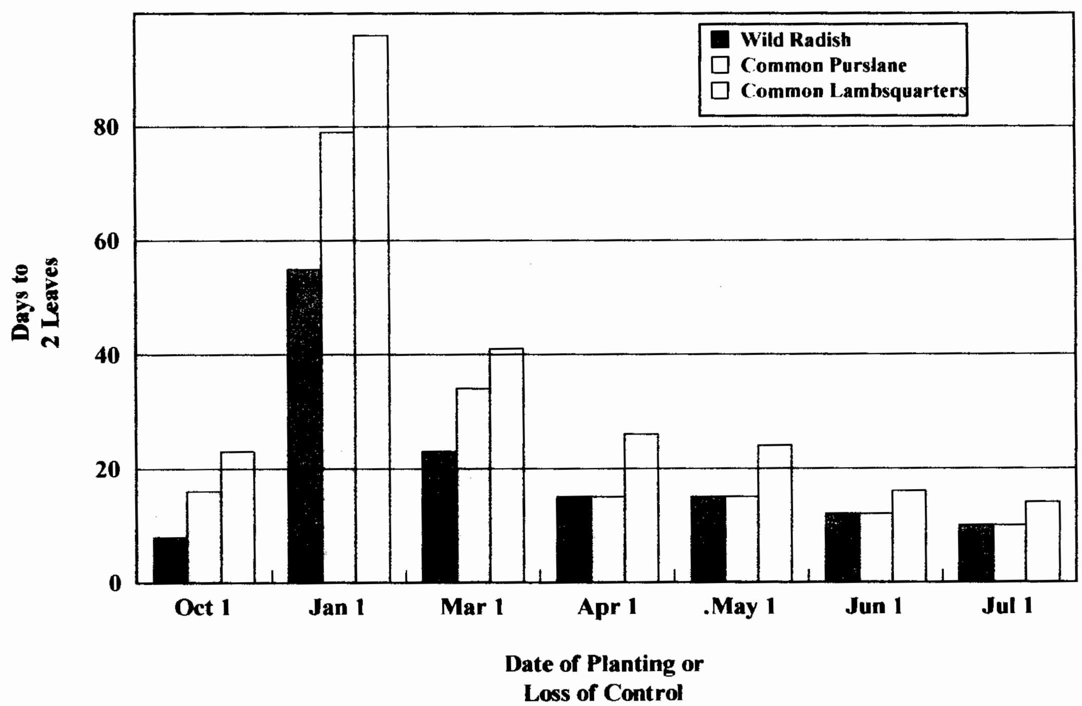

Figure 2. The effect of starting point for plant development for wild radish, common purslane and common lambsquarters on the number of calendar days required to achieve the 2 leaf stage.

Year to year variation in weather will change the calendar date at which a particular growth stage occurs. Accumulated degree day models will still reliably predict phenological development. Using historical temperature data to run the degree day models produced an interesting result. For two years with different temperature patterns, 1989 and 1996, weed species had the greatest calendar day variation in the winter and spring (Figure 3). For a number of species, the summer months were similar between years. The difference in calendar days between seasons is important because it means that once the degree day relationships have been worked out for species emerging in May through September, calendar dates can be used for prediction of growth stage. Degree day models will still need to be run for species emerging in late winter and spring.

Once species assemblies have been formed and the seasonal relationships are well understood, our ability to schedule weed control will be enhanced. Applications for degree day models are already under study. Examples include timing Surflan applications to just prior to common purslane emergence, and timing plantings of tomatoes to avoid severe competition from sheperdspurse. Basing control decisions on degree day models should improve efficiency of control and efficacy as well.

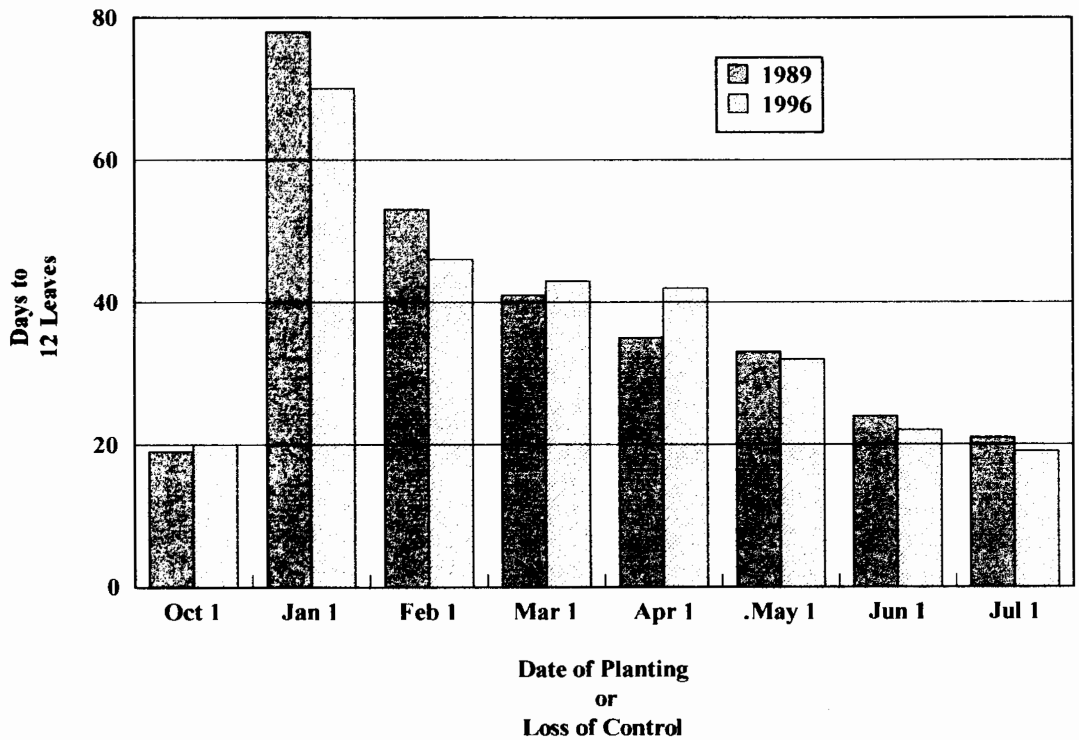

Figure 3. The effect of starting point for plant development for wild radish in two years on the number of calendar days required to achieve the 12 leaf stage.

WEED MANAGEMENT IN ORCHARDS AND VINEYARDS, "WHAT THE FUTURE WILL BRING"

Clyde L. Elmore, Extension Weed Specialist

Predicting what the future will bring is of course very difficult, even when you know the past developments. One can let their imagination run wild and see if the future catches up or one can be realistic and plan for some short-term goal. I will try to do a little of both today.

In the past we often had weedy or "dirty" orchards and vineyards, that is, the growers would allow plants to grow in between the tree or vine rows and even grow in the row until they could cultivate in the spring and early summer, thus weeds were growing all winter in the orchards. Cultivation with disks or mowing were about the only method of control. Often trees were planted far enough apart to get equipment between the row and between the trees, thus they could cross disk. Sometimes the weeds were grazed by livestock between the trees. The weeds were not native plants, but introduced species that had naturalized in California. I am mentioning this because more growers are allowing weeds to grow in the winter months again.

There was early research with cover crops in orchards. In 1922, peach trees were planted and cover crops were planted in 1923 at Davis. The purpose of the studies was to increase water holding capacity of the soil. Though it was not measured, the water holding capacity could be related to the organic matter of the soil. They stated that "under the warm, semi-arid conditions of Davis, in an irrigated orchard, cover crops have not increased either nitrogen or moisture-holding capacity of the soil during a 10-year period. The same authors reexamined the study after 25 years. They found that annual cover crops did not increase the organic matter, total nitrogen or water holding capacity at Davis. Alfalfa did increase total nitrogen but not water holding capacity. In other climates with less oxidation of organic materials, this result may not be valid. There is also research to show that planted cover crops act similarly to weeds to reduce nutrients and water that should be available for the crops.

Much of the weed control methods that we see today started with full floor treatment of citrus groves with herbicides in the late 50's and early 60's. These herbicides were not safe to use on deciduous fruits and vines and were not an adopted practice until simazine and diuron were introduced. Work by B. Day, A. Lange and others showed that a strip treatment of herbicides in the row reduced costs, reduced herbicides and continued the advantages of keeping the weeds away from the base of the trees and vines. Additional new herbicides were introduced to fit this niche market. Those herbicides are used today and include such herbicides as napropamide, oryzalin, pendimethalin and oxyfluorfen.

Where are we going from here?

New Equipment

There has been a renewed interest in small equipment for more precision cultivation. The French or hoe plow has been modified to have in-row cultivators with a similar trip lever design for many cultivators such as the Kimco, Clements, Howard, Weed Badger and others. These have become more precision and efficient for controlling weeds. They tend to be easy on young plantings and leave less of an "island" of plant materials round the base of the plant. Some are effective only on young weeds but others are good at even controlling large weeds. If weeds aren't removed when they are young, the competition for nutrients and moisture is still occurring. These cultivators still also cut surface roots where much of the nutrient uptake is occurring. They tend to be slow to use because of the precision and are thus somewhat expense to use. The cultivators are needed more than once during the season as new weeds germinate and grow.

There are also in-row mowers and mowers that can be used between the rows to reduce weed growth. These mowers can be adapted to throw the mowed biomass into the tree or vine row as a mulch to reduce annual weeds. There will be mowers that are more adept to cut and throw the biomass than those found today. They will probably be adjustable in width and will deliver both directions into rows. They may also be found where they can cut in front of the tractor, rather than currently from behind.

Mulches

There will be an increase in the use of mulches in trees and vines, at least until there start to be rodent problems with the mulches. The mulches are going to be both organic (wood and plant by-products) and synthetic organic products such as polypropylene and polyester geotextiles. There are large amounts of yardwaste that is being generated in the cities. Because of the large quantities, it is feasible that the price of mulch will be cheap enough that the transportation costs will not price it out of the market for agricultural uses. The consistency of the product must be improved before it can become a major source for use. Other by-products from agriculture that may be used include grape pumice, rice straw and almond shells. Control of annual weeds can be good with these products if they are distributed uniformly and reduce light enough to inhibit seedlings. Perennial weeds will become more prominent unless herbicides continue to be used. Mulching with geotextiles is high cost up front but if it is cared for in the field so it will not be ripped or displaced out of the row, it will last for years. There will be major claims for better growth and crop quality to persuade growers to use these materials.

Plants may be selected that have been shown to have additional benefits beyond light suppression. If it can be shown that allelopathy is present in a species it may be possible to transfer this trait to other plants that can be used as a suppressing species, either while growing or as a dead mulch in the tree or vine row. Of course it will be required that the tree species will tolerate the chemicals and not cause a residue in the fruit.

Herbicide application

Another technology that is in its infancy is the use of light sensitive sprayers. The one machine that is on the market today works well in low population (low % ground cover) to help save the amount of herbicide needed to control weeds. The techniques of using a mulch in the row and then this light reading applicator to control escaped weeds can greatly reduce herbicide use. Can this be used to selectively control broadleaves in grass cover crops, or could it be used to selectively control narrowleaf plantain (supports rosy apple aphid) in a cover crop without killing all the cover to reduce weed and insect problems? How specific can this technology become?

Non-herbicide equipment

A technology that has not been developed but may have potential, is the use of a moderate energy laser that could be directed to the base of trees and be roughly parallel to the ground or directed toward the base with multiple heads to burn off weeds at the ground level. The bark of the tree is dead and should protect the tree or vine; thus weeds could be controlled without a lot of energy. It would control weeds without a concern for residue in the fruit or soil and thus have little environmental concern.

Herbicides

New herbicides and new registrations of current materials should occur. Herbicides that need additional registrations include pendimethalin for bearing trees and vines, clethodim for bearing trees and vines, and thiazopyr for deciduous trees and vines (currently registered on citrus). There are four new herbicides that currently do not have any registrations in trees and vines that may get registration for some trees crops, 1) sulfosate (Touchdown) is a glyphosate trimethylsulfonium salt. It is a postemergence herbicide with many of the same characteristics of the glyphosate that you know now. It should have many of the same uses in trees and vines. 2) clopyralid (Stinger) is a postemergence herbicide that is exceptionally effective for the control of Aster family weeds. It has some soil activity and this may limit its use in some areas and some crops. 3) glufosinate (Rely, Ignite) is a postemergence herbicide that controls a broad spectrum of annual and perennial weeds. Though it is primarily a contact material, it does translocate some in plants, thus achieving a broader spectrum and better control. 4) azafenidin (Milestone) is primarily a preemergence herbicide with some post activity with some weeds. It has activity on both annuals and some perennials. It has soil activity and should combine with or replace some current herbicides. There will not be many new herbicides developed for trees and vines in the long term, but those developed will have to be specific and safe to use. This safety will include not only safety to the tree or vine but to the workers, applicators and the environment.

Other factors influencing vegetation management in orchards and vineyards.

Another factor that may impinge upon weed control in trees and vines include regulations on dust generated in the management process such as disking, floating and harvesting. The management of the orchard floor may change to accommodate these problems. This may promote more plant materials (cover crops) planted in orchards and vineyards where the commodity is not harvested from the ground.

If there is an increase in the number of orchards and vineyards that use resident vegetation or planted cover crops, there will be an increase in water use. This water use may be monitored to reduce unmaintained plantings if there is a reduction of water for agricultural use. Likewise the movement of insects, pathogens or weed seed from these low maintenance orchards or vineyards may create problems between neighbors.

The future

As there are more orchards and vineyards allowing weeds (covers) to grow in the field, have we finished the full circle of vegetation management in orchards and vineyards? Have we gone from vegetation, cultivation, mowing, herbicides and back to vegetation? Maybe this will occur in some areas, or some orchards, but not in the majority of the orchards and vineyards of California. I foresee a continued use of herbicides in strips in the tree or vine rows with cover crops or resident vegetation used between the rows.

THE USE OF LONG-TERM CHRONIC BIOASSAYS AND BIOMONITORING IN EVALUATING THE ENVIRONMENTAL IMPACT OF A COPPER-BASED ALGAECIDE USED FOR CONTROLLING ALGAL GROWTHS IN A HYDROELECTRIC WATER CONVEYANCE SYSTEM

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Introduction

Historically, copper-based algaecides have been commonly used as an effective means of controlling algal growths in many aquatic environments (Pryfogle, P.A., et al, 1997). However, in recent years the use of these types of algaecides has been of increasing concern to resource agencies in California, due primarily to a perceived long-term negative effect on aquatic ecosystems. Conclusive data on this subject are currently unavailable, especially for site specific applications, and more research is needed to evaluate long-term environmental effects.

The Pacific Gas & Electric Company (PG&E) operates numerous hydroelectric power facilities in California, with over three hundred miles of water conveyance canals. Algal growths in these canals create frequent maintenance problems and reduce the maximum flow through the canal, which directly effects power generation and overall operating costs. As one part of a multi-year study to investigate available algal control technologies, chemical control agents were evaluated for potential use in controlling algal growths in two representative canal systems. These two systems were: the Tiger Creek Canal, which eventually flows into the Mokelumne River; and the Drum Canal, which flows into the Bear River. The overall goal of the study was to develop environmentally sound, cost-effective, long-term management strategies for controlling algae in PG&E water conveyance canals.

Following a preliminary evaluation of numerous algaecide products, a chelated copper sulfate product called EarthTec was chosen for further testing. This product was chosen because of its unique formulation that allows it to be applied at very low concentrations of copper (20-30 ppb), in comparison to other products which are applied at higher concentrations (0.5-1 ppm); and because of its purported effectiveness in waters with low alkalinity, low pH, and low bicarbonates, typical of many high Sierra streams and the water in the Tiger Creek and Drum canals.

Prior to conducting either the field tests or the laboratory tests, the California Department of Fish and Game (CDF&G), California Regional Water Quality Control Board, and the Amador County Agricultural Department were apprised of the proposed algaecide applications. All three of the agencies participated in reviewing the study design and application procedures for this project.

To ensure that the use of this product was not detrimental to aquatic resources, CDF&G required that: bioassays be conducted to evaluate potential acute and chronic effects of the proposed EarthTec applications on primary fish species occurring in the two river drainages; and that a long-term monitoring program be developed to assess the effects of potential copper accumulation in sediment and aquatic insects resulting from the use of EarthTec in the canals. This report addresses the results of the bioassays that were conducted to allow the use of EarthTec in the canals, and the preliminary results of the field monitoring program.

Methods

Based on the manufacturers recommendations, initial EarthTec applications to the canal were to be made at 22 and 30 ppb for 6- or 12-hour durations, at weekly or biweekly intervals to determine effectiveness in controlling algal growths. A 96-hour acute bioassay was conducted using rainbow trout fry to determine the LC50 of EarthTec in water representative of the canal water. Secondly, to evaluate the potential effects of the proposed treatments on rainbow trout, a bioassay protocol was developed to mimic the actual application procedure to be used in the 17-mile long Tiger Creek Canal.

From March through April, 1996, a series of bioassays were conducted with EarthTec. In these tests, rainbow trout fry were subjected to repeated exposures of 25 ppb for 7-hour periods, and 35 ppb for 7- and 13-hour periods, on 7- and 14-day intervals. To provide a conservative estimate of the effects that might be encountered during actual canal applications of 22 and 30 ppb, slightly higher concentrations of 25 and 35 ppb were chosen for testing. Following exposure, rainbow trout fry were transferred to freshwater (with the same water quality characteristics as that found in the Tiger Creek Canal) until the next treatment. In each of the test scenarios, rainbow trout fry were exposed to EarthTec concentrations three to five times at either 7- or 13-hour treatment durations, at 7- and 14-day intervals. A summary of the test scenarios are provided in Table 1. A total of 40 trout (20 trout in two replicate aquaria) was used for all test scenarios and for controls.

Table 1. Test scenarios for the March-April, 1996 bioassays.

EarthTec Concen-tration	Chemical Exposure Duration	Duration in Freshwater from One Treatment to the Next	# Days After Initial Exposure that Fish were Analyzed for Copper	Total # of Treatments
25 ppb	7 Hours	7 Days	7, 14, 21, and 28	5
25 ppb	7 Hours	14 Days	14, 28, and 42	3
35 ppb	7 Hours	7 Days	7, 14, 21, and 28	5
35 ppb	7 Hours	14 Days	14, 28, and 42	3
35 ppb	13 Hours	7 Days	7, 14, 21, and 28	5
35 ppb	13 Hours	14 Days	14, 28, and 42	3
Control	----	Continuous	7, 14, 21, 28, and 42[1]	----

[1] Control fish were analyzed on these days, but were never exposed to copper treatments.

Fresh EarthTec concentrations of 25 and 35 ppb were prepared each week just prior to treatment. Fish from both replicate aquaria of each test scenario were carefully transferred from their freshwater tanks into aquaria containing the fresh EarthTec solutions. Following treatment, the fish were transferred back to their freshwater tanks. Control fish were transferred to new freshwater tanks every two to three weeks so that any handling effects would be consistent for all fish.

Water changes were conducted on a weekly basis during periods in freshwater to maintain water quality parameters similar to that found in the Tiger Creek Canal. These parameters were: pH = 6.8-7.2; alkalinity = 10-15 mg/l $CaCO_3$; and hardness = 10-15 mg/l $CaCO_3$. Control water, dilution water, and water used in weekly water changes were created using deionized water and reagent grade chemicals. All aquaria were aerated throughout the test period. Dissolved oxygen, pH, temperature, percent survival, and any unusual behavior was recorded every other day for all test aquaria throughout the test period.

Whole body copper analyses were conducted periodically, on both test and control fish to monitor copper body burden levels. Percent survival and copper body burdens for trout in each of the test scenarios, were the primary end results determined during the testing period. A body burden analysis was performed rather than a gill tissue, or liver analysis, due to the small size of the fish.

Test and control fish to be used for whole body copper analysis were randomly obtained from each replicate aquarium at the end of the required period in freshwater, just prior to the next EarthTec treatment. Three rainbow trout fry were removed from each of the two replicate aquaria of each test group prior to re-treatment. After removal from the aquaria, fish to be used for copper analysis, were placed in carbonated water until dead. The fish were then placed in plastic zip-lock bags, labeled, and quickly frozen for transport to PG&E's Technical & Ecological Services Analytical Chemistry Unit in San Ramon, for processing. The three rainbow trout fry from each replicate aquaria were composited separately to obtain two copper body burden values for each treatment scenario. Fish samples were prepared for analysis using a nitric acid/hydrogen peroxide digestion performed in Teflon pressure vessels with microwave assisted heating. This method is a variation on the Association of Official Analytical Chemists (AOAC) closed vessel digestion method 974.14 for mercury in fish. This variation is documented in the CEM microwave digestion system methods manual. The digested samples were subsequently analyzed using atomic absorption spectrophotometry. Preparation blanks were used during each set of analyses.

Because the results of the field tests to control algae in Tiger Creek Canal during the summer and fall of 1996 were only partially successful, a second series of new field tests were scheduled for the summer of 1997.

The proposed Tiger Creek Canal treatment procedures for 1997 involved the application of EarthTec at the same concentration of 30 ppb, but for significantly longer periods. Consequently, new long-term bioassay tests were needed to provide the necessary data to support these new application rates.

To determine the effect of the proposed 1997 EarthTec applications on resident trout species, three application durations at one concentration (30 ppb) were proposed for testing. These durations were 48-, 72-, and 96-hours, with a period of one to three weeks between treatments. These application scenarios were designed to allow for flexibility in the canal treatment schedule, depending on the effectiveness of a particular treatment duration. Again, the primary goal was to determine the shortest treatment duration with the longest period between treatments necessary to maintain control of algal growths in the canal. Because the new proposed treatment durations were significantly longer than previous applications, CDF&G requested that the bioassay testing also include brown trout, which occur in the Mokelumne River drainage. Consequently, new bioassay test procedures were designed to replicate the new proposed canal treatments to determine the effects of each EarthTec treatment scenario on rainbow trout fry and brown trout fingerlings.

The second series of bioassays was conducted from October, 1996, through January, 1997, for a period of 28-84 days, depending on the treatment duration and the length of time in freshwater between treatments. Rainbow trout fry and brown trout fingerlings were exposed to 35 ppb EarthTec for all of the proposed treatment scenarios. Again, a slightly higher concentration of 35 ppb was used to provide a conservative estimate of the effects. The same general procedures described previously for the March-April bioassays were used in these tests. A total of 24 brown trout fingerlings (12 trout in replicate aquaria), and 40 rainbow trout fry (20 trout in replicate aquaria) were used for all test scenarios and for the controls. A summary of the new test scenarios are provided in Table 2.

Table 2. Test scenarios for the October, 1996 through January, 1997 bioassays.

Fish Species	**EarthTec Concen-tration**	**Chemical Exposure Duration**	**Duration in Freshwater from One Treatment to the Next**	**# Days After Initial Exposure that Trout were Analyzed for Copper**	**Total # of Treatments**
Brown Trout	35 ppb	48 Hours	5 Days	14, 21 and 28	3
Brown Trout	35 ppb	48 Hours	12 Days	14, 28, 42 and 56	4
Brown Trout	35 ppb	72 Hours	11 Days	14, 28, 42 and 56	4
Brown Trout	35 ppb	72 Hours	18 Days	21, 42, 63 and 84	4
Brown Trout	35 ppb	96 Hours	10 Days	14, 28, 42 and 56	4
Brown Trout	35 ppb	96 Hours	17 Days	21, 42, 63 and 84	4
Brown Trout	Control	----	Continuous	14, 21, 28, 42, 56, 63 and 84[1]	----
Rainbow Trout	35 ppb	48 Hours	5 Days	14, 21 and 28	3
Rainbow Trout	35 ppb	48 Hours	12 Days	14, 28, 42 and 56	4
Rainbow Trout	35 ppb	72 Hours	11 Days	14, 28, 42 and 56	4
Rainbow Trout	35 ppb	72 Hours	18 Days	21, 42, 63 and 84	4
Rainbow Trout	35 ppb	96 Hours	10 Days	14, 28, 42 and 56	4
Rainbow Trout	35 ppb	96 Hours	17 Days	21, 42, 63 and 84	4
Rainbow Trout	Control	-----	Continuous	14, 21, 28, 42, 56, 63 and 84[1]	----

[1] Control fish were analyzed on these days, but were never exposed to copper treatments.

Test trout were exposed to the 35-ppb EarthTec solution for varying treatment durations (i.e., 48-, 72-, and 96-hours) for a minimum of four treatments. The fish were then transferred back to the freshwater tanks for a 5- to 17-day period, depending on the treatment duration (e.g., 48-hour treatment/5 days freshwater, 72-hour treatment/17 days freshwater, etc.). The number of days in freshwater between treatments was established so applications would always fall on the same day of the week.

Once again, test and control fish to be used for whole body copper analysis were randomly obtained from each replicate aquaria at the end of the required period in freshwater, just prior to the next EarthTec treatment. However, during this test two rainbow trout fry and one brown trout fingerling were removed from each of the two replicate aquaria of each test group prior to re-treatment. The two rainbow trout fry from each replicate aquaria were composited separately to obtain two copper body burden values for each treatment scenario. The brown trout fingerlings were analyzed individually.

Field Monitoring

As part of the overall monitoring plan for EarthTec applications on the Tiger Creek Canal, CDF&G required PG&E to develop a monitoring plan for evaluating the long-term effects of copper on downstream aquatic habitats potentially affected by the algaecide. The monitoring plan was initiated in 1996 at the beginning of the algal season with the collection of baseline samples from the Tiger Creek Canal system, and from Tiger Creek, which is linked with the canal. Monitoring involved the collection of sediment samples from five stations within the Tiger Creek Regulator Reservoir, and sediment and aquatic insect samples from two stations on Tiger Creek, which flows into and out of the regulator. The control station was located on Tiger Creek above the regulator, which is not affected by algaecide applications to the Tiger Creek Canal. Figure 1 provides details of the canal system and copper monitoring stations.

The monitoring protocol required that samples be collected each year just prior to the first use of EarthTec, a second set of samples to be collected midway through the summer, and a third sampling effort after the last application of the year. The data would then be analyzed and evaluated by PG&E and CDF&G prior to the next year's applications. The results would be used to determine if the EarthTec applications were causing a net increase in copper levels in either sediment or aquatic insects, during the year, or from one year to the next.

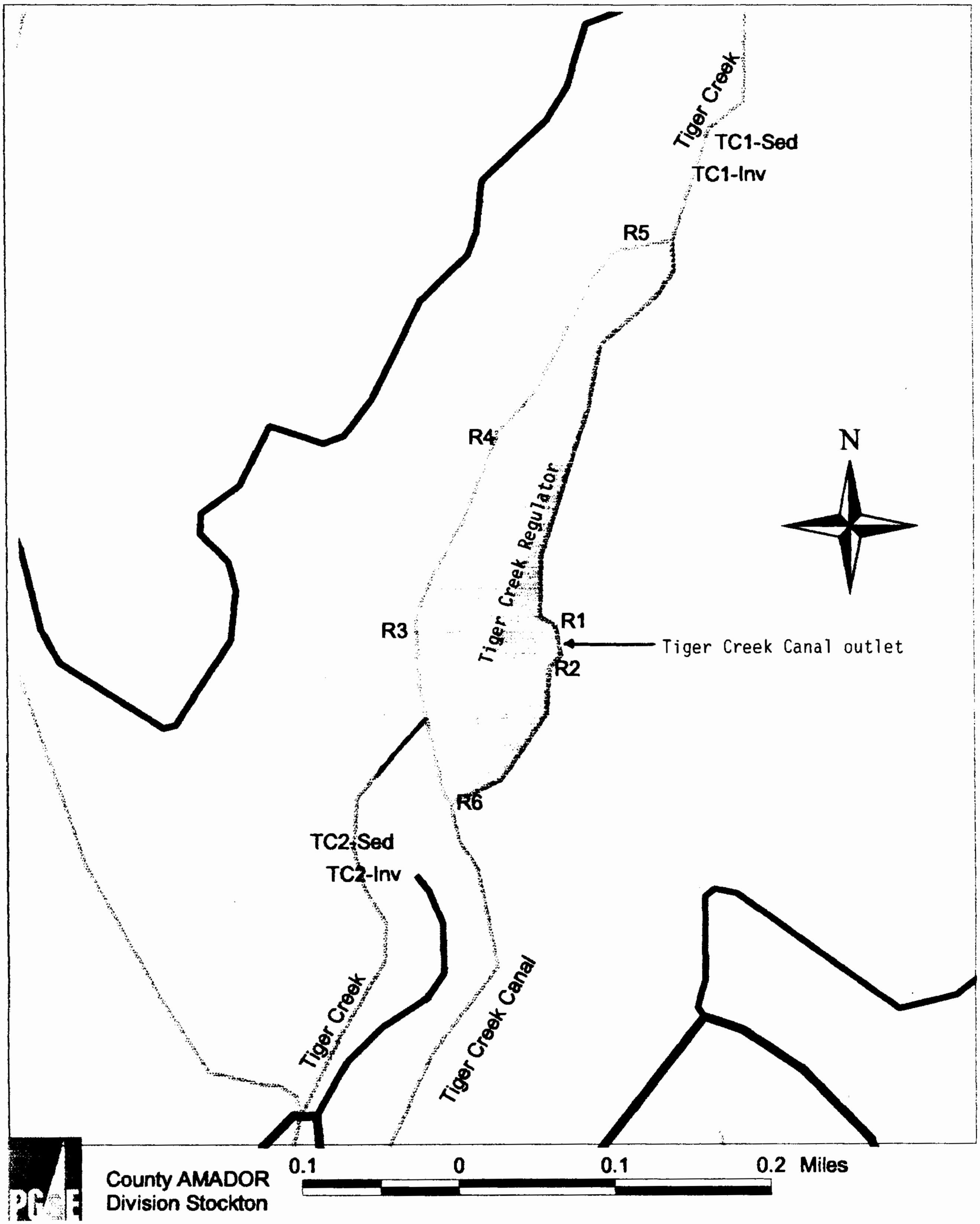

Figure 1. Copper Monitoring Stations for Sediment and Aquatic Insects.

Results

Series 1 Bioassays, March-April, 1996

In the 42-day test period from March to April 1996, rainbow trout fry survival was 100 percent for all test scenarios, and for the controls. The results of the whole body copper analyses showed little difference in copper concentrations between test fish and control fish over the duration of the test period. Table 3 provides a summary of the results. In addition, trout growth rates in all test aquaria were similar to that of control fish.

Table 3. Rainbow trout fry whole body copper analyses from the March-April, 1996 bioassays.

Test Scenario	EarthTec Concentration	Total Treatments	Results of Whole Body Copper Analyses in ppm (mg/kg Cu)[1,2]				
			3/19	3/26	4/3	4/11	4/18
7 Hr. Treatment/ 7 Days Freshwater	25 ppb	5	0.85		1.18		0.98
7 Hr. Treatment/ 14 Days Freshwater	25 ppb	3		0.83		1.54	
7 Hr. Treatment/ 7 Days Freshwater	35 ppb	5	0.83		1.00		0.84
7 Hr. Treatment/ 14 Days Freshwater	35 ppb	3		0.79		0.81	
13 Hr. Treatment/ 7 Days Freshwater	35 ppb	5	0.95		0.92		0.98
13 Hr. Treatment/ 14 Days Freshwater	35 ppb	3		0.82		0.91	
Control	-----	-----	0.85	0.77	0.83	0.82	0.89

[1] Three rainbow trout fry were composited for each analysis.
[2] The detection limit for all samples ranged from 0.1 to 0.2 mg/kg Cu.

In addition to the copper present in the EarthTec, the rainbow trout chow contained 9.9 mg/kg copper, which contributed to the body burden levels found in all of the fish. Even the test fish, when originally obtained from the hatchery, contained low levels of copper. Three replicate samples of rainbow trout fry obtained from the hatchery had a mean copper level of 1.80 mg/kg prior to being subjected to test conditions, which was similar to values obtained for fish analyzed at the end of the test period after four applications. Based on this information, copper levels found in the control rainbow trout, which were similar to the levels found in the test trout, appear to represent a baseline condition for all trout in the test.

Based on the positive results of the 1996 bioassays, and the results of the initial field applications on the Drum Canal, EarthTec was used to control algae in the Tiger Creek Canal during the summer and fall of 1996. These operational applications to the canal were generally successful; however, the maximum application rate and duration (30 ppb for 12 hours) was only partially effective in controlling the growth of algae in the canal. Consequently, significantly longer treatment durations were proposed for the 1997 algae season.

Series 2 Bioassays, October, 1996 through January, 1997

During the 84-day test period from October, 1996 through January, 1997, all six test scenarios for both brown and rainbow trout were successfully completed. Survival rates for both the rainbow trout fry and brown trout fingerlings were generally in the 90 - 100% range at the end of the test period. This is an extremely high survival rate considering that the tests were conducted in static aquaria over an extended period of time (28 to 84 days), and that fish were handled repeatedly throughout the test period.

With the exception of the rainbow trout 96-hour/17 day freshwater test, no unusual problems occurred in any of the test scenarios throughout the duration of the study. During the last eight days of the test (days 76-84), 13 rainbow trout fry died in the two replicate aquaria of the 96-hour/17 day test. Water quality parameters in the two tanks were similar to all other test and control aquaria. There was no evident reason for the mortalities; however, the fish were somewhat lethargic and may have developed a disease. It is unclear whether the 96-hour treatments weakened the fish and predisposed them to disease or whether the mortalities were due to some other extraneous factor. However, since the other 96-hour test scenario (96-hour/10 days freshwater) had more frequent treatments with 100% survival, it seems unlikely that the treatments caused the mortalities.

Based on the high survival rates for all test scenarios (except the rainbow trout 96-hour/17 day freshwater treatment) repeated long duration (48- to 96-hour) EarthTec exposures did not negatively affect either brown trout fingerlings or rainbow trout fry. Growth rates did not appear to be negatively affected by any of the EarthTec treatment scenarios. The mean length of test fish was similar to that of control fish for both rainbow trout fry and brown trout fingerlings.

Whole body copper analyses were conducted on both rainbow trout fry and brown trout fingerlings after each EarthTec treatment and the required period in freshwater, except for the 48-hour/5 day freshwater scenario, which started after the second treatment period. Control fish were also analyzed each time test fish were analyzed. The results of the whole body copper analyses showed little difference in copper concentrations between test fish and control fish for both rainbow and brown trout throughout the duration of the test period.

Rainbow trout and brown trout copper body burdens did not change significantly from one EarthTec treatment to the next, regardless of exposure time or the duration in freshwater. In addition, the copper levels in the test fish were not significantly different from the copper levels in the control fish. Tables 4 and 5 provide a summary of the rainbow trout fry and brown trout fingerlings analyses results. An Analysis of Variance (ANOVA) showed no significant difference between treated and control fish for any of the test scenarios. Results of the copper analyses indicate that, for the scenarios tested, the periods in freshwater between the EarthTec treatments was sufficient to allow depuration of copper from the bodies of both rainbow and brown trout.

Table 4. Rainbow trout fry whole body copper analyses from the October, 1996 through January, 1997 bioassays.

Test Scenario[1]	Total # of Treatments	Results of Whole Body Copper Analyses in ppm (mg/kg Cu) for Replicate Aquaria[2,3]						
		10/28	11/4	11/11	11/25	12/9	12/16	1/6
48 Hr. Treatment/	3	0.81[4]	1.15	---[5]				
5 Days Freshwater		0.96[4]	1.10	---[5]				
48 Hr. Treatment/	4	0.84		1.22	1.97	1.10		
12 Days Freshwater		0.78		1.00	1.16	0.96		
72 Hr. Treatment/	4	0.73		0.75	1.06	1.07		
11 Days Freshwater		0.68		1.13	1.11	1.15		
72 Hr. Treatment/	4		0.86		0.86		1.14	0.99
18 Days Freshwater			0.82		1.00		1.14	1.09
96 Hr. Treatment/	4	0.68		0.94	1.36	1.04		
10 Days Freshwater		0.88		1.35	1.27	1.26		
96 Hr. Treatment/	4		1.32		1.02		1.26	1.65
17 Days Freshwater			0.99		0.77		1.15	1.47
Control	----	1.05	0.81	0.99	1.31	1.52	1.08	1.12
		0.75	1.07	0.83	1.04	1.15	1.30	1.15

1 All test scenarios were conducted at EarthTec concentrations of 35 ppb.
2 Two rainbow trout fry were composited from each aquarium for analysis.
3 The detection limit for all samples ranged from 0.2 to 0.3 mg/kg Cu.
4 Fish with weekly treatments were initially analyzed for copper after the second chemical treatment, and after each subsequent treatment. In other treatment scenarios, fish were analyzed for copper after all treatments.
5 The fish removed from the 48-hr. treatment on 11/11 were misplaced at the laboratory and consequently were not analyzed.

Table 5. Brown trout fingerlings whole body copper analyses from the October, 1996 through January, 1997 bioassays.

Test Scenario[1]	Total # of Treatments	Results of Whole Body Copper Analyses in ppm (mg/kg Cu) for Replicate Aquaria[2, 3]							
		10/21	10/28	11/4	11/18	11/25	12/2	12/9	12/30
48 Hr. Treatment/	3	1.39[4]	0.81	2.08					
5 Days Freshwater		0.93[4]	0.96	1.62					
48 Hr. Treatment/	4	1.27		1.24	1.32		1.47		
12 Days Freshwater		1.14		1.79	1.33		1.81		
72 Hr. Treatment/	4	0.76		1.09	1.08		1.47		
11 Days Freshwater		1.04		1.51	1.03		1.60		
72 Hr. Treatment/	4		1.20		1.86			1.32	1.87
18 Days Freshwater			1.11		0.83			1.16	1.59
96 Hr. Treatment/	4	1.28		1.84	1.11		1.38		
10 Days Freshwater		1.58		1.31	1.49		1.66		
96 Hr. Treatment/	4		1.62		1.29			1.52	1.21
17 Days Freshwater			1.85		1.62			1.41	0.92
Control	----	0.84	0.73	2.09	1.40	1.15	1.43	1.56	1.52
		1.17	1.21	1.83	1.70	0.87	1.11	1.19	1.46

1 All test scenarios were conducted at EarthTec concentrations of 35 ppb.
2 The detection limit for all samples was 0.1 mg/kg Cu or less.
3 Brown trout fingerling were analyzed individually.
4 Fish with weekly treatments were initially analyzed for copper after the second chemical treatment, and after each subsequent treatment. In other treatment scenarios, fish were analyzed for copper after all treatments.

The rainbow trout chow contained similar levels of copper as described in the results for the March-April, 1996 bioassays. The brown trout chow also contained copper (approximately 12.5 mg/kg), which contributed to the body burden levels found in all of the fish. The test fish, obtained from the hatchery, also had low levels of copper. Based on this information, copper levels found in the control brown trout, which were similar to the levels found in the test trout, appear to represent a baseline condition for all trout in the test.

Field Monitoring

The results of the 1996 and 1997 sediment and aquatic insect monitoring program indicate that EarthTec applications to the Tiger Creek Canal have not caused a net increase in copper in either sediment or aquatic insects at any station. Table 6 provides a summary of the results obtained through 1997. The monitoring program is scheduled to continue through the year 2000. If at the end of this period, results still show no increasing trend in overall copper levels, the monitoring program may be terminated after consultation with CDF&G.

Table 6. Copper monitoring data for sediment and aquatic insects for Tiger Creek and the Tiger Creek Regulator.

Station Location	Sampling Dates and Copper Analysis Results in ppm (mg/kg)					
	7/11/96	9/6/96	11/26/96	4/3/97	8/7/97	11/18/97
Tiger Creek Regulator R1 - Sediment	21	17	49	38	64[2]	25
Tiger Creek Regulator R2 - Sediment	36	35	21	22	16	24
Tiger Creek Regulator R3 - Sediment	20	17	12	26	62[2]	24
Tiger Creek Regulator R4 - Sediment	21	17	35	21	20	31
Tiger Creek Regulator R5 - Sediment	8.1	6.7	7.3	6.2	8.3	6.6
Tiger Creek Regulator R6 - Sediment	---[1]	9.4	17	14	22	15
Tiger Cr. above Regulator						
TC1 - Sediment	6.6	4.6	10	8.1	67[2]	5.4
TC1 - Insects	5.3	4.4	5.3	5.2	8.3	8.2
Tiger Cr. below Regulator						
TC2 - Sediment	---[1]	---[1]	21	33	62[2]	28
TC2 - Insects	12	12	12	7.8	13	17

1 These samples were originally not required as part of the monitoring plan, but were added later to augment information from the other stations.

2 Data are highly suspect; extremely high values may be due to contamination at the laboratory.

Conclusions

Considering the high rate of survival in both series of bioassays, and the results of the whole body copper analyses, none of the test scenarios appeared to have a negative effect on either the rainbow trout fry or brown trout fingerlings. Based on these findings, EarthTec applications on the Tiger Creek or Drum canals of 30 ppb for 48- to 96-hour durations (every two to three weeks) does not appear to have an acute or chronic effect on either rainbow trout or brown trout.

Based on the overall results of both series of bioassays, CDF&G approved the continued use of EarthTec on the Tiger Creek and Drum canals at the application rates that were tested.

The results of the 1996 and 1997 sediment and aquatic insect monitoring program show no increasing trend in copper in either the sediments, or in aquatic insects. Based on these data, PG&E will continue EarthTec treatments in 1998.

FIFTY YEARS OF VEGETATION MANAGEMENT

Turney J. Hernandez
Executive Director
National Roadside Vegetation Management Association

In September 1952, I joined the DuPont Co. They had just developed the Substituted Urea herbicides (Monuron & Diuron) and my primary responsibility, over the next 5 years, was to introduce them in cotton, sugar cane and non-crop markets in Louisiana, Arkansas, Mississippi and east Texas. At that time, the primary herbicides used in IWC were the phenoxys, ammonium sulfamate, sodium chlorate, the borates and metaborates, weed oils, sodium arsenate and tri-chloracetic acid. The substituted triazines were introduced shortly thereafter.

As we all know, most of these "old" products posed serious liabilities. The phenoxy esters presented volatility and drift concerns, sodium chlorate was highly flammable, the arsenicals label carried skull and crossbones, the borates were applied at 2,000 to 4,000 lbs per acre, ammonium sulfamate was corrosive and required rates of 120 to 180 lbs per acre, and the weed oils were considered environmental pollutants. Conversely, monuron and diuron were much safer, highly effective herbicides and use rates ranged from 10 to 60 lbs per acre for bare ground weed control and 0.25 to 0.3 lbs per acre for weed control in cotton and 0.50 to 2 lbs per acre in sugar cane.

The introduction of these compounds was a real learning experience. In crops, we had results ranging from non-performance during dry periods to outstanding results after rainfall in sandy and clay loams, and phytotoxicity in deep, fine sands. The key factors affecting performance were soil type, availability of moisture and weed species. We learned the hard way about the K factor, adsorption, need for activation, photo breakdown and the need for the proper equipment, nozzles and calibration, etc.

In non-crop weed control, we had few successes. We learned that deep-rooted perennials such as Johnsongrass, bermuda, vasey and dallis grass required rates twice the initial label rates. "Telvar" was effective on most vines but diuron was ineffective. Few customers had the proper equipment so we had to "rig up" and calibrate the sprayers.
In short, selling a job entailed setting out test plots to determine exact rates required, assist with the applications and follow-up.

One of the best lessons we learned was how to handle complaints. We decided early to investigate all complaints. In cotton, during our first year, over 40% of the farmers complained about crop injury or inadequate control. Every year thereafter, fewer and fewer complaints were received as we refined rates and application techniques. Within 5 years, over 70% of the cotton acreage in the Mississippi Delta was treated with "Karmex" as a pre-emergent herbicide. In non-crop weed control, with "Telvar", the higher rates were very effective but off-target washing and injury to roots of valuable plants required label refinement and remedial considerations.

DuPont was very successful with the ureas and Geigy with the triazines in corn and IWC markets. This seemed to have encouraged many companies to invest heavily in developing new compounds during the late '50's. By the early '60's, several new herbicide families were introduced: "Treflan" and "Cotoran" for cotton and soybeans, and "Dowpon", "Hyvar", "Tordon", "Banvel", "Trysben", "Tandex" and "Spike" for IWC markets. These compounds quickly found niches in the marketplace and were widely used. They upgraded our ability to develop programs for customers. "Hyvar" was particularly effective on perennial grasses and was a superior residual for arid areas. Picloram's effectiveness on brush, perennial vines and noxious weeds was also very important.

During this period, universities were establishing weed science departments and curriculum that turned out graduates by the hundreds. They were well trained in the basics and significantly impacted the industry. Most were raised on farms and had been introduced to "hard work". Upon graduating, they went to work for herbicide manufacturers as researchers for universities, by utilities, railroads, state highway departments, county weed districts, etc. These professionals upgraded the industry to a technical level unmatched by any other ag related science. Researchers developed outstanding herbicides that had been thoroughly tested and were marketed and used with a high level of expertise.

During the '60's and early '70's, industry continued to develop compounds at a rapid rate. Compounds such as "Roundup", "Krenite", "Arsenal", "Velpar", "Garlon" and "Krovar" were followed by the sulfonyl ureas in the mid to late '70's. They continued to upgrade our flexibility in planning superior programs for customers. This was an era of great progress. Non-crop markets mushroomed. These compounds ("Oust", "Telvar", "Glean", "Escort") really impacted the market. They opened up sizeable selective weeding programs. Bermuda release in the south became a vast market. We were able to control tall growing broad-leaved plants as well as the tall, undesired grasses; to rèlease short desired species, such as saltgrass, bermuda and bluegrass. Mowing costs were slashed by highway departments, railroads, utilities, drainage and plant sites. Highway departments mowing 8 to 10 times per year were able to reduce to 1 or 2 herbicide applications plus 1 or 2 mowings to realize savings of $40 to $100 per acre.

The introduction of the sulfonyl urea herbicides and other like compounds was an important development because of their low mammalian toxicity, broad activity on weeds and unbelievably low use rates (as low as 1/4 to 4 ounces per acre). The fantastic activity of these compounds necessitated they be kept on target. They helped to defend the use of herbicides with activists, the EPA, the public and elected officials.

By now, the vast array of products on the market sold by so many different companies created a very competitive business climate. It also made it possible to offer a program that would solve most of a customers needs. Bare ground, short term weed control, selective weeding, chemical trimming or control of brush, was possible for most any site regardless of its nature or plant species involved.

As marketers, we also got smarter. We analyzed customers needs and designed programs based on personal inspections of properties. We were able to "customize" jobs without injuring valuable plants, chemical trespass, or creating erosion problems. Our credibility was enhanced because we were using our own compounds as well as competitors to do the best job, the safest and at the least cost. This marketing technique resulted in significant market enhancement. This "service selling" is the key to success to this day.

There were a number of other developments that impacted this era:
1. During the '50's and '60's a number of states passes "Noxious Weed Laws" that delivered great dividends to the farmers by reducing weed control costs in crops and to all inhabitants. The county weed directors are professionals in weed identification, application techniques, and weed control technology, who perform a great service to their counties and state.

2. The introduction and marketing of a number of good surfactants, spray adjuvants, drift control agents, inverts, etc. also played an important role in that we were able to improve sprayability, reduce spray volumes, improve coverage, make applications safer and maximize performance at little additional cost.

3. The manufacturers of nozzles, valves, sprayers, hoses, agitators, injectors and computer equipment have also played an important role in this industry. Most railroad spray equipment has the capability to spray 2 or 3 different treatments simultaneously to rail beds, crossings, bridges, signs and switch stands while traveling 10 to 18 mph. The vast array of equipment available on the market facilitates getting the job done with safety to the public and the application personnel, regardless of the nature of the problem or the site.

4. We realized early on that it was impossible to call on every prospect. Also, many could ill afford to hire and train manpower, purchase the equipment and determine the right treatment. Custom application was the answer. In my territory, by 1956, I had five custom applicators actively involved in the business. They, in time, were well trained, had the proper equipment, were licensed and had insurance to protect against liabilities. Today, about 95% of the railroads are custom treated; utilities 80% to 90%; plant sites 90% to 95% and forestry 80% to 85%. The roadside markets and county weed districts are still largely self applied.

The environmental movement has had a significant impact on pesticide use. It really started with Rachel Carson's book "The Silent Spring". During the 50's, most of us grew up on farms and were delighted to replace "back-breaking" work (like cotton chopping, hoeing sugar cane, or pulling weeds in rice) with herbicides. But the image of the old herbicides (i.e. agent orange, arsenicals, chlorates) was hard to shed. Activists claimed that most pesticides were dangerous, creating questions in the minds of the public. Initially industry failed to properly defend pesticides. I remember DOW spending millions to defend phenoxys, only to get a "bloody nose". In time, the activists overplayed their hand with misinformation and industry, with leadership and guidance from organizations such as NACA and RISE, helped turn things around. They are still a problem, but to a high degree, have shifted their attention to more enticing areas such as logging old forests, endangered species, CO's and local legislation that would make it more difficult to use pesticides.

Since the '80's, few products from new chemistry have been introduced. The cost of developing new products has mushroomed. The ureas cost DuPont in the range of $3 million. Today's costs are in excess of $50 million. Few business managers have the resources or the guts to gamble that kind of capital considering the "climate" in the marketplace. Efforts are being diverted to bio-technology and plant modification so that old chemistry can be utilized or modified to reach the substantial markets that exist.

Now a few brief comments:

1. Environmentalism is a moral issue. We have no alternative but to accept it. IRVM Programs are a must.

2. The Endocrine issue will require patience and, hopefully, science will disprove the claims.

3. Activists are here to stay and less of a factor, but we must be vigilant and defend our actions.

4. In IRVM programs, beautification and releasing desirable native species, should be important ingredients.

5. Safety is a major issue. Training programs are working.

6. The high cost to develop and re-register compounds is impacting the industry.

7. The edict to reduce pesticides 50% is resulting in an increase in the cost of vegetation management programs.

Marketing herbicides today is so different from my era of 1952 to 1985. Salesmen have, in many cases, 2 to 3 states as a territory. Their computer is their lifeline to colleagues and customers and travel budgets are a fraction of what they used to be. I entered the business when it was in it's infancy. We made great strides. It was fun - a dynamic business!

PAST TRENDS AND THE FUTURE OF VEGETABLE WEED CONTROL

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U.C. Cooperative Extension, Monterey County

Fifty years ago when this conference began, the vegetable growers' weed control programs were limited to the "hoe", weed oils, and the limited use of dinitro-selective and potassium nitrate. Although these early developed herbicides were limited to crops such as carrots, celery, onions, garlic and peas, the growers were becoming educated in the tremendous benefits of using selective herbicides.

California vegetable growers had become an economic force in the production of asparagus, tomatoes, spinach, lettuce, and cole crops, while relying only on mechanical weed control. In that post World War II era, available labor was limited, which ultimately led to the U.S.- Mexican Bracero program, allowing for the importation of labor for agriculture. Even with this available labor source, weeding costs were oftentimes a major limitation in the production of these crops. Weeding costs in 1955 were reported to cost one hundred dollars per acre for asparagus, and spinach costs were as much as eighty dollars per acre. Even with these types of costs, entire fields were abandoned near harvest because of excessive weeds making the crop unharvestable.

Growers' best judgment was used to "outsmart" weeds by trying to plant crops at periods of low weed germination, selecting "clean" fields, and using transplants that would help gain some time over germinating weeds. In the early 1950's, transplants were limited to "bare root" type plants, mainly limited to tomato, celery, and cauliflower.

What appears to be the first soil-applied selective herbicide for vegetable was IPC (propham). Like so many of the early herbicides developed during this period, its performance was inconsistent due mainly to the lack of required rainfall or just inadequate information. California growers were limited to furrow irrigation, and the early preemergent herbicides would <u>not work</u> when applied to the soil surface.

A major contribution to developing application techniques for preemergence herbicides was Stauffer Chemical Company, specifically Dr. Joe Antognini. He was instrumental in developing the "ROTOTILLER" as an essential tool for preplant incorporation of herbicides. This technique led to greater grower usage of soil-applied selective herbicides in vegetable weed control.

The 1960's saw a greater use of selective herbicides with more herbicides becoming available and a major political decision not to renew the U.S.-Mexican Bracero program. I attribute this immediate loss of reliable labor force for hand weeding a major factor in coastal vegetable growers' adoption of selective herbicides.

<u>Historical Crop - Herbicide Development</u>

The early development of lettuce herbicides included Vegedex and IPC. These two herbicides effectively controlled purslane and stinging nettle, two of the most important weeds in the Salinas Valley. It was not uncommon to see seedling lettuce fields disced under when either of these weeds was so dense as to prohibit economical thinning of the stand. In the mid 1960's, the development of Balan provided a more consistent herbicide for the control of summer weeds. Throughout the late 1960's, Balan and combinations of Balan, Vegedex and IPC became the standard lettuce weed control program. The development of Kerb in the mid 1970's was considered a major breakthrough for lettuce weed management. This product did not require preplant incorporation and it provided excellent control of crucifer and nightshade type weeds. During this period, the increased use of sprinklers had become most common for the germination irrigation, which led to the rapid use of Kerb as the major herbicide for lettuce. As we moved into the 1980's, we started to see cancellations of such herbicides as IPC and Vegedex, leaving only Balan, Kerb and Prefar as soil-applied herbicides for lettuce.

Early herbicide development in cole crops such as broccoli and cauliflower were limited to Treflan, Dacthal, and Vegedex. These herbicides required soil incorporation under furrow irrigation. A major development in herbicide adoption to furrow irrigation was the introduction of TOK. This herbicide was extremely effective with surface applications using furrow irrigation. The primary difference was that TOK's mode of action was primarily at the short tip of germinating weeds, compared to root uptake by Treflan, Vegedex and Dacthal. TOK subsequently became the major herbicide used for these crops due to the above and also its effectiveness on cheeseweed and purslane.

The subsequent loss of TOK and Vegedex due to herbicide cancellation left a large deficiency in weed management systems for these crops. Dacthal became the major herbicide used. Subsequent cultural practices such as the utilization of transplants for cauliflower and modified fertilizer applications in broccoli resulted in excellent weed management practices.

The umbellifere crops - celery, carrots, and parsley were severely impacted by the cancellation of selective weed oils. The loss of weed oil in carrots greatly limited where they could be planted as nutsedge-infested, coarse-textured soils were a prime growing site for carrots. Without effective nutsedge control, carrot acreage declined dramatically in Monterey County. This left Treflan as a preplant treatment and Lorox as a post-emergent herbicide, which are effective on most grasses and broadleaves.

The cultural shift in direct-seeded celery to transplanting was a salvation for weed control. The crop has been maintained with excellent weed control systems using Treflan preplant and Caporal or Lorox post-emergent.

Weed management in parsley was extremely limited until the recent registration of prometryne as a preemergent herbicide for this crop.

Asparagus is one of the major vegetable crops that has had effective weed control materials for the past 50 years. This perennial vegetable was able to tolerate soil persistent herbicides, which resulted in effective weed control. Although several of the original herbicides have been lost, the crop currently has six soil-applied herbicides and three post-emergent herbicides which provide excellent weed management systems when used effectively. Herbicide persistance following asparagus is of concern and labels should be followed to reduce herbicide injury to rotational crops.

Onions were one of the first annual crops that received early weed control inputs, enabling growers to use high density plantings for optimum yields. Although dinitro-selective, potassium nitrate, TOK, and Tenoran are no longer registered for onions, other herbicides have been good replacements. Currently the major preemergence herbicide in use is Dacthal. Two post emergent herbicides, Buctril and Goal, provide excellent broadleaf control whereas Prowl is used in established onions for late germinating weeds. Three systemic grass herbicides, Fusilade, Poast and Prism are registered for onions.

Garlic was formerly a major crop grown in the coast counties. Due to several factors, much of the acreage has shifted to the interior valleys of California. Weed control methods include Prowl or Dacthal as a preemergent application, followed by Buctril and Goal. Two systemic grass herbicides are currently registered.

Another important perennial vegetable crop to the central coast area are artichokes. This winter harvested vegetable crop received early herbicide registrations in the 1960's with Karmex and Princep. Applied as a directed spray, they allowed for weed-free conditions during the harvest period. Princep is no longer registered, but additional herbicides now registered include Kerb, Devrinol, Goal, and Poast. Using these herbicides in winter growing periods, and tillage practices during late spring and summer, provide effective weed control systems.

The advent of value-added packaging of salad type crops has had a significant impact on spinach production. This crop, formerly grown mainly for processing, is now a major fresh-market commodity. Planted as a high density crop, requirements for hand weeding are extremely costly. Several preemergent herbicides have come and gone for this crop due to economical considerations. Two marginally effective herbicides remain. Those are Ro Neet, applied preplant/preemergence and Spin Aid, a post-emergent herbicide. Hand weeding costs may run between $200-$300 per acre. Growers often seek "weed free" soils in which they can produce economical crops with lower weeding costs.

What are the Future Weed Control Trends?

If one were to use a single word to describe the future of vegetable herbicides, it would be "less". Since many of the currently registered vegetable herbicides are 30 to 35 years old, one can readily visualize their economical and regulatory fate is extremely limited on today's market. So, if one has a pessimistic outlook on future existence, one must ask "are there going to be replacements?" The days of traditional herbicide development moving from agronomic crops (soybeans, corn) to vegetable crop development are most unlikely, especially if the trend continues toward developing Transgenic varieties resistant to herbicides. The question that one must ask is "are vegetables scheduled for future herbicide tolerance using this same concept?" I believe one can definitely say "yes!" What is the time frame?... maybe anyone's guess! The cost of research and development for this technology by Agro-Chemical-Seed Company partnerships is intense. These costs must be paid for in future profits, which can come only from extensive usage. Unless this process becomes extremely inexpensive, vegetable usage appears to be limited to large acreage crops such as tomatoes and lettuce.

Research in these crops is under development at this time and, if successful, may pave the way for other vegetables. In addition to the cost factor, public concerns over Transgenic vegetables may become a political issue that would restrict the development process.

The benefits of 40 years of selective herbicide usage in the Salinas Valley have demonstrated the feasibility of reducing the "weed seed bank" to the extent that some crops are planted without the use of herbicides, thus growing in a weed-free environment. If growers maintain a vigilant position in preventing weed seeds from infesting their fields, they need be less reliant on selective herbicides. The challenge will be to incorporate diligence in the integration of good cultural practices with the remaining selective herbicides.

I am optimistic for the future because the California vegetable farmer is a very resourceful entity. I have no doubt that his innovativeness will provide the means to develop and adopt weed control systems for the 21st century.

WEED CONTROL STRATEGIES IN ARTICHOKES

Lionel G. Handel, Senior Field Advisor, Kleen Globe, Inc.

There are two important times when herbicides are used to control weeds in artichokes; at planting and after winter ditches are made. It is obvious that any newly planted field must be as weed free as possible in order to ensure the plants a good start without excessive weed competition. The second important time is after the winter rains when ditches are made in perennial artichokes to assure proper drainage. Artichokes are hand harvested every 7-10 days during the winter. The harvesting requires a walking path on the shoulder of these ditches. If this area is weedy it not only slows down the harvesting operation but it also reduces the drainage rate and field drying rate.

As a minor crop, artichokes are limited to only six registered herbicides; Devrinol, Goal, Karmex, Kerb, Poast and Simazine. Under the new FQPA, that list could possibly dwindle down to four. At the same time only three new potential herbicides are actively being persued for registration. A new registration of Gramoxone Extra could be useful as a preplant as well as a postemergent herbicide. Prowl (Pentagon) and Visor look to be useful as a preemergent herbicide. Unfortunately, only time and patience will tell if these new registrations are forthcoming.

Artichokes are grown two different ways. The traditional method is using transplanted crowns when planting perennial artichokes. The second and newest method is annual plantings using direct seeding or transplants. Since herbicide use differs greatly depending on annual or perennial type production, I will address each on an individual basis.

Perennial Artichokes

These are artichokes of the Green Globe variety, grown only along the coastal areas where the summers are cool and the winters are mild. New plantings of this selected variety are made from the crowns (ratoon - vegetative reproduction) from plants of a producing field that are normally taken out and slated for major changes. These plants are topped, and undercut 2 to 3 inches below ground level. These crowns are then divided into smaller sections and replanted. Kerb is registered to be banded over these newly planted crowns at the rate of 2# a.i. per broadcast acre and is normally incorporated with sprinkler irrigation. Because the new crowns are planted in a shallow trench, with just enough soil to cover the roots, the field will be kept wet with frequent irrigations, making cultivation impossible for at least 30 days or more. After about 30 days if the plants are properly established, the field will be cultivated with the rows. Cross cultivation may be delayed even longer. These transplanted crowns have good tolerance to the 4# Kerb rate even in the lighter soil types. An additional 4# of Kerb can be applied at a later date directed between the artichoke rows 60 days prior to harvest. This application would normally be applied immediately after winter ditches have been made on a new field which is not yet in production.

Direct Seeded / Transplants

Through a California SLN, Kerb can be applied to direct seeded artichokes or artichoke transplants at 2 to 4 pounds of product (1-2 lbs. a.i. per acre). The application can be made by air or ground but it is normally banded on the beds by ground.

Seeded chokes are grown as an annual crop and are normally planted on 40 to 80 inch beds. These seeded varieties are grown and rotated with various other vegetable crops in areas outside of the normal coastal areas. These artichokes appear to be a little less tolerant to Kerb, therefore reduce the herbicide rate if you are planting on lighter soil. At present other artichoke herbicides are not registered for direct seed plantings or transplants.

Winter Ditch Weed Control

The major herbicide usage in artichokes is during the fall season after winter ditching. Artichoke fields are ditched to provide maximum drainage from excessive water that can accumulate during the winter time. Artichoke roots do not tolerate wet soil for an extended period without serious damage or stand loss. Once the ditching is completed in October, the fields will no longer be cultivated until the closing of the winter ditches in May. This creates a 7 month stretch during which an attempt is made to maintain weed-free ditches. Proper weed control through the winter months not only helps facilitate proper water drainage but also eases harvesting. Every 7-10 days the harvest crew has to walk on the ditch shoulders to harvest the chokes.

After Goal became registered for artichokes, it became the main herbicide used on winter ditches. It is used mainly as a contact spray but applications are timed prior to an expected rain or scheduled sprinkler irrigation which will also benefit residual weed control. The other registered herbicides, Devrinol, Karmex and Simazine are preemergent herbicides. Therefore, they are normally used in combination with a contact spray rather than by themselves. A combination of a postemergent and a residual herbicide gives the best season-long winter ditch weed control. There are several factors to consider when using the post/residual weed control approach: (1) the weed spectrum; (2) the size of the weed already emerged; (3) the condition of the weeds; (4) the condition of the field; (5) weather conditions and forecasts of rain; (6) the timing of the application as it pertains to days to harvest. Our best results have been achieved when using Goal as a contact/residual herbicide plus adding one of the preemergent herbicides to the mix. This approach has provided our customers with the best spectrum of weed control with the longest season control at a cost that is acceptable.

Specialized equipment is required to apply the herbicides to these winter ditches. Because of the rolling terrain and a network of cross ditches and tail ditches, normal tractors and application equipment can not be used. In addition, most herbicide applications are made during the rainy season under wet and muddy conditions, requiring further specialized equipment. Four-wheel drive all terrain vehicles (ATV's) with a modified wheel base are used to straddle the ditches. To reduce the strain on our drivers and equipment, portable bridges are used to span the cross and tail ditches.

SPECIALIZED WEED CONTROL

In established perennial artichokes, missing plants are replanted after normal cut-back of the field. Depending upon when this replant operation is completed, much of the replanting is done close to ditching time. After ditches are made, normal mechanical cultivation operations stop, leaving these smaller plants to compete with weeds. In past years the only alternative was hand weeding which was costly and time consuming. Last year the time restriction period for using Goal in artichokes was lifted, allowing for chemical weed control trials. Once again, growers have found that spot treating weeds around these transplants cuts costs when compared to regular hand weeding. The replanted crowns can tolerate a postemergent application of Goal if care is taken to avoid contacting most of the artichoke foliage. Hand weeding is also effective but when certain troublesome weeds such as oxalis are present, a material like Goal with contact/residual activity gives longer weed control.

A specialized herbicide that now fits late season weed control in artichokes is Poast. A new label revision now allows for an aerial application to control grasses not only in the ditch areas but also in between the plant rows. A standard 2 pint rate plus 2 pints of a crop oil can be used to clean up entire grassy blocks or for spot treating selected parts of fields.

Hand weeding is still an option for growers who wish not to use chemical herbicides or who are integrating cover crops within their artichoke fields.

Comparison of Preemergence Cole Crop Herbicides as Replacements for Dacthal

Kevin Larkin, Gowan Company

Early last year ISK Biosciences notified the pest management community that they planned to cease production of an agrichemical they had been producing for nearly 30 years. This product was DCPA, more commonly known as Dacthal, a preemergence herbicide developed in the 1960s and in use by California growers to this day. The reason for halting the production of Dacthal was related to ISK's inability to conform to Federal EPA regulations dealing with manufacturing processes required to produce the material. From all reports, the manufacture of Dacthal results in byproducts and contaminants, most notably, carbon tetrachloride, which allegedly pose human health and environmental safety hazards. The finished product is safe to handle and poses no threat to the environment; however, to reach that endpoint ISK was forced to implement retrofits to their plant which they considered unfeasible.

This announcement forced the users of Dacthal into a search for a replacement. Presented here is an overview of currently registered preemergence herbicides which may fit that bill.

To illustrate and better understand the importance of Dacthal to California agriculture, reference to the most recent California Department of Pesticide Regulation Use Reports is useful. In 1995 over 650,000 pounds of Dacthal were used to treat over 130,000 acres. Members of the *Brassica* vegetable family represent the largest category of crops for which Dacthal serves as the primary means of preemergence weed control. Over two-thirds of broccoli and cauliflower acreage are treated with Dacthal. When other *Brassica* crops such as Brussels sprouts, Chinese Cabbage, etc., are included, a total of over 100,000 acres of cole crops are treated with Dacthal annually. These statistics certainly verify the importance of a preemergence herbicide to producers of these crops.

Onions constitute the other major use for Dacthal. In 1995 over 70% of the onions planted by California farmers were treated with Dacthal at planting.

1995 California Department of Pesticide Regulation Use Report Data of Dacthal Treated Acreage

Broccoli and Cauliflower	86,000
Onions	23,500
Misc. *Brassicas*	14,400
Cucurbits	1,500
Beans	1,500
Cotton	1,300
Horticulture	1,000
Other	1,000
Total	130,200

Dacthal has served as the primary preemergence herbicide for cole crop producers for over twenty years. This has been possible for several reasons. It has been effective at consistently and predictably controlling a certain group of weeds, most notably hairy nightshade, knotweed, lambsquarters, nettleleaf goosefoot, and purslane. The use of topical ammonium nitrate fertilizers has complemented Dacthal well by providing a method of eliminating the harder-to-control weeds which Dacthal misses - shepherdspurse, common groundsel, cheeseweed, and pigweed.

It has at the same time exhibited a high degree of crop selectivity, leading some to speculate that it is impossible to apply enough Dacthal to hurt broccoli or cauliflower. It is safe to handle and easy to apply. Generally applied as a post-plant preemergence band on direct seeded crops or banded ahead of transplanting: it is also safe to apply over transplants or as a layby directly over the top of seedling crops.

Dacthal fits well into vegetable rotations, showing no signs of persistent residues which could damage subsequent crops. It requires no particularly complicated rinsing of application equipment for applicators moving from one crop to the next. All of this is accomplished at a cost to the producer far below what hand labor would cost for the same service.

Faced with the elimination of this extremely versatile crop protection tool, the pest management community is forced to provide equivalent performance with one less arrow in its quiver. The fact that no new preemergence herbicides providing all of the traits listed has been registered for vegetables in over 10 years and with none on the horizon, the only relief in sight is what can be found in the label books today.

Currently Labeled Cole Crop
Preemergence Herbicides

DCPA (Dacthal)
Bensulide (Prefar)
Napropamide (Devrinol)
Trifluralin (Treflan/ Trifluralin)
Oxyfluorfen (Goal)

A search through the label books for preemergence herbicides registered in California for use on cole crops doesn't take a lot of time. In addition to Dacthal the four listed here are all that is available. Goal is the most recent addition to this list, appearing in 1988. At the current rate of development and based on an informal survey of weed scientists and manufacturers it could easily be another 10 years before there are further additions to this list.

Modes of Action and Labeled Use Instructions

The mode of action and physical characteristics of these materials dictate the most effective methods with which to use them.

Prefar is a mitotic inhibitor affecting newly developing root tip tissue. For this reason it must be present in the root zone of germinating weed seedlings as they emerge from the seed coat. Application necessarily must be made prior to the first irrigation and before any weed seeds have germinated. There is little or no shoot uptake. Current labeling will not allow post-transplant or layby application, in spite of the safety in doing so, without establishment of new residue tolerances for registered crops.

Devrinol also acts on developing roots and must also be present in the root zone prior to germination of weed seeds. Current labeling does allow for application over the top of transplanted crops but does not allow for layby treatment.

Both Devrinol and Prefar exhibit low water solubility at 73ppm and 25ppm, respectively, and both resist leaching in clay soils. In conditions of moderate sunlight and soil surface temperatures such as short daily periods up to 100° F Prefar and Devrinol are stable for two to three days on the surface prior to initial irrigation. Areas where air and soil surface temperatures exceed 100° F both materials should be incorporated immediately after application. Devrinol and Prefar work best when incorporated into the top inch of soil with 1/2-3/4 of an inch of overhead irrigation immediately after planting.

Trifluralin acts primarily by root uptake and must be present in the top two inches of soil. At <0.1ppm water solubility, Trifluralin requires thorough mechanical incorporation to contact germinating weeds.

Goal is also very insoluble in water, at <0.1 ppm. However, it is active only on leaf and shoot tissue, therefore must remain very near the soil surface to contact developing weed seedlings. Due to its foliar activity and lack of seedling selectivity, Goal must be applied to the seedbed prior to the setting of transplanted crops.

In contrast to these materials, Dacthal can be applied postplant preemergence, over the top or ahead of transplants, or as a layby treatment. It is very stable on the soil surface for up to two weeks with no significant loss to photodecomposition or volatilization.

Crop Registrations

Dacthal is labeled for use on what the USEPA defines as the *Brassica* Leafy Vegetable Crop Group. These are all members of the genus *Brassica* and include broccoli, cauliflower, Brussels Sprouts, cabbage, Chinese broccoli, Chinese cabbage, broccoli raab, Tat soi, Chinese mustard, collards, kale, kohlrabi, mustard greens, mizuna, rape greens, and a few other truly minor crops.

Prefar, like Dacthal, is labeled for use on the Brassica Leafy Vegetable Crop Group. Devrinol is limited to broccoli, cauliflower, and Brussels Sprouts; Trifluralin to broccoli, cauliflower, Brussels Sprouts and cabbage; and Goal to transplanted broccoli, cauliflower and cabbage.

In this period of heightened regulatory scrutiny, the broader the label the more valuable a product becomes to a diversified producer.

Crop Selectivity

Over the years, Dacthal has rarely, if ever, injured cole crops to which it was applied. A high level of crop selectivity by a preemergence herbicide is particularly important in extreme conditions leading to prolonged seedling exposure to the herbicide. Conditions such as low soil temperatures, soil crusting or the presence of pathogens, soil insects, or soluble salts can often lead to delayed seedling emergence and increase the chance that injury may occur. A high level of crop selectivity is also been a benefit where appliction accuracy is compromised or soil texture is variable through a field.

In contrast, each of the other preemergence herbicides registered for cole crops has exhibited an upper limited to which the crop is tolerant, particularly under adverse conditions. The considerations here relate to crops germinating and developing under favorable conditions.

Prefar and Trifluralin have been demonstrated to show no injury to cole crops when applied at rates of 2X the labeled rates on light soils, low in organic matter under normal germination conditions.

Devrinol rates must be adjusted for soil texture. The maximum rate of 1# active ingredient has been shown to cause injury on light textured soils.

Sensitivity to Goal by cauliflower and broccoli transplants is more often related to the condition of the seedlings than the rate of herbicide applied. Seedlings which are not well hardened off after leaving the greenhouse or which are too young or set too deeply at planting have been injured.

Soil Persistence and Plant Back Restrictions

Persistence of soil-active herbicides is desirable from the standpoint of increasing length of economic weed control. However, in most vegetable rotations, persistence can lead to undesired effects on subsequent crops where the cropping pattern may yield three or four crops per acre in a single year. Dacthal has been used in a multitude of crop rotations with no significant phytotoxicity problems.

The Dacthal labels specifies a 240 day waiting period from time of application before planting non-labeled crops. In practice, non-labeled crops such as lettuce, celery, spinach, carrots, and tomatoes are routinely planted within the recommended plant back period with no apparent problems. This has certainly been one of the most important factors leading to its sustained popularity.

The Prefar label specifies a waiting period of 120 days between application and planting of non-labeled crops. With the exception of spinach and beets, Prefar is labeled for use on most major and many minor vegetables reducing the chances of a conflict in label compliance.

The Trifluralin label specifies a 150 day waiting period before planting of non-labeled crops. Celery and transplanted peppers are the only vegetables other than *Brassicas* labeled for treatment with Trifluralin prior to planting. Other vegetables, particularly lettuce and spinach, are sensitive to Trifluralin carryover in lighter soils.

The Devrinol label specifies a waiting period of 12 months before replanting non-labeled crops. Brassicas, tomatoes and peppers are all tolerant of Devrinol residue. The most sensitive non-labeled vegetable crop is head lettuce. Significant delay in maturity will result when planted 9-10 months following Devrinol application. Spinach and celery show little effect when planted six months after application with Devrinol.

Goal is very short-lived in the presence of water. It volatilizes rapidly with very little movement into the soil. Residues within a few weeks after application and subsequent wetting by rainfall or irrigation rarely are present in concentrations high enough to affect direct seeded crops.

Weed Spectrum

	Dacthal	**Prefar**	**Trifluralin**	**Devrinol**
Annual Bluegrass	P	N	C	C
Burning Nettle	P	C	P	C
Cheeseweed	N	N	N	P
Chickweed	C	N	P	C
Common Groundsel	N	N	N	C
Crabgrass	C	C	C	N
Hairy Nightshade	C	N	N	N
Knotweed	C	P	C	P
Lambsquarters	C	C	C	P
Mustard	N	N	N	N
Nettleleaf Goosefoot	C	C	C	P
Nutsedge	N	N	N	N
Pigweed	P	C	C	C
Purslane	C	C	C	C
Shepherdspurse	N	N	N	N
Sowthistle	N	N	N	C
Watergrass	P	C	C	C

C = Controlled

P = Partially Controlled

N = Not Controlled

Summary

For direct seeded cole crops, as replacements for Dacthal, Bensulide and Napropamide are the only post-plant preemergence options. Trifluralin requires the extra operation of pre-plant incorporation. Bensulide offers the greatest flexibility in planting back of rotational crops and has the broadest label including the minor Brassica vegetables. Napropamide controls the broadest weed spectrum. None of the products available will control members of the Nightshade family; however, each controls other weeds not controlled by Dacthal.

In transplanted cole crops Bensulide, Napropamide, Trifluralin, and Oxyfluorfen can all be applied ahead of setting transplants. Trifluralin must be mechanically incorporated. Napropamide is the only product which can be applied over transplants after setting.

A handful of alternatives to Dacthal for preemergence weed control in cole crops does exist. No single herbicide combines all of the positive traits of persistence, weed spectrum, and application flexibility of Dacthal. The user must decide which of these traits is most important in deciding what to use as a replacement.

Mulches for Weed Control in Tomatoes
Work in Progress

(Principles, Promises and Problems of No-Till Transplanted Vegetable Production)

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Abstract

Although reduced tillage production systems have been successfully developed and used with advantage in a number of cropping contexts throughout the world, very little work has been carried out on these techniques in California. Our research is evaluating the effectiveness of surface organic mulches in reduced tillage transplanted tomato production systems for suppressing weeds, improving production efficiencies in terms of nutrient inputs, providing optimal soil temperature regimes for crop growth and conserving soil moisture. Field experiments are underway in Sacramento and San Joaquin Valley tomato production regions.

Introduction

Weeds are frequently ranked as the number one pest problem in tomato production systems of California's Central Valley (Flint and Klonsky, 1985). Nightshades are the most serious weed problem statewide, thought barnyard grass and yellow nutsedge are also common problems in San Joaquin and Sacramento Valley production areas. For conventional growers, herbicide applications and cultivation tillage are currently the primary means of weed control. Hand weeding costs in organic tomato production can range from $150 to $200 per acre.

Losses in soil quality due to intensified crop production with resulting impacts on productivity are also becoming major concerns in a number of tomato production areas. A number of the cropping practices in these systems suggest the development of a "spiralling feedback loop" (Stirzaker and White, 1995). Intensification of cropping necessitates increased need for increadsed cultivation, irrigation and perhaps fertilizer inputs. Information on alternatives for improving the quality of the soil resource base as well as for managing weeds, the primary pest in tomato production sytems is therefore critical for sustained economically viable production, resource conservation and environmental preservation in California's vitally important tomato production regions.

One possible option ofr achieving the dual purposes of sustaining soil quality/nutrient cycling while accomplishing economically adequate weed control, may be to use surface organic mulches derived from "off-season" grown cover crops. The winter annual legume hairy vetch for example, has been used successfully as both a cover crop and as a mulch in fresh-market tomato production systems on the east coast (Abcul-Baki and Teasdale, 1993; Abdul-Baki, Stommel and Teasdale, 1995). As a cover crop, the vetch fixes N, recycles nutrients, reduces soil erosion and adds organic matter to the soil. When mowed and converted to a mulch, the vetch reduces weed emergence, lowers soil temperature during the hot summer months, reduces water loss from the soil and acts as a slow-release fertilizer (Abdul-Baki and Teasdale, 1993). Recent work in Australiz by Stirzaker (1992) with subterranean clover has shown similar benefits in lettuce and tomato production systems (Stirzaker, Sutton and Collis-George, 1992; Stirzaker, Passioura, Suttona and Collis-George, 1993). There may be however, problems associated with using cover corps in this way: land is put out of production, soil moisture may be depleted during the cover crop growing season relative to a winter fallow, and early summer season temperatures may be cooler under a surface mulch than bare soil. There may also be problems related to the management of cover crop residues that can be phytotoxic to certain crops that follow a green manure mulch (Lovett and Jessop, 1982).

There is clearly sufficient evidence however, to support testing of cover crops that are used as surface organic mulches as a non-chemical option for weed control and to improve soil physical properties and nutrient cycling. The objective of our current research in this area is:

- to evaluate the effectiveness of surface organic mulches in reduced-tillage tomato production systems for:
    - suppressing weeds
    - improving production efficiencies in terms of nutrient inputs
    - providing optimal soil temperature regimes for crop growth and
    - conserving soil moisture

Procedures

Field experiments are being conducted at the University of California West Side Research and Extension Center (*WSREC*) in Five Points, CA, the Kearney Agricultural Center (*KAC*) in Parlier, CA and at the Sustainable Agriculture Farming Systems (*SAFS*) Project on the University of California, Davis campus to evaluate various aspects of the use of cover crop mulches in no-till tomato production systems. The experimental cover crop treatments at the *WSREC* are:

winter fallow / summer + herbicide
winter fallow / summer - herbicide
Sava "Snail" Medic
Sephi "Barrel" Medic
Triticale / Lana vetch
Merced rye / Lana vetch

The cover crop treatments at the UCD *SAFS* site are:

winter fallow / summer + herbicide
winter fallow / summer - herbicide
Magnus pea / Oat / Common vetch
Common vetch
Subclover
Snail Medic cv Kelson
Snail Medic cv Sava
Barrel Medic
Triticale / Lana vetch

These treatments permit a testing of mulches with different growth and cover attributes and cover crop mixtures of different seed costs. Each mulch / fallow plot at the WSREC and at KAC is split into 3 subplots. In each subplot one bed is fertilized at 100 lbs N / acre and one at 200 lbs N / acre and one is not fertilized to evaluate the potential for reducing fertilizer inputs in this system. The mulch / fertilizer treatments are repllicated four times in a split plot design with fertilizer applications as main plots and mulch treatments as subplots. Common tomato varieties are transplanted using a single-row machine transplanter that has been modified by B & B No-Till of Laurel Fork, VA. The modifications are based on a successfully-used no-till transplanter that has been developed by R. Morse at Virginia Polytechnic Institute (Morse, 1995). Changes in soil water content during the tomato season are monitored by neutron hydroprobe (Campbell Pacific Nuclear) readings in access tubes installed in the planted row before and after irrigations. Fruit yield determinations are accomplished by machine harvesting using field weighing gondolas at the *WSREC* site, and by hand harvesting the *KAC* and *SAFS* sites.

At one month intervals following tomato transpslanting, weed cover and species composition are assessed in each subplot. In both the *WSREC* and *KAC* experiments the average time taken by hand weeding crews is determined in each plot.

Companion screening trials at the *WSREC* are being conducted to evaluate 15 prospective fall and winter-growing cover crops and cover crop mixtures for growth, nitrogen productivity and potential utility as surface mulches in no-till systems.

Results

The following summary of 1997 results is quite preliminary and very much reflects the embryonic stage of development and refinement of no-till techniques in California tomato production systems. Results to date indicate that individual cover crop species that are used as mulches require specific management within the overall production system to optimize potential benefits. Sava snaial medic, for example, can be effectively killed by mowing alone, while Sephi barrel medic, rye / vetch and Triticale / vetch seem to require herbicide treatment prior to transplanting tomatoes. In 1997, we used a combination of sickle mowing and *Roundup* herbicide to kill the rye / vetch and Triticale / vetch cover crops. This was quite successful except for vetch plants that were on the shoulder of beds.

Monitoring of photosynthetically active radiation (PAR) using a Decagon Ceptometer below cover crop mulches in April and May indicated that the mulches intercpet aobut 70 - 80% of the light that reached the experimental field. The grass / vetch mixtures typically intercpeted more PAR than either of the Medic species.

Weed density data were collected in May, June and July of 1997 at the *WSREC* and *KAC* sites. Preliminary data from the *WSREC* site indicate relatively low % weed cover in the Triticale / vetch relative to both the cultivated $\pm$ herbicide treatments early in the season (Figure 1).

The WSREC experiment is evaluating the potential of cover crop mulches to provide part of the nitrogen requirement for tomatoes by evaluating productivity in plots with 0, 100 and 200 lbs N. In 1997, there was no clearcut benefit of the cover crop mulches in terms of supplying N relative to the fallow plots at 0 and 100 lbs N (Table 1).

Preliminary data from soil temperature sensors placed at 10 cm depths indicate that soil temperatures were about 2 degrees cooler under the Triticale / Lana vetch and Ryegrass / Lana vetch mulches relative to fallow soils early in the 1997 season.

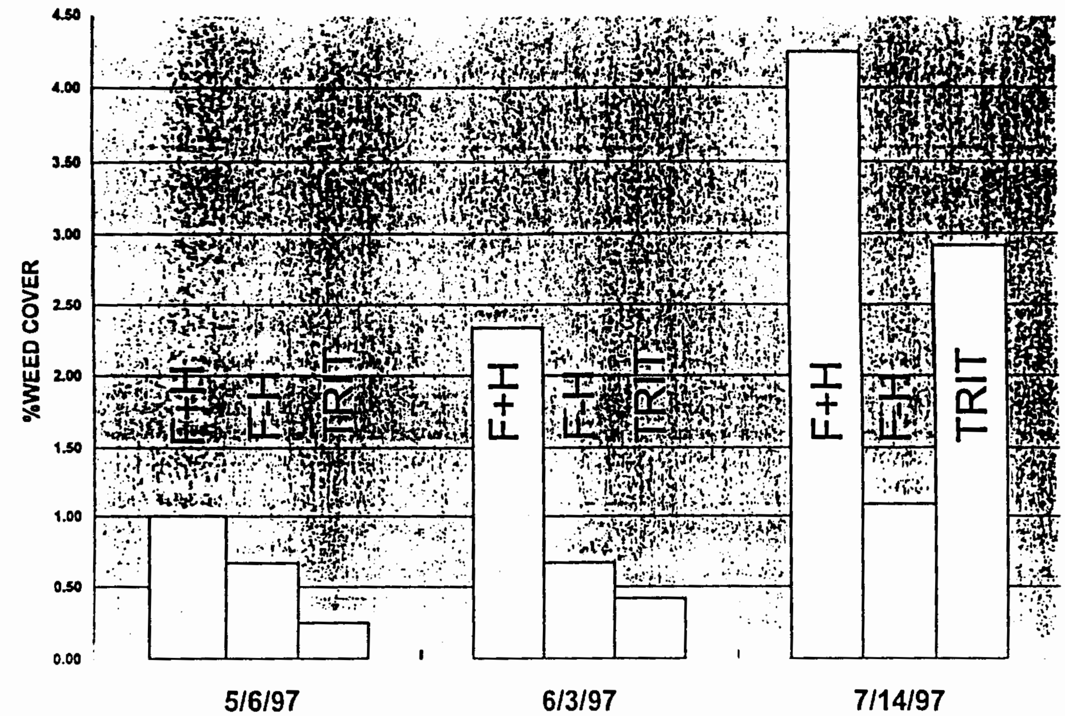
Changes in soil water storage under the Triticale / Lana vetch mulch relative to a fallow were monitored during July. Preliminary data show that volumetric water content was higher under the Triticale / vetch mulch than the fallow (Figure 2).

Summary

A potential issue that will need to be addressed if cover crop mulches have utility in processing tomato production systems is how they are managed during machine harvesting. In 1997, the *SAFS* site was hand harvested and the *WSREC* field was machine harvested over the course of two days. On the first afternoon, no serious difficulties were encountered in terms of having the harvester go through the mulch that was on the soil surface at the end of the season. However, early in the morning of hte second day of harvesting, the harvester, which was a sickle mower bar type, jammed repeatedly in the grass / vetch mixture plots because the mulch residue wrapped around the spindle mechanism at the top of the harvester. Why this happened only on the second dya of harvesting is not clear at this time, however it may be due to the fact that the residue was quite moist from dew on this morning and this may have resulted in the residue being more resistant to cracking during the machine harvest. This may be remedied perhaps, by mowing the mulch into finer pieces or perhaps by not mowing at all, but merely leaving the mulch intact and fixed to the soil. We will evaluate these options in the spring of 1998.

This work will be continued through the next several years to thoroughly evaluate the potential of mulch production systems in a variety of cropping contexts in California. Research objectives that will be addressed during the coming two years include mulch species mix optimization, operations for killing mulches in spring, control of winter weeds and cost benefit analyses of the entire system of production.

WEED COVER (N=200)



F+H (Winter fallow with spring herbicide and cultivation)
F-H (Winter fallow without spring herbicide)
TRIT (Triticale cover crop without spring herbicide)

SOIL WATER STORAGE(0-45)

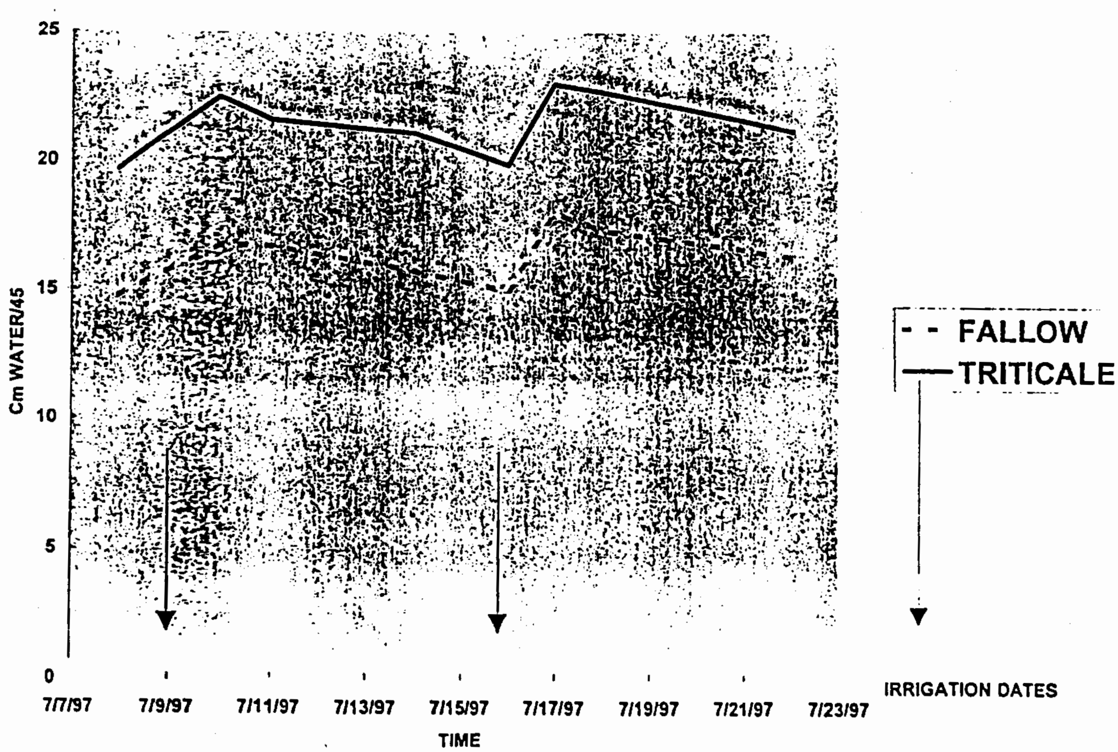


Table 1

WSREC Mulch Experiment: Yield at different nitrogen fertilization levels

Nitrogen=0 lb/acre

Treatment	Yield (tons/acre)	st dev
Fallow+H	39.23	4.39
Fallow	31.41	13.03
Tritic.+Vetch	28.00	3.57
Sava	26.87	1.68
Rye+Vetch	24.21	2.61
Sephi	18.08	5.79

Nitrogen=100 lb/acre

Treatment	Yield (tons/acre)	st dev
Fallow+H	37.59	5.53
Sava	36.22	6.47
Fallow	35.09	6.93
Tritic.+Vetch	34.69	0.49
Rye+Vetch	33.79	7.82
Sephi	23.70	5.35

Nitrogen=200 lb/acre

Treatment	Yield (tons/acre)	st dev
Tritic.+Vetch	37.98	6.18
Fallow	37.53	9.38
Fallow+H	36.68	8.65
Rye	36.32	4.54
Sava	34.01	4.29
Sephi	28.48	10.28

THE CONFERENCE BEGINNINGS

Harry Agamalian, Weed Science Advisor (Emeritus)
U.C. Cooperative Extension, Monterey County

Fifty years ago the need for collective action seemed to be the motivating force that brought this pioneer group of regulatory agencies, University scientists, industry personnel, and applicators together for the first conference. Throughout the early proceedings of this conference, the one theme that permeates their objective was education and cooperation.

In reviewing the first meeting, the sessions concentrated on the basics such as: weed collection-identification, herbicide chemistry-mode of action, application equipment, control of specific weeds, and concerns about drift.

The Early Leaders

The first slate of officers were really pioneers in California weed control, as well as for the nation, individuals such as:

Walter Ball, Department of Agriculture, Chairman of the first conference, President of the 1950 conference, President of the WSWS (oldest weed conference), and later served as C.W.C. Business Manager; a good educator and dedicated public official.

Alden Crafts, Professor U.C. Davis, second President of the conference, student of Professor W.W. Robbins, who served as his inspiration to work in plant physiology and weed control research. Dr. Crafts was a dedicated Professor whose many students became leaders in the discipline of Weed Science.

Murray Pyror, California Dept. of Agriculture, fourth President of the conference, drafted the original constitution and bylaws of the conference, member of the 1949 Organization Committee, presented the first paper on 2,4-D drift in California in 1951.

Norman Akesson, Professor/Agricultural Engineer U.C. Davis, Chairman of the first Nominating Committee, presented the first paper on the development of weed control equipment in 1949, became the 18th President of the conference.

Bill Harvey, U.C. Davis Weed Control Specialist, attended the first conference as a Monsanto Company representative; at the second conference he presented the first paper on weed control in vegetable and field crops, served as fifth President of the conference; tireless educator on weed control throughout the state.

The above individuals represent only a few who were willing educators and provided leadership in this fledgling science.

Issues and Conference Structure

In many ways the issues at that first meeting were not unlike the same topics we are concerned with in 1998... product performance, efficiency in herbicide application, concerns about drift, knowledge as to how the herbicide works, and the ongoing question of what is the "best method of control." One sensed there was a great exchange of information on the techniques of "killing weeds."

The Officers were selected from the three major categories of attendees: industry, regulatory, and education. Candidate selection was at the discretion of the Nominating Committee and the candidates were offered to the conference for approval. It wasn't until 1980 that Officers were elected by the ballot system. In order to provide continuity of the conference administration, the Bylaws allowed for the Secretary to proceed through the chairs over a three-year period. A Board of Directors was later added to the organization and, in 1960, a Steering Committee was developed to serve at the discretion of the President for advice and counsel.

Program format at the conference was changed to allow for concurrent sessions in the early 1980's. It was recognized that single sessions did not allow for adequate coverage of the extensive amount of information being developed. Although most members recognized the benefits of concurrent sessions, it was a "heated" and widely debated topic. The diversitiy of subjects propelled the conference to make this structural change, which resulted in a greater outreach of information to the attendees.

Later improvements by the organizers of this conference added special sessions devoted to weed schools, herbicide mode of action, specific weed biology, environmental issues, and the politics of pest management.

Perhaps the greatest legacy the conference will leave to future students of weed science is the text, Principles of Weed Control in California. This tremendous achievement of volunteers committing their knowledge and time was an outstanding example of the cooperative spirit that has prevailed within the conference. Two individuals who must be recognized, among many, are Floyd O. Colbert and Edward M. Rose, the co-chairmen of this accomplishment.

The Conference Future in the 21st Century

During the intense period of the development of weed control information, our conference was considered to be a primer meeting. The challenge of you young members in the profession is to maintain the quality and vitality of the conference as a major source of weed science information. The major attendees are those in pest management. There are many educational opportunities for those requiring pest control advisors' accreditation and weed management information. It will behoove the leaders of this conference to continue their efforts to present timely, objective, and effective information. The trends for longer periods of herbicide development and greater proprietary information may restrict the freedom of extending information to the general public.

The concept of transgenic plants being resistant to herbicides may limit the public sector research vs. the private research developments. If this becomes so, the results may be a reduced involvement in problem solving by public weed workers, with greater dependency upon the plant protection industries as the primary source of product information.

As I look back, the exciting years were the 1960's and 1970's where the development of so much chemistry was upon us! The adoption by growers was rapid, resulting in tremendous labor savings and increased yields from the bountiful technologies of industry.

It has been said that agriculture is a "mature" industry today. The taxpayers' willingness to consider public monies to be for the benefits of "<u>all society</u>" may be a thing of the past!

The discipline of weed science will continue to be under close scrutiny by the regulators and political interest groups. Consumers' concern for food safety and the environment will place greater efforts on a strong educational outreach. The California Society of Weed Science should continue to be a dynamic force in this arena.

I certainly believe the future for "weeds" and their existence in the 21st century is assured.

EARLY BEGINNINGS OF AGRICULTURE

James L. Dewlen
Retired, Union Carbide Ag Products
Carmichael, CA

It is a real pleasure to appear before this California Weed Science Society and be one of the Luncheon Speakers. It is hard for me to realize that this conference is celebrating its 50th anniversary. I have been attending these meetings for almost 40 years. I missed the first one in 1949 but attended all the rest of them until 1982 when I retired and spent the winter months traveling.

In the early years of the conference there were three areas selected to hold the annual conferences for convenience of travel - northern, central and southern California. The state was so large that the idea was to rotate the locations so people from all counties could attend. Travel budgets were very tight in those days and state, county and university members had trouble getting to the conference if it was very far away. In my own county, the supervisors would sometimes question the price of meals and hotels that were only ten to twelve dollars a night.

When I went through the chairs as an officer, I started as Treasurer and then worked up to President. I enjoyed each position and became acquainted with many people throughout the state. The year of the first conference I had just been hired by the Riverside County Agricultural Department and sent to Coachella Valley. The All-American Canal was nearing completion and the growers were concerned about the spread of Johnson grass. It was of limited infestation and the farmers had asked Th Agricultural Commissioner to send a man to the valley to work with the growers to eradicate the grass if it was possible.

At that time, there were approximately 20,000 acres of land under cultivation which were irrigated by wells. When I arrived in the valley I was supposed to be an expert. What little I knew of Johnson grass was what I had learned about while growing up on a farm in Kansas but I knew it was a very tough weed to control. I found that weed oil was about all we had to use. The growers could plow and dry cut the soil and kill the rhizomes which were effective under the high temperatures of the desert.

We were always on the lookout for any of the noxious weeds listed in the agricultural code. Any of these weeds, when found, were subject to control and eradication. One of the weeds listed was Camel thorn. In the early 1920's, Egyptian Alfalfa seed was imported and planted in the Coachella Valley and some of the seed was contaminated with Camel thorn. The few locations infested were thought to have been eradicated and the land had reverted to desert. With completion of the canal, the land was again leveled and the salt leached out and planted to cotton. Many Camel thorn plants appeared in the fields and each cotton row had to be walked and surveyed for Camel thorn plants.

Since 2,4-D would not always control it, we used one of the older methods called the arsenic jar method of translocation. We planted a fruit jar next to the plant and filled it with a 1% solution of arsenic and stuffed the tops of the plant into the jar. This was a very effective method of control but we used many sprayers as the bottom would soon drop out of the sprayers due to the arsenic.

New herbicides were being introduced every year and were being reported upon at each annual conference. TCA was one of the first, then Dowpon, Aminotriazole and Malic Hydrozide. 2,4-D had been around for some time and many new formulations were being introduced. Users were finding that 2,4-D could be hazardous to most broadleaf crops, especially through drift. The Agricultural Commissioner's offices had developed the permit system to allow the use of 2,4-D only under certain conditions and even then we had trouble. A permit was given to the Coachella Valley Irrigation District to spray cattails in the fall in drainage ditches. The following spring, 2,4-D symptoms began showing up in cotton near some of the sprayed areas. This prompted Dr. Boysie Day at the Citrus Experiment Station, to establish field trials using various 2,4-D formulations to determine their volatility under high temperatures. I was fortunate to participate in these tests along with Ethelbert Johnson of the Bureau of Chemistry and Bob Russel of the University of California. This work was published in Hilgardia, a publication of the University of California. It was entitled "The Volatility of Herbicides under Field Conditions".
Dr. Day became one of the leading experts and gave testimony at many trials in courts throughout the State. He was also sent to Vietnam, along with Dr. Fred Shirley, USDA, to evaluate the results of Agent Orange.

The Annual California Weed Conferences was a great place to meet the many people doing field testing of herbicides. Talking to them in the halls or over a cup of coffee was a wonderful source of information for solving mutual problems. Some of the people with the University of California Cooperative Extension Service were Bill Fischer, Fresno County, Hal Kempen, Kern County and Harry Agamalian, Monterey County. In the Agricultural Commissioner's Offices were Si Dudley, Orange County, Cecil Pratt, San Bernardino County and myself of Riverside County. There were many others too numerous to mention.

After I left Riverside County I joined Amchem Products Company who specialized in producing herbicides and growth regulators. I worked all phases of weed control and one of my assignments was the railroads in Western United States. At that time, use of herbicides was usually limited to one herbicide throughout the whole division with applications being done under contract. Through the efforts of other company representatives and myself, we persuaded the railroad companies to send their people to the Weed Conference meetings. This resulted in the railroads using many chemicals that were usually in combinations and were more effective.

Many Irrigation Districts in California in the early 1950's were starting to use herbicides. The Imperial Irrigation District was treating hundreds of miles of drainage ditches with weed oil and their spray rigs were using as much as a truck and trailer-load of oil a day. Some districts were slow in using any herbicides as the engineer in charge most often felt the only way to control weeds was with a bulldozer or dragline.

Everything was not always a "bed of roses" for the herbicide industry. In the late 50's, Aminotriazole was reported to be used on cranberries. This made headlines at Thanksgiving time. 2,4,5-T was also condemned by its use in the forest industry. There were others that received publicity and much of the public believed all the bad things they heard or read.

Many years ago I attended the first hearings against the use of 2,4,5-T in Globe, Arizona. The Forest Service had been spraying a burn area to prevent hardwoods from crowding out newly planted trees. I was amazed at what some of the protestors would do to sway public opinion against the Forest Service. They also tried to stop the use of herbicides by Los Angeles City and County. It was amazing that so few people could create such a furor even when faced with scientific facts. It took a forceful chairman to handle some of the people giving testimony.

I look back with pride at having been a part of the California Weed Science Society discipline. It is always great to meet old friends and renew acquaintances. I look forward to attending many more California Weed Science Society annual conferences.

GETTING CONTROL OF TOUGH WEEDS IN ALFALFA

Mick Canevari[1]

ABSTRACT

Most weeds are not a factor in alfalfa production, since it is a perennial crop with a rapid growth recovery following harvest. The weeds that are a problem have adapted to the frequent harvest schedule of every 30 days and are often perennial or biennial type weeds. Three weeds that are becoming more of a problem in the San Joaquin Valley are: Curly dock (Rumex Crispus), Cheeseweed (Malva Parviflora) and yellow nutsedge (Cyperus

These weeds have adapted very well to alfalfa culture, and are not controlled by standard herbicide programs used only in the dormant season. The following research has focused on developing an effective control program of best treatments and application timings of post and pre-emergence herbicides.

Key Words: curly dock, cheeseweed, yellow nutsedge, butyrac, pursuit, poast, prism, EVO, NIS, UN 32

Curly dock: is a perennial distributed throughout the valley and foothill areas of California. It is a troublesome weed in alfalfa fields, pastures and sugar beets. Also referred to as sour dock, it can become a problem early in young alfalfa, especially in low areas of the field or at the ends where water collects. It reproduces by seed that matures in the winter and germinates in the spring. The mature plant is 2' to 5' tall with a large fleshy taproot. Once it has gained a foothold, it becomes immune to soil active herbicides used and continues to spread as alfalfa populations decrease. Its impact is from competition of a large foliage canopy and deep root system capable of pulling moisture and nutrients from alfalfa. Curly dock has been reported to accumulate oxalates and is suspected to have produced losses of livestock to poisoning.

BEST TREATMENTS AND APPLICATION TIMING FOR CONTROL OF CURLY DOCK

Fall Application

Treatment	Rate lb/A	% Control
Butyrac+Pursuit+EVO	.5+.094	97%
Butyrac+EVO	1.5	95%
Butyrac+Pursuit+EVO	1.0+.063	95%
Pursuit+EVO+UN 32	.094	75%
Pursuit+EVO	.094	40%
Pursuit+NIS	.094	33%

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Spring Application

Treatment	Rate lb/A	% Control
Butyrac+NIS	1.0	77%
Butyrac+Pursuit+NIS	.5+.063	63%
Butyrac+Pursuit+NIS	.5+.047	53%
Pursuit+EVO	.063	20%

Fall application treatment = December 16, 1996. % Control @ 95 days after treatment.
Spring application treatment = February 6, 1997. % Control @ 20 days after treatment.
EVO = HASTEN® @ 1 pt/acre
NIS = Unifilm 707 @ .25% VV
UN 32 = Liquid Fertilizer @ 2 qts/acre

Cheeseweed: are a broadleaf plant in the mallow family and a frequent problem in newly planted seedling alfalfa. In California's central valleys moderate climate, it will survive the winter months and continue into the summer, therefore classifying it as a biennial. Cheeseweed, once established, is a difficult weed to control in any crop. In seedling alfalfa it is very competitive, robbing the young alfalfa seedlings of light, moisture and nutrients. Once mature, one cheeseweed plant can reach 5' in height, 2' in diameter and have a large taproot. The entire plant is considered toxic, with horse, cattle and sheep having been affected. Two unsaturated fatty acids, malvalic acid and sterculic acid are considered the cause of the toxicity.

BEST TREATMENTS AND APPLICATION TIMING FOR CONTROL OF CHEESEWEED

Early Timing

Treatment	Rate lb/A	% Control
Pursuit+EVO+UN 32	.063	100%
Pursuit+EVO+UN 32	.094	95%
Pursuit+Butyrac+NIS	.063+.75	81%
Pursuit+Butyrac+NIS	.047+.5	70%
Butyrac+NIS	.75	53%
Buctril+EVO	.375	33%

Cheeseweed size = 3 to 5 leaf, 2" to 5" diameter
Treatment Date = January 7, 1997
% Control @ 105 days after treatment
NIS = Unifilm 707 @ .25% VV
EVO = HASTEN @ 1 pt/acre
UN 32 = Liquid fertilizer @ 1 qt/acre

Late Timing

Treatment	Rate lb/A	% Control
Pursuit+Butyrac+ Buctril+NIS	.047+.5+.25	69%
Pursuit+COC+UN 32	.063	60%
Pursuit+Buctril	.063+.375	55%
Pursuit+NIS	.063	17%
Butyrac+NIS	.75	15%
Buctril+COC	.375	13%

Malva size = 6 to 12 leaf, 3" to 8" diameter
Treatment Date = February 6, 1997 % Control @ 75 days after treatment

Yellow Nutsedge: is a perennial distributed throughout the entire alfalfa growing area of California. It is a troublesome weed in newly planted and established alfalfa as well as other field and vegetable crops. It is commonly referred to as nut grass for its similarity of grass like leaf blades. It produces underground nutlets that give rise to new plants, as does its ability to produce seeds as a means of reproduction. Nutsedge begins to emerge in February and continues through September in the northern San Joaquin valley. In alfalfa it reduces the palatability and the nutrient value of the forage.

Alfalfa: due to its competitive ability and multiple harvests, it can be considered a crop to reduce nutsedge populations when timed with an effective herbicide.

BEST TREATMENTS FOR CONTROL OF YELLOW NUTSEDGE
IN ESTABLISHED ALFALFA

	Rate lb/A - # of applications	
Eptam 10g	3.0 - 4x	70%
Eptam 10g	3.0 - 3x	65%
Eptam 10g	3.0 - 2x	20%
Eptam 10g	3.0 - 1x + 1x	65%
Pursuit	0.094	60%
2,4-DB	1.5	15%

% control @ 60 DAT
Nutsedge preemergence for Eptam
Postemergence suppression for Pursuit and 2,4-DB

SUMMARY

The best weed management strategies for cheeseweed, curly dock and yellow nutsedge involves a crop rotation pattern where different cultivation practices and other herbicides can be used to prevent establishment of the weed or allow seed development. Once the problem weeds seed bank has been reduced, entering back into alfalfa production can successfully be achieved. The importance for a good seedbed, adequate fertilizing, land leveling for water management with proper variety selection are as important as any herbicide to control weeds. Combining this information with label recommendations will provide satisfactory results in controlling some of alfalfa's toughest weed competitors.

NIGHTSHADE CONTROL IN DRY BEANS

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Black nightshade (Solanum nigrum L.) and Hairy nightshade (Solanum sarrachoides Sendtner) continue to be problems for California Dry Bean growers. In 1986 Dr. Larry Mitich reported at the 38th Annual California Weed Conference on the Economic Losses and Control of Nightshade in Dry Beans (1). Dr. Mitich reported that the nightshade complex had become a serious weed in dry bean production because: 1) A single nightshade plant produces 8000 to 178,000 seeds per plant and the seeds are efficiently dispersed by the sticky fluid in the nightshade berries. 2) The nightshades are tolerant to many chemical control methods, and they respond inconsistently even to generally recommended herbicide treatments; ultimately, they fill the voids left by the elimination of less resistant weeds, and 3) The members of the Solanum complex vary widely in their vegetative characteristics making identification for control difficult.

Black and Hairy Nightshade were also the Weed of the Year at the 40th Annual California Weed Conference and many reports were given at the general session discussing their distribution, biology and control.

In 1995 California farmers grew 137,000 acres of dry edible beans and 130,000 acres in 1996. Various varieties of Dry Beans are grown throughout California in different soil types, climate and environmental conditions on relative small acreage (Table 1).

Table 1. 1996 California Dry Beans Planted Acres by Variety

Bean Variety	1,000 Acres	Major Growing Areas
Large Lima	22.0	Stanislaus and Fresno Co.
Baby Lima	24.0	San Joaquin, Fresno and Sutter Co.
Black Eye	27.0	Fresno, Tulare and Kern Co.
Light Red Kidney	10.0	San Joaquin and Butte Co.
Dark Red Kidney	5.0	San Joaquin and Butte Co.
Pink	8.0	Yolo, Sutter and Solano Co.
Garbanzo	25.0	Fresno and Kern Co.
Small White, Navy, Great Northern, Small Red, Pinto	10.0	Stanislaus Co. North
Cranberry	3.0	Stanislaus Co. North
Black Turtle Soup	1.0	Stanislaus Co. North
Other (Misc.)	10.0	Various

Since 1986 the number of registered herbicides used in dry beans for nightshade control have remained the same. Chloramben is no longer available for use but Imazethapyr has been registered for use in kidney bean with plant back restrictions.

The UC IPM Pest Management Guidelines for Dry Beans list the registered herbicides, the bean varieties that they can be used on and any restrictions placed on the use of the herbicide (Table 2). It is essential that the user identify Hairy Nightshade and Black Nightshade correctly because of the species selectivity of the registered herbicides.

Reports from County Farm Advisors working in dry beans indicates that although early nightshade control is obtained by some herbicides, season long control usually has not been obtained. Late germinating nightshade growing after the last cultivation on the edge of the bed or furrow is causing serious problems at harvest. Even though bean yield may not be affected bean quality, an essential part of production, may be seriously reduced. The Sticky fluid that aids in spreading the nightshade seed stains the beans and reduces harvest efficiency, and the green berries are mildly toxic and presents a potential danger of poisoning.

This year a trial for Hairy and Black Nightshade control was established in blackeye beans at the UC Davis Vegetable Crops Research Farm. Over the years the use of tomato herbicides in this field has created a heavy infestation of both Hairy and Black Nightshade. The plot area was pre-irrigated 10 days before planting. Preplant incorporated herbicides were applied June 2, 1997 (Table 3.) and the beans were planted June 3,1997. After planting 0.2 inches of rain occurred. As soon as the plot area dried a light harrowing was done to prevent soil crusting. Just prior to the first irrigation on June 23 the area was cultivated to reshape the beds that had been flattened by the rain and light harrowing. The population of Hairy and Black nightshade was reduced by these mechanical treatments compared to other areas in the same field. Lay-by soil incorporated (Table 3), Postemergence over the top of the beans and Postemergence directed spray treatments were applied to provide nightshade control late in the season (Table 4). The beans were not harvested because of a heavy Lygus infestation. Wheat was planted on the treatment area on December 23,1997 to evaluate any herbicide residue in the soil that would carry over and affect the next season's crop.

Preliminary results

More research needs to be done on 1.) Timing of cultivation for control of nightshade seedlings. 2.) Further evaluation of non-registered herbicides such as Frontier, FMC-6285, Axiom, and Permit alone or in combination with currently registered herbicides. 3.) Timing and method of applying Layby herbicide treatments to extend nightshade control and insure crop safety.

Table 2. Broadleaf Herbicides Registered in California Dry Beans

Dual	Lasso
Prowl	Treflan
Eptam	Basagran
Sonalan	Pursuit

Table 3. 1997 UC Davis Preplant or Lay-by Incorporated Herbicides

Dual	Axiom
Sonalan	Dual + Sonalan
Frontier	Dual + Frontier
FMC-6285	Sonalan + Frontier
FMC-8426	

Table 4. 1997 UC Davis Post Emergence Herbicides

Dual	E-9636
Frontier	Resource
Sonalan	Permit
Axiom	FMC-6285

Reference

Mitich, Larry W. and Guy B. Kyser. 1986. Economic losses and control of nightshade in dry beans. Proceeding 38th California Weed Conference. PP 128-135

WEED CONTROL IN RICE: WHERE HAVE WE BEEN? WHERE ARE WE GOING?

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California yields have more than tripled since rice was introduced in 1912. Improved varieties, more efficient fertilizer management, laser-directed leveling and herbicides have all contributed to advancing yields. In California as in most of the other highly mechanized rice cropping areas of the world, rice is direct-seeded. However, the vast majority of the world's rice area, principally in Asia, is still transplanted. Most rice historians believe that the ancient practice of transplanting was adopted not only to shorten the growing season, but more importantly to control weeds. Three to five week old transplant seedlings have a head start on newly germinating weeds as well as the advantage of tolerating a continuous flood which further suppresses weed growth. It is interesting to note that the increasing wealth of Asian nations is rapidly leading to direct-seeded rice to offset higher labor costs.

In California, rice was initially dry-seeded, but the rapid buildup of barnyardgrass all but rendered much of the land useless for production after three years of continuous rice. Following the lead that continuous flooding greatly suppressed many weeds, especially barnyard grass and sprangletop and to a large extent the watergrasses (*Echinochloa* and *Leptichloa* species), water seeding of pregerminated seed was introduced in California. With regard to continuous flooding, water-seeding followed the ancient practice of transplanted rice systems for weed suppression. Although water seeding adequately controlled many small-seeded grass weeds, aquatic weeds such as ricefield bulrush, smallflower umbrella sedge, California arrowhead, water hyssop, ducksalad and others flourished in the aquatic system. Furthermore, the grass complex shifted to the large-seeded *Echinochloa* species of watergrass, capable of surviving continuous floodwater. The post World War II introduction of the phenoxy herbicides 2,4-D, 2,4,5-T and MCPA greatly improved the control of aquatic broadleaf and sedge weeds. These herbicides were followed in succession by bentazon (1979) and bensulfuron (1989) as the major herbicides for broadleaf weed control. Grass herbicides were also introduced: First propanil (1964), which also controlled some broadleaf and sedge species; then molinate (1973), an *Echinochloa* herbicide, followed by thiobencarb (1981) a grass herbicide with good activity on smallflower umbrella sedge and suppression of a few broadleaf aquatic weeds. Each of these herbicides contributed significantly to good weed control and the unprecedented high rice yields of the 1990s. Their introduction and use patterns are shown in figure 1. But herbicide resistance, weed species shifts, water pollution and drift to sensitive crops have taken their toll on herbicide registrations and use patterns in California rice. Furthermore, the difficulty of herbicide registration in a relatively small rice market and in an aquatic environment has limited the growers choices for herbicide rotation to avoid these problems. Hence, weeds remain as the primary pest problem of California rice growers.

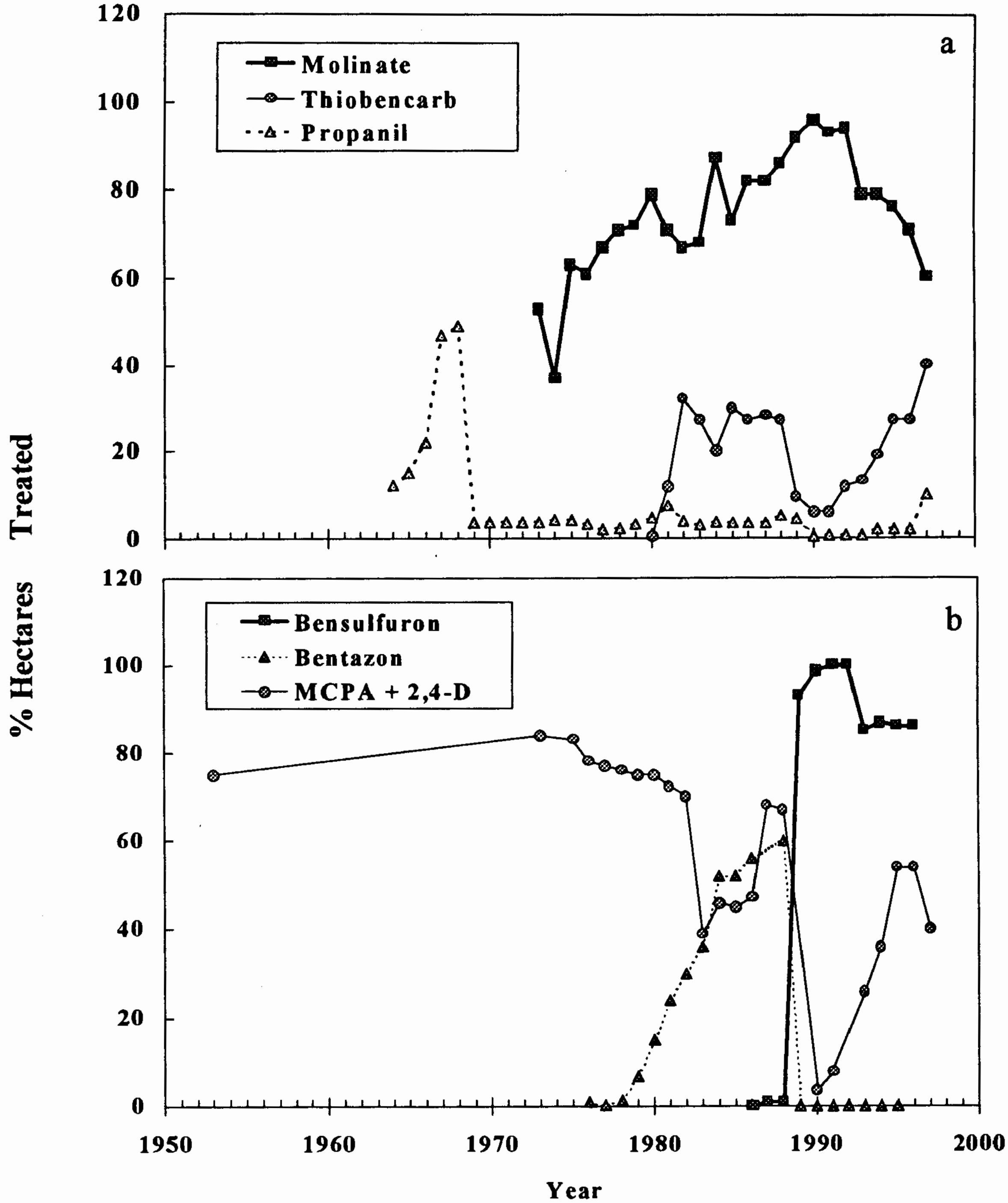

Figure 1. Herbicide use patterns over time: (a) California grass herbicides; (b) California broadleaf herbicides.

Weed Resistance: Weed resistance is caused by a genetic shift rendering a species once normally controlled by a herbicide the ability to survive treatment. Bensulfuron was introduced in 1989 to California rice and by 1993 four aquatic broadleaf and sedge species had develop resistance. The single gene mechanism for ALS inhibitors such as bensulfuron was highly vulnerable to selection for resistance, but even herbicides with more complex mechanisms of action used continuously may eventually allow selection for resistance. It took many years of use for barnyardgrass and junglerice to develop resistance to propanil in the southern United States and South America, respectively. It appears now that resistance of late watergrass to molinate, thiobencarb and fenoxaprop has developed in California rice . Resistance is most often the result of continuous use (every rice crop) or overuse (higher rates or more applications than needed) of a single herbicide. Herbicide resistance is best solved by rotating or combining herbicides with different mechanisms of action or with crop rotations (limited in rice) or targeting rates to the dominant weed species if less than the label rate will provide control. The early identification of resistance is important to begin management strategies before seed banks of resistant biotypes build up to levels that ensure a continuous source of seed for future recruitment. The recent removal of phenoxy labels for rice will exacerbate the problem of herbicide resistance in California rice.

Weed Species Shifts: Weed shifts are caused by increases in weed species that are not controlled by the principal herbicides used in the rice cropping system. For example, the widespread use of bensulfuron which effectively controlled annual species, allowed many of the perennial species such as Greg's arrowhead to expand. Similarly, the adoption of early drainage or the so-called pin-point flood has increased the abundance and incidence of sprangletop as a problem weed. Solutions to weed species shifts are similar to those for weed resistance--rotation of crops, herbicides and management practices to break weed cycles.

Water Pollution: The aquatic environment for rice is unusual among crops and provides special challenges to prevent off-site pollution of downstream waterways with fertilizers and pesticides used in production. Although in-field water movement may actually be detrimental to weed control by dilution of the herbicide, the primary problem is water pollution from off-site movement to surface or groundwater. Weed control is affected indirectly through restricted use or the deregistrations of herbicides. In California, much has been accomplished in the management of rice irrigation and tailwaters to mitigate problems of surface water pollution.. The extensive use of recirculating irrigation systems, static irrigation systems, gravity recapture irrigation systems and just plain good water management in conventional systems has reduced off-site herbicide movement by over 95%. However, political and regulatory pressure continues to rachet down on water pollution. Perhaps the most difficult herbicide loss to good weed control and resistance management was the deregistration of bentazon use in 1989 due to very low residues found in well water.

Drift to Sensitive Crops: Herbicide drift has been a long-standing problem for rice producers. The flooded environment has favored aerial application for speed and timing, but aerially applied herbicides are more difficult to keep on target compared to those applied by ground. In California, the phenoxy herbicides have long been excluded from most areas of the San Joaquin Valley after March. Similar regulations are now being enacted for the Sacramento Valley. Thus, after 50 years of mostly successful use, the phenoxy herbicides will be severely restricted, if at all available in 1998 for California rice growers. Drift to sensitive deciduous orchards, particularly prunes, caused propanil to be restricted to a very limited acreage in 1969. More recently the acreage has been expanded due to improved formulations and restrictions to ground-only application where sensitive crops are nearby. Liability issues from drift often limit the manufacturer's interest in product registration, particularly in California where agriculture is highly diversified and rice is a relatively minor crop. The principal solution to drift problems will be from improved formulations, herbicides with less potential for drift damage, better application methods (such as the direct-dry application pioneered by DuPont for bensulfuron) and with precision ground equipment guided by global positioning systems (GPS) and operated in concert with geographic information systems (GIS) to provide historical records (and perhaps "smart" weed identification systems).

Summary: California rice farmers have taken great strides in improving field infrastructure in ways that provide good cultural and chemical management of weeds. Two of the most important are precision leveling for water management and the development of irrigation systems to control water movement within the field and to prevent water pollution from tailwaters. It will be critical to diversify weed management by coupling cultural control strategies with those new and few remaining "old" herbicides available for use. Fortunately, a few new herbicides are on the horizon such as V-10029 and carfentrazone, as well as the advent of rice genetically engineered for glufosinate and glyphosate resistance. Additionally, the expansion of currently registered herbicides such as propanil and the labeling of older products such as trichlopyr will help immensely in maintaining the diversification necessary to minimize drift, water pollution, weed shifts and resistance as previously described. At least for the near term, based on the foliar activity of both new and expanded herbicides, ground applications will increase driven by both regulations and stewardship. The old strategy of market dominance with herbicides (get there first and with the most) will have to change to one of partnerships to ensure that diversity in weed management systems is maintained.

TRANSGENIC HERBICIDE TOLERANT COTTON

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Cotton variety development and testing have entered into a new phase and into the 21st century with the advent of biotechnology and transgenic varieties. Genetic engineering techniques allow the introduction of genes from unrelated species, resulting in a new version of an existing variety with a "value added" trait, such as herbicide tolerance. Herbicide tolerant cotton is becoming a reality across the US cotton belt with the introduction of Roundup Ready and BXN varieties. As this technology develops, herbicide tolerant cotton will become common place in California production systems.

The development of transgenic tolerant cotton varieties takes a number of years due to the process and steps necessary in molecular genetics. Once a gene of value is identified (Roundup or Buctril tolerance) and its structure is mapped, molecular biologists use enzymes to cutout the DNA segment and insert it into DNA of an individual cotton cell. This process is called transformation. During the regeneration stage, transformed cotton cells are grown on a nutrient medium in petri dishes forming a mass of undifferentiated tissue or callus. The callus is then induced to differentiate into an entire cotton plant which contains the new trait.

Regeneration is only the beginning as screening is necessary to eliminate undesirable plants. All transgenic cotton varieties are regenerated using Cocker 312, an older variety that produces lesser yields and quality than newer varieties. Cocker 312 is used because it is one of the few varieties that can be easily regenerated.

A considerable amount of time (4 to 6 generations) is then needed to conventionally backcross the transformed trait into desired varieties. More screening and testing are needed before seed increases can begin. Once a progeny line is selected, seed companies then increase seed for commercial use. This entire process can take up to 6 to 8 years.

In the San Joaquin Valley, cotton varietal development and release is controlled by state law and administered through the San Joaquin Valley Cotton Board, made up of grower representatives within the six cotton producing counties of the San Joaquin Valley. Prospective cotton varieties are tested for a 3 year period. If they meet or exceed the yield and quality traits of the Board's standard variety (Maxxa since 1990) they then are released for grower use. As approved varieties are transformed with herbicide tolerance, making them different than their recurring parent, they again must be tested for three years before approval. The additional testing is to insure that its yield and quality characteristics have not been compromised and inferior Cocker 312 traits are not expressed in the new herbicide tolerant variety.

At present, three Roundup Ready cotton varieties are being tested and evaluated by the San Joaquin Valley Cotton Board. If these varieties meet board standards, the first commercial herbicide tolerant cotton varieties will be available to California cotton growers in 2000.

As this technology is developed and made available to the California grower, a number of questions and concerns arise, the most important being the issue of weed resistance or weed species shifts. If weed control programs are developed which rely solely on one herbicide, weed resistance may become a problem. Since plants only have one reproductive cycle per year, it normally takes several years to develop a resistant population. But, growers need to implement resistance management strategies including crop rotation, herbicide rotation and control of weed escapes by tillage in order to prevent resistance from developing.

A number of studies were conducted to evaluate Roundup Ready and BXN (Buctril) transgenic cotton varieties. Studies evaluated control of annual morningglory and cotton tolerance when Roundup Ultra and Buctril were applied to their respective varieties at various rates and stages of growth.

Roundup Ready Studies

Roundup Ultra applied to morningglory in Roundup Ready DP6100RR cotton provided excellent season long control up through harvest when applied to seedling morningglory over the top of 2 to 3 leaf cotton followed by one post directed treatment. A second post directed treatment did not enhance control.

Evaluations of Roundup Ultra applied over the top of DP6100RR cotton at various rates and stages of cotton growth showed the extreme importance of limiting over the top application to no more than the 4 leaf stage. No visual injury symptoms were noted when Roundup Ultra was applied over the top at any rate or stage of cotton growth. But, final plant mapping data indicated significantly lower boll retention levels in most treatments when compared to a single over the top application at the two leaf stage. Seed cotton yields were numerically less with all Roundup Ultra treatments and significantly lower at the 9 and 12-node stage of application when compared to a single over the top application at the two leaf stage. Post direct treatments of Roundup Ultra at the 8 and 17-node stage of cotton had no detramental effect on yield.

Preharvest or late season applications of Roundup Ultra at 8 NAWF (nodes above white flower), 5 NAWF (cutout), 8 NACB (nodes above cracked boll), and 4 NACB showed no adverse effect to cotton growth and development except at the 8 NAWF application. Roundup Ultra applied at 8 NAWF significantly lowered percent boll retention in the 95 percent zone and seed cotton yield.

When Roundup Ultra was applied to DP6100RR cotton in combination with Staple there was no adverse effect to cotton growth, development and yield. Staple applied at all rates over the top of 3 to 4 leaf cotton produced the same visual symptoms as when applied to non Roundup Ready cotton varieties. Yellowed, crinkled leaves appeared 3 to 5 days after application, but were almost nonexistent at 14 days after treatment.

BXN Studies

Buctril applied to seedling annual morningglory over the top of BXN Stoneville 47 cotton provided acceptable control for 35 days when followed by a post directed treatment of Buctril. Either a single over the top or single later post directed treatment provided unacceptable control of morningglory. At 90 days after treatment, control was also unacceptable with the over the top followed by a post directed treatment. Additional studies indicated no visible, detrimental effects to cotton when Buctril was applied to BXN Stoneville 47 at any stage of growth. There were no differences in yield when compared to a standard weed control program of Staple applied to Maxxa cotton.

In summary, herbicide tolerant cotton, if properly managed, will provide growers with a viable weed management strategy for effective, economic weed control. Presently available transgenic varieties will be the forerunners of future transgenic varieties which will provide the grower with greater application flexibility and with multiple traits including herbicide tolerance and insecticidal properties. But, as this technology is developed and integrated into production systems a number of concerns must be addressed including:

1. Effects on herbicide use - if a crop is tolerant to a non selective herbicide such as Roundup, can all other herbicides in the system by eliminated? Will it be necessary to use preplant, preemergence, post emergence or over the top selective herbicides? Will herbicide tolerant crops allow replacement of herbicides that are used in higher doses with those used at lower doses? Will growers be able to wait to determine if a weed problem develops then apply a non selective herbicide?

   On the other hand, will herbicide tolerant crops cause growers to solely rely on herbicides for their weed problems, resulting in greater herbicide use?

2. Can cultivation and hand weeding be reduced or eliminated? Will minimum and/or no till production systems be developed in California? Will herbicide tolerant crops allow the elimination of hand weeding and what will be the economic "trade off?"

3. Crop productivity, quality and safety - the implications of genetic engineering as a process in developing herbicide tolerant crops, raises the question of maintaining current yield and quality levels as well as food safety?

4. Weed Resistance - Will herbicide tolerant crops lead to weed resistance or shifts to hard to control perennials?

5. Environmental Effects - What effect will herbicide tolerant crops have on air, water and soil quality? The San Joaquin Valley is a non attainment area for PM_{10} and ozone levels in the atmosphere. Will herbicide tolerant crops result in less cultivation, ultimately reducing the amount of dust and PM_{10} particles released into the atmosphere. Will soil and water quality be effected by the elimination of soil, residual herbicides which have a potential of effecting subsequent rotational crops and movement into the ground water supplies.

6. Economic effects - Will herbicide tolerant crops result in more economical weed strategies for growers? If cropping systems are developed that rely only on a few non selective herbicides; what effect will that have on the development and commercialization of new alternative herbicides? Will this technology lead to a complete restructuring of the ag chemical marketing system?

Control of Hooded Canarygrass with Puma: Matthew H. Ehlhardt, AgrEvo USA, W. Mick Canevari, University of California Cooperative Extension.

Abstract: Grassy weeds in the Northern San Joaquin and Sacramento Valley small grain growing areas include wild oat, annual ryegrass, hood canarygrass and various brome grasses. The standard postemergence herbicide program has included Hoelon and Avenge since the early 1980's. Presently there are limited tools for brome grass. Avenge is registered for controlling wild oats. Hoelon controls all four species but does not have any brome grasses on the California section of its label and has growth restrictions for applying to hood canarygrass and wild oats. Recent surveys conducted by the University of California Cooperative Extension has indicated that canarygrass (hood and little seed) is becoming the primary grassy weed in California wheat and a problem in barley. The window for applying Hoelon to control hood canarygrass is limited to the 1-3 leaf stage of gorwth of the weed with only one application allowed per growing season. Multiple germinations or missing the appropriate application timing may result in a yield reducing hood canarygrass infestation.

Puma (fenoxaprop-p-ethyl and menfenpyr-diethyl) is a new annual grassy weed herbicide manufactured by AgrEvo USA. Research was conducted during 1996 and 1997 to evaluate the efficacy of Puma on different growth stages of hooded canarygrass. Rates of 0.067, 0.089 and 0.112 lbs.a.i./A were applied to the 1-4 and 6-7 leaf stage of weed development. All treatments were applied using a CO2 backpack sprayer and replicated three times. Percent visual weed control and crop phytotoxicity ratings were recorded at 14 and 28 DAT and prior to harvest. Results from the preharvest assessment, averaged across three locations, had control ratings of 95.9, 98.5 and 100% for the three rates at the early timing and 84.4, 85, and 100% at the latter timing. At 14 DAT crop phytotoxicity ratings had early damaged expressed as chlorosis ranging from 6.7 - 8.3% with the early timing and 10.1 - 11.8 % with the late timing. No crop symptoms were evident by the preharvest evaluation. Yield data did show an increase response in removing the species early with yield increases ranging from 4.6 - 23.7% with the early applications when compared to the same rates applied at the latter timing.

FIFTY YEARS OF WEED CONTROL IN GROWING FOREST

OR

CHOPPIN' COTTON 'N GROWING FOREST

by
Larry Ballew

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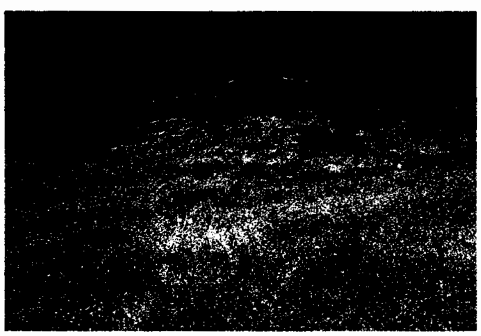
In 1940 at the age of 6, I was given this hoe! It is over 57 years old, and it is the one thing that made the greatest change in my life. I was taken to the end of a cotton row, told to chop weeds, and they would see me at the other end. There are only a few things a person thinks of when choppin' cotton: when will it end and an easier way to do it. This continued until I was 12, when I broke the handle out the hoe and said I would never be a 'hoe'er' again.

I used salt, arsenic, and crud oil. I killed every thing I touched: weeds, crop, and trees. In 1948 I watched a man named Walt Emrick put out in the town of Ahwahnee, Calif. a 'numbered' chemical manufactured by DuPont. No one knows if it was ever registered, but it worked! It was to improve the range and oak-woodlands in the Sierra-Nevada Mountains. After 50 years, the treated site is still one of the most productive parcels of range lands in Madera County. I was impressed.



Single herbicide treatment in 1948 for brush control and still holding. Madera County

Soon becoming a professional forester, gave me insight into growing trees. My mother present me with this hoe, with a new handle, upon college graduation. At that time we had no non-selective brush/tree herbicide compounds. About the early 1950's, we had a few grass compounds, i.e. Atrazine, dalapon, simazine and the damn hoe. They helped in our reforestation, but we needed more! We built great machines like the Mt. Shasta Brush Plow, and Mardin Chopper that could move the Earth. We dug holes and planted trees in the holes, we bulldozed the top 6" of top soil, we disk, we plowed and finally we hit on 'terracing with use of herbicides'. The terraces gave us a brush free area, unconsolidated soil, in-place nutrients, and with herbicides a grass free environment.

This not only increased our survival but increased the growth. We increased fiber yields over natural timber stands by 200%. These stands were logged [thinned from below] at age of 30. Growth of the trees removed was remarkable. The harvested trees cut to release the 'real growers' were growing at the rate of .6" in diameter per year.

1958 Nelson Cove Plantation. Burned by wildfire, terraced by tractor, sprayed for grass control, and planted. The area was logged in 1990, by selectively weeding out the slow growing trees.

Then in the mid to late 1950's we heard about some possible new research on a couple of selective brush compounds: 2,4-D and 2,4,5-T. After a lot of failures and dead trees, these proved out to meet our needs. Because of the failures, and temperamental nature of the application timing, we still had a lot of "hoe'ers" in the profession.

A few of us became chemist of sorts. We mixed herbicide combinations and 'witches brews' that met our objectives in the complex plant communities and terrain in which we worked. Most were still tied into some major mechanical or prescribed fire treatment. There was still about 7 percent of our forest lands which contained bear clover, the 'hoe'ers' said we would never reforest.

This process went on for about 17-18 years. Forestry and range were considered then and still today a 'niche' market by many pesticide manufactures. In about 1976 there was an RPAR on 2,4,5-T which questioned the safety of the product due to the possibility of a dioxin. Weed control suffered a major set-back when 2,4,5-T was politically removed from our bag of tools. This was compounded by the birth of a new-breed of 'hoe'ers' from the 'sixties'. Then in 1977, three companies began looking at Forestry with some new enthusiasm and new chemistry. They were the DuPont Company, Dow Chemical, and Monsanto.

We had some new toys to play with! A group of professionals, University, and researchers teamed up to solve the reforestation problems of the day. Between 1977 and

1979 we tested some chemicals called Garlon, Round-up and Velpar. We still made bigger and better witches brews, that I believe still bubbled to this day.

In 1979 the greatest single item to improve timber production in California for the past 20 years was registered. Velpar L Herbicide! It increased fiber production by 600% when combined with normal professional silvicultural practices. It was and is our only weed control product which is selective, residual, and effective on grass, brush and hardwoods. It has become the foundation of reforestation in the ponderosa pine and mixed conifer forest of the west. With an active program of weed control with hexazinone [Velpar L], followed by a maintenance treatment using foliar herbicide products, foresters can maximize fiber production.

During the past 50 years I have seen the profession move from barrels, to buckets, to gallons, to quarts, and now finally to ounces of chemicals per acre.

During the next 50 years the Professionals Foresters will keep growing forest, and the 'hoe'ers' will continue to 'chop cotton'. The only thing for sure is Larry Ballew will be here looking to the future!

A reforested man-made 'clear-cut', which is producing wood products for the future, pre-European timber stand conditions, and duplicating ancient forest habitat. Professional foresters can grow forests to meet all needs.

FIELD RESULTS OF CALIFORNIA FOREST HERBICIDES
New Advances in Control of Problem Hardwoods

Ed A. Fredrickson-Forester, Roseburg Forest Products

INTRODUCTION

Depending on the managers objectives, resprouting hardwoods after harvesting activities or wildfire can be a serious problem when the desired goal is conifer establishment. Hardwood sprouts most often have the ability to outcompete seedling conifers for water, light and nutrients due to massive root systems which remain after harvest. To insure successful plantation establishment, chemical control of hardwoods is often required when densities reach a critical level.

Historical control of hardwood sprouts in California has typically been through basal applications of growth regulator products such as triclopyr or in some cases 2,4-D in an oil carrier, or spotgun treatments with hexazinone. Control of mature hardwoods has been attempted with amine formulations of triclopyr and 2,4-D as a frill or girdle, hack and squirt, or cut stump treatment, with some success.

Control methods in the past have produced mixed results and were often expensive. This in turn has led to an increased effort to find new and more effective ways to control unwanted hardwoods. The objective of this paper is to provide an update of current research findings and field trials dealing with this issue.

NEW TOOLS IN FORESTRY

10% Roundup-Low Volume Foliar Treatment

In July of 1994, Bruce Kelpsas of UAP Pacific in cooperation with Roseburg Resources put out a set of trials to evaluate the effect of low-volume high-concentration foliar treatments of Roundup® (Monsanto) and Garlon 4® (Dow-Elanco) on two year old black oak *(Quercus kelloggii)* clumps. Treatments consisted of Roundup at five and ten percent in water, Garlon 4 at five and ten percent in water and a tank mix of Roundup and Garlon 4 each at five percent in water. Ten clumps were sprayed with each treatment.

Although the trial was never formally evaluated, excellent results were obtained with Roundup at 10%. The 5% treatments were slightly inferior to the 10%. Garlon 4 treatments along with the tank mix provided immediate brown-out after treatment, but the following growing season vigorous resprouting from the stems negated virtually all treatment effects.

Good initial results from the 10% Roundup treatments led Roseburg Resources to implement a small operational trial of 150 acres in 1995. The program increased to 1500 acres in 1996 and in 1997 our 10% Roundup treatments on hardwoods totalled 6500 acres.

This treatment has many advantages over historic hardwood treatments in California. First, the results are extremely consistent. Three years after treatment we are seeing very little resprouting. Coverage is the most important factor. Good coverage all the way around the clump as well as the growing leaders will ensure adequate control. Second, labor and chemical costs are about half of basal treatments on comparable clump sizes and densities. This is primarily due to the low application volume. Third, the need for a petroleum based carrier is negated. Fourth, we have found that we are able to treat clumps when they are small (2 years old). The cost increases dramatically as crown volumes increase. The longer the wait, the higher the cost. On the Fountain Fire, average volume per acre of solution in 1995 was 1.8 gallons per acre (3 year old clumps), in 1996 it was 3.5 g.p.a., and in 1997 it was 7.5 g.p.a.. Fifth, the mix is easier on conifers if accidentally hit, especially after bud set.

Ten percent Roundup treatments have shown to be an effective, efficient, and easy method of hardwood control.

Imazapyr

Imazapyr is a versatile herbicide first used in forestry in the middle 1980's. Currently registered in 49 states in the USA, its California registration is pending.

Imazapyr is in the Imidazolinone chemical family. It is a highly systemic and phloem mobile compound which inhibits the enzyme acetolactate synthase (ALS) which catalyzes the synthesis of three amino acids valine, leucine and isoleucine. It is mainly a foliar active compound but it does have some soil activity. Alaska data has shown imazapyr remains in the top six inches of soil (Newton et al. 1996). The field half life is generally between 25 and 142 days. Other benefits include extremely low toxicities to humans, fish and wildlife. The oral LD-50 for rats exceeds 5000 mg/kg of body weight.

One of the major benefits of imazapyr is its ability to be used in a variety of different application techniques. These include hack and squirt, foliar, basal, thinline and cut stump treatments.

Imazapyrs ability to control deciduous species is well documented. Cole & Newton (1990) showed good control of bigleaf maple (*Acer macrophyllum*) with a broadcast application of imazapyr at 0.5 lbs a.i./acre at a volume of 10 gallons per acre. Broadcast applications have also successfully controlled salmonberry (*Rubus spectabilis*), vine maple (*Acer circinatum*), and hazelnut (*Corylus cornuta*) (Cole & Newton, 1988). Red alder (*Alnus rubra*), Pacific madrone (*Arbutus menziesii*), and white oak (*Quercus garryana*) are highly susceptible to stem injection treatments with imazapyr (Cole et al., 1989).

California Imazapyr Trials

Beginning in the fall of 1995 a series of trials were installed on Roseburg Resources property in Cooperation with Joe DiTomasso-Non Crop Weed Ecologist University of California, Davis. The objectives were to establish rates which could adequetly control black oak for a variety of application techniques, assess the relative contribution from the addition of several types of surfactant, and assess the phytotoxicity of imazapyr on ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*) and white fir (*Abies concolor*). Only a brief overview of the experiments and results will be given here.

<u>Broadcast Arsenal Trials on Black Oak Sprouts</u>

The first trials were installed to assess the ability imazapyr to control three year old black oak stump sprouts in a broadcast application. Arsenal AC® (4# a.i./gal) was the formulation used. The treatments consisted of Arsenal at rates of 2, 4, 6, 8, and 16 ounces product per acre. These rates were in combination with no surfactant, R-11® (0.5%, non-ionic surfactant), and Sylgard 309® (0.15%, silicone based surfactant), to assess the adjuvant contribution if any. Arsenal at 2, 4, 6, and 8 ounces was also combined with 2 quarts Accord® with Sylgard 309 for and additional comparison. Five percent conventional Garlon 4 basal treatments and 20% low volume Garlon 4 basal treatments in kerosene were also included in the study to note differences in post treatment resprouting. All treatments were applied at a 10 gallons per acre, excluding the basal treatments. Timing was September 22, 1995. There were five replications per treatment.

The second year results have been collected but have not yet been statistically evaluated. However, initial inspection of the data shows very apparent trends. The addition of surfactant significantly increased control. No differences were apparent between surfactant types. No treatment without a surfactant achieved greater than 65% crown reduction. Ninety percent crown reduction and greater was achieved with the 16 ounce treatments and a surfactant. The tank mix of 8 ounces Arsenal and 2 quarts Accord with Sylgard also produced 90% crown reduction. Five and twenty percent Garlon 4 basal applications had 76% and 89% crown reduction, respectively. However, basal resprouting was noted on roughly 40% of the clumps treated. Some recovery of clumps was noted for all treatments from the first year evaluations. Therefore, it is probably unlikely that significant long term control of black oak sprouts can be achieved through aerial applications.

<u>Directed Arsenal Trials on Black Oak Sprouts</u>

A second set of trials was established to evaluate directed ground applications of imazapyr to control black oak sprouts. Arsenal AC was again the formulation of imazapyr used. Rates of Arsenal were 0.5, 1, 2, 3, and 5 percent in water with Sylgard

309 (.15%). Treatments consisted of Arsenal only applications and in combination with 2% Accord as a tank mix. Two percent Accord with Sylgard was also applied by itself to complete the factorial treatment structure. Garlon 4 basal treatments at 5 and 20 percent were again implemented for comparison. Plots were individual black oak clumps and were treated September 24, 1995. There were five replications per treatment.

The second year data has been collected but again, the statistical evaluations have not been completed. Two years after the application took place, all treatments of Arsenal alone and the Arsenal/Accord tank mixes provided above 94% crown reduction with the exception of the 0.5% Arsenal/2.0% Accord mix which was 74%. The 5% and 20% Garlon basal applications provided 89% and 95% crown reduction, respectively. However, basal resprouting occurred on roughly 35% of clumps treated.

Overall, directed hand spraying of black oak clumps appears to be a very effective and cost efficient treatment. For the average size clump in this study, 26 and 11 ounces of solution were applied per clump for Garlon 5% and 20% basal applications, respectively. This equates to $0.81 and $1.38 per clump in chemical cost alone. Meanwhile, applications of Arsenal alone ranged from $0.07 per clump for the 0.5% treatments to $0.67 per clump for the 5% treatments.

Hack and Squirt Trials on Mature Black Oak Trees

Four trials were established in 1996 to determine the effectiveness of hack and squirt applications on mature single stemmed black oak trees. Treatments were applied in March, June, August and November of that year. Hack spacing varied along with the rate of solution injected. Trees were hacked once for every 2, 3, 4 and 5 inches of diameter at breast height. The rates of Arsenal AC were 0% (trees were hacked but no chemical), 50% and 100%. Chemical injections were at a volume of 1 milliliter per hack. There were five replications per treatment.

First year evaluations took place in September of 1997. At this time no treatment differences were apparent between or among any of the timings. Virtually all chemical treatments had 95% or greater crown reduction. However, due to the slow acting nature of the chemical, no recommendations should be made until the second year data has been collected and evaluated. Mature black oak does appear to be highly sensitive to imazapyr.

Hack and Squirt Trials on Large Black Oak Sprout Clumps

The question of what to do with very large sprout clumps (greater than 15 feet tall) came up in the early stages of these trials. In 1996, a trial was installed to determine the effectiveness of hack and squirt applications on black oak clumps. Similar to the tree hack and squirt study, hack spacing as well as rate of solution varied. Clumps were hacked once for every 1, 2, 3, 4 and 5 feet of clump crown diameter. The largest stems in the clump were hacked first. Rates of Arsenal AC were

0%, 50% and 100% in one milliliter injections per hack. Treatments were replicated five times and applied December 19, 1996.

First year evaluations were completed in September of 1997. Similar to the mature black oak study, no treatment differences could be discerned. All chemical treatments had greater than 98% crown reduction except the treatment with the lowest rate and greatest hack spacing which was 91%. Therefore, the second year evaluations are needed before any trends can be validated. Due to the homogeneity of the data, no statistical analysis will be done until the second year data has been collected. Again, this appears to be a very effective treatment.

Operational Trials

Other application techniques are also being evaluated with small operational trials. Thinline and low-volume basal treatments with Chopper, the basal formulation of imazapyr are of considerable interest. Two timing trials in the spring and summer of 1996 were installed to determine these techniques effectiveness on black oak clumps. Neither has been formally evaluated to date. Treatments included chopper at 2%, 5% and 10% in kerosene as a thinline treatment and in combination with 25% Garlon 4 also in kerosene. Low volume basal treatments were also included at the same rates as the thinline treatments with the April timing. Only thinline treatments were evaluated in the July trials.

While no formal evaluations have yet been made, some trends are apparent. Generally, April treatments gave only moderate control and had a fair amount of resprouting. Low volume basal treatments were more effective than thinline in April but they did not yield an acceptable level of control. Treatments in July had the best results. All thinline treatments produced virtually 100% crown reduction one year after treatment. However, the full effect has yet to be seen and it should be noted that stem reduction was very poor at this time. The July trials were sprayed when the oaks were fully leafed out, minimizing the amount of chemical actually reaching the stem. Therefore, there may be a more effective timing when leaves are off such as late fall that would allow maximum deposition of chemical on the target.

Conifer Tolerance Trials with Imazapyr

In April of 1997, a conifer tolerance trial was installed to evaluate broadcast applications over the top of planted seedlings. The chemical treatments were identical to those of the broadcast oak clump trials mentioned earlier. Plots were layed out (12'x36', .01 acre) and planted with five white fir, Douglas-fir, and ponderosa pine per plot. Each treatment was replicated three times. The plots were then left free to grow until mid-September 1997. Plots were sprayed at that time with a twelve foot nitrogen powered backpack sprayer equipped with a 12 foot boom. All applications were at 10 gallons per acre and sprayed with one timed pass.

First year data from these plots will be collected and analyzed in the fall of 1998.

CONCLUSIONS

With the introduction of imazapyr to California and the development of high concentration Roundup treatments, there are more options for controlling problem hardwoods than ever before. While there have been many advances in the last several years, there is still more work which needs to be done. However, these new developments should provide more consistent and efficient results than past experiences. The full results of these trials will be available in a future publication.

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NOXIOUS & INVASIVE RANGELAND WEEDS, A RANCHER'S PERSPECTIVE
CALIFORNIA WEED SCIENCE SOCIETY
MONTEREY. CA. 1/13/98

by Ken Zimmerman, Chairman
CCA Range Improvement Committee

Invasive and noxious weeds ... we all have them. The simple fact is, whether they are on private rangelands, right-of-ways, or public lands, something has to be done about them. What's being done about them?

The federal government created the Federal Noxious Weed Act of 1974 (PL 93-629)(U.S.C. 2801 et. seq.) as amended by the Food, Agriculture, Conservation and Trade Act of 1990; Section 1453 ("Section 15, Management of Undesirable Plants on Federal Lands"); and the Carson-Foley Act ("Public Law 90-583). Sounds pretty impressive until you hear that no funding was made available until September 1991, and they are still having meetings and studying the problem. The California Interagency Noxious Weeds Coordinating Committee (CINWCC) was created to outline a program to address the noxious weed problem on public lands in California and after attending several CINWCC meetings we felt the livestock industry needed to take the lead on any programs addressing noxious weeds on California Rangelands.

The CCA Range Improvement Committee decided not to wait for the agencies to decide what could be done about the problem of noxious weeds and sent out a survey asking local cattlemen's associations to list ten of the most invasive weeds in their area. Twenty counties responded to the survey and the lists were made available to the CINWCC, CDFA, and other interested parties in the form of an inventory of A, B, and C rated weeds. Many phone calls were made throughout the state and a lot of discussion within CCA took place, which led to the concept of developing a CCA "Noxious Weed Pilot Program." Recognizing that maintaining private property rights would be the paramount objective, implementation of a pilot program would require that our members become involved and that we provide the means to furnish allied industry support and new technology to our members.

This would turn out to be a much larger task than we had anticipated and raised three key questions: 1) Since California does not have the variety of herbicides for rangeland applications that are available to the other 49 states, what could be done to make those products available for use in California? 2) Other than herbicides, what other technologies were available to control noxious weeds? 3) How could we monitor and record quantitative and qualitative data for others to use?

Letters were sent out to allied industry chemical manufacturers and suppliers of herbicides notifying them of our desire to proceed with pilot programs and requesting their support and participation in implementing the programs. The response was very positive and there is a genuine commitment and concern by the company field representatives and at the company headquarters level to help livestock producers deal with noxious weed problems.

The California Dept. of Food and Agriculture (CDFA) was contacted to assist us in developing research and monitoring guidelines, we also requested CDFA to be the lead agency for projects which require special permits. The USDA Western Regional Research Center in Albany, Ca. was also contacted to determine bio-control agents that might be on the horizon and to obtain information on existing bio-control programs. Our contact with the ARS Lab - Albany exposed a facility understaffed and underfunded. We also found that the 1998 FY federal budget contained no additional funds for Albany. CCA quickly teamed up with the California Native Plant Society, The Nature Conservancy, California Farm Bureau, and other western state cattlemen and farm bureau organizations to conduct an intensive Congressional lobbying effort which lasted several months. We pressured all members of the appropriations subcommittees in both houses as well as the full committees to support a funding increase for Albany to get it properly funded. While various versions of appropriations subcommittee and conference committee reports were shuffled around, we were assured by Congressional staffers that our message had clearly been heard and that we had succeeded in getting new funding for at least one more scientist. Unfortunately after the dust had settled, it turned out that our efforts and those of our Congressional friends were lost on ambiguity in the appropriations language that turned up no money for Albany. However, we were subsequently told that ARS-Washington was able to fund $50,000 for a scientific assistant at Albany which will help some, and that a proposed 1999 FY ARS budget is already floating around which does contain the funding necessary to hire a least one more full-time scientist for Albany. CCA will again be looking to our traditional allies for help in making sure Albany does not get lost in the dust again this time around.

An outline of CCA's proposed Noxious Weed Pilot Program was subsequently sent to all local cattlemen's association's requesting input. The responses were few and apprehensive. So we took a step back to see what it was that we had overlooked. More questions arose: 1) How large an area was needed for a pilot program? 2) How do we protect private property rights while allowing access for monitoring? 3) What would be the investment of time, money, and lost grazing use to the volunteer member? 4) What would be the benefits of the program in increased forage availability?

I am now pleased to say that I can answer some of those questions. First, the desired total acreage needed is 50 - 100 acres (base acreage should be similar in topography and soil types). Second, for the pilot programs we have set up so far, we held meetings with all interested parties prior to visiting the problem sites. We answered as many questions as we could and discussed access before and after treatments; financial responsibility; special needs such as required equipment and labor; available forage before treatment measured for production potential; and desired and projected results after treatment.

Currently there are three pilot programs in place - in Yolo, Glenn and Inyo Counties. Dow-Elanco has been working with us on the pilot programs in Yolo and Glenn Co. using a product called "Transline" to control yellow starthistle. The monitoring has been completed for the first year in Yolo and Glenn Counties and "Transline" was quite effective. Control is estimated to be 99% and except for isolated outbreaks Transline's control of yellow starthistle brings hope that some day our ranges will recover. Dupont is working with us in Inyo Co. using "Tellar" for tall whitetop or perennial pepperweed. We are told that we can expect one treatment to control 90%-plus of the weed for up to 3 years. Tellar currently does not have rangeland application approval, however, the rangeland studies required are being done and Dupont is optimistic that the approval will be forthcoming within the next year. The pilot programs that we have implemented have been a very rewarding experience for all that have participated. Nate Dechoretz and his crew at CDFA, Joe Di Tamaso - UC Davis, Tim Baldwin - Dow-Elanco, and Frank Aulgur - Dupont, have supported us and have been a pleasure to work with. Currently we are talking with Nate about doing a pilot program for Wild Licorice on City of L.A. DWP Land and Wild Iris on private property both in Mono County. Our plan is to treat the areas this spring if the weather cooperates.

The problems of noxious weeds along our highways is another story. The weeds are spreading to adjacent private, state, and public lands at an alarming rate. Recently two counties (Mendicino and Humboldt) have adopted county resolutions directing CalTrans to cease herbicide application on their rights of ways within their county. For those producers who raise alfalfa, grass, or other hay crops, there is a program which suggests weed free forage certification requirements for any hay being fed on BLM or USFS managed public lands. We have not yet seen the criteria for certificates of weed free forage, but one can be assured that if your field is adjacent to rights of ways or lands infested with noxious weeds the chances of qualifying weed-free are poor. For reasons such as this and that there are no proven alternative methods to control noxious weeds such as yellow starthistle, we cannot allow policies such as those in Mendicino and Humbolt counties to become state wide policies. Sheila Massey and I met with CalTrans in their state office early in 1997, Larry Shields and others from CalTrans assured CCA that they had no interest in seeing this policy expanded. We were also told that CalTrans would respond to local concerns if organized and directed through the agricultural commissioner.

The CCA range improvement committee has formed a CalTrans Coordinating Subcommittee and is forming local working groups at the county level to work with the agriculture commissioner and CalTrans to identify noxious weed priority areas. The local working groups are asking the agencies and signatory parties of the CINWCC to participate, we believe that this is a model which will replace meetings with treatment and control of invasive noxious weeds on California rangelands. The Range Improvement Committee is committed to maintaining private property rights while participating in the implementation of programs to control noxious weeds through out the state on adjacent State and Federal managed lands.

Finally, we need to collectively forge a much stronger coalition to work on a number of fronts in the fight against noxious weeds, including:

1. Immediately activate your grassroots letter-writing and telephone calling trees to urge your Congressional representatives and U.S. Senators to support adequate funding for Albany in the FY 1999 budget. Explain the devastating problem of noxious weeds in your area and urge that the ARS budget include at least $800,000 in new money for the Albany lab. Believe me it's not too early to start your contracts now before the train leaves the station and any chance for a budget augmentation is missed!
2. Support CCA's legislative efforts this year to change the Department of Food and Agriculture's noxious weed classification system to focus more energy and resources on the weeds that are wreaking the greatest havoc rather than keeping them on a list of the "most hopeless" which don't receive priority attention. Then help with passage of the bill through your letters and phone calls.
3. COMMUNICATION - Call me or the CCA office and let us know what pilot programs you are interested in to determine where CCA's pilot programs could dovetail in the future. Share research or news articles you come across that report on new noxious weed control methods or products. Also contact me or the CCA office for information about our local working groups.
4. Be ever vigilant of where and what type of weed infestations are occurring, particularly on public lands. One idea would be to start a clearing house of

data, categorized by type of weed, location of the problem, size of the problem (acreage), damage occurring to resources, etc. This information can be extremely valuable in talking to local and state decision-makers. Also be sure to report any attempts to transport hay with noxious weeds from other states into California which you become aware of to your county Ag. Commissioner. Recently in Bishop, Ca., the county agricultural commissioner received a tip that hay from Nevada containing whitetop was going to be sold and transported into Inyo County. After several phone calls were made, the Nevada State Agriculture Dept. decided to implement a program to put a stop to this practice.

5. OUTREACH - We need to contact golf courses, airports, county park officials and others to determine the extent of their noxious weed problems. We need to make an effort to schedule appointments with local newspaper editors to discuss the problem and ask that they do a feature article, but we must be sure we present them with the facts about the extent of the problem in any one area. CCA is certainly willing to be part of the team that makes these editorial visits.

On behalf of the California Cattlemen's Association, I sincerely appreciate the opportunity to give you these remarks today. As stewards of our ranges, we are committed to reducing the spread of noxious weeds and leaving healthy rangelands for future generations to use. Please remember that our advancement on the noxious weed issue is rooted in the willingness of all affected interests to be a cooperative partner. CCA looks forward to building on the partnership we already have with many of you. Thank you.

TRANSLINE HERBICIDE IN RANGELAND AND WILDLIFE HABITAT RESTORATION

Vanelle F. Carrithers, Dow AgroSciences LLC

Transline* is a unique, selective, broadleaf herbicide which provides excellent control of many tough broadleaf invasive plants, yet is tolerant to a wide variety of herbaceous and woody plants, including grasses (Table 1). It is applied as a foliar spray and translocates throughout the plant to the root system, thereby reducing the potential for re-sprouting in perennial plants. It is active in controlling many invasive plants particularly in the Asteraceae and Fabaceae families. This paper will provide background information on Transline and report its activity on yellow and purple starthistles and artichoke thistle.

The active ingredient in Transline* herbicide, clopyralid, was discovered to have herbicidal activity in the 1950's. Even though clopyralid provided excellent selectivity, further development of the material was not pursued because it's spectrum of activity was deemed to be too narrow at that time. As vegetation managers began to understand the benefits of Integrated Pest Management (IPM) programs, Dow AgroSciences LLC began development of more selective herbicides including clopyralid. Transline has been registered by both the Federal Environmental Protection Agency (EPA) and the California Department of Pesticide Regulation (CA DPR) for use on: wildlife openings; non-cropland areas; and rights-of-way, including grazed areas on these sites; and on rangeland and pastures. During the registration process more than 120 tests have been completed on Transline and reviewed by EPA and CA DPR. Transline has been found to be: non-carcinogenic; non-mutagenic; non-teratogenic; and not a reproductive hazard. It degrades in the environment through the activity of soil microbes.

Three efficacy trials will be reported here, two on yellow starthistle and one trial on both artichoke thistle and purple starthistle.

MATERIALS AND METHODS

Yellow starthistle

Applications were made to plants at spring rosette, bud and fall rosette stages of development. Broadcast applications were made at each stage in 20 GPA water. Transline was applied at 2.6 fl. oz., 0.33, 0.66, 1, and 1.33 pt./A and Tordon* 22K at 1.5 pt./A. Dates of application were: spring rosette, March 30 and April 14, 1996; bud, June 4 and 13, 1996; and fall rosette, November 11, 1996. Evaluations were made 6 weeks, 3, 4, 5, 7, 12, or 14 months after applications depending on application timing.

Artichoke thistle and purple starthistle

Applications were made to plants at rosette (February 26, 1997) and bud (April 15, 1997) stages of development.

* Trademark of Dow AgroSciences LLC

Broadcast applications of Transline at 0.33, 0.66, 1 and 1.33 pt/A or Banvel at 2 pt/A were applied in 20 GPA of water at the rosette stage or 50 GPA of water at the bud stage. At the bud stage an additional treatment of Transline at 0.25% v/v was applied spray-to wet on all plants in the assigned plots. Evaluations were made approximately 2.5, 4 or 6 months after application depending on application timing.

RESULTS AND DISCUSSION

Yellow starthistle

Transline applied in the spring at the rosette stage provided 95-100% control of yellow starthistle in the season of application (Figure 1). Grass cover increased in plots with Transline use compared to grass cover in untreated areas (data not shown). Control from treatments applied at bud stage was 80-98% (Figure 1). Plants not completely controlled did not flower or produce seeds.

Following spring rosette treatments, control of germinating yellow starthistle through the winter season was 45-78% when few other plants were present to compete with new seedlings (Figure 2). Control was 95-100% where perennial grasses were established. Bud stage applications provided excellent (95-99%) control at both sites 1 year after treatment.

Applications applied in the fall on new seedlings varied by site. Control at the Cool location was 65-90% versus 98-100% control at the Woodland site (Figure 3). The difference may have been due to the presence of perennial grasses at the Woodland site.

Artichoke thistle and purple starthistle

Artichoke thistle control was excellent (100%) when Transline was applied at rosette stage (Figure 4). Plants at the bud stage (figure 5) were more difficult to control even with increased coverage. At California label rates up to 2/3 pint/A, the control was 78-86% at bud stage. Control was increased to 93% with the spray-to-wet application (0.25% v/v)of Transline.

Purple starthistle control was excellent (100%) at rosette stage with all treatments but was poor (5%) at bud stage (Figure 6).

CONCLUSIONS

Transline has excellent activity on yellow starthistle when applied as low as 0.33 pt./A at the rosette stage. Control of yellow starthistle into the next season was optimal when perennial grasses or other species compete with new yellow starthistle seedlings.

Control of artichoke thistle and purple starthistle is optimal when applied at rosette stages. Purple starthistle will not be effectively controlled after that stage of growth. Populations of artichoke thistle can be suppressed with applications of Transline at the bud stage, but re-treatment with Transline in subsequent years will be needed if complete control is the management objective.

Transline can be used to control other invasive species, especially thistles, such as: bull thistle, Canada thistle, milk thistle, musk thistle, kudzu, spotted, diffuse, and squarrose knapweeds, and orange and yellow hawkweeds. The selectivity of Transline means that certain plants including: filaree, small burnet, rabbitbrush, service-berry, dogwood, oaks, grasses (like crested wheatgrass, bluebunch wheatgrass, and Idaho fescue), cottonwoods, poplars, and conifers show good tolerance to Transline. Transline should be used if management objectives call for: (1) effective control of yellow starthistle, Canada thistle, spotted and diffuse knapweeds, hawkweeds; (2) control of other sensitive invasive plants, especially for habitat management; and (3) applications over or around desirable, non-sensitive vegetation.

Table 1. PLANT SENSITIVITY TO TRANSLINE.

SENSITIVE TO TRANSLINE			NOT SENSITIVE TO TRANSLINE	
Bull thistle	Groundsel	Salsify	Conifers	Grasses
Buckwheat	Hawkweeds	Scotch thistle	Douglas-fir	Cottonwood
Burdock	Knapweeds	Sowthistle	Ponderosa pine	Poplar
Canada thistle	Kudzu	Sunflower	True firs	Willow
Clovers	Mayweed	Teasel	Redwood	Dogwood
Cocklebur	Musk thistle	Vetch	Scotch pine	Oaks
Cornflower	Nightshades	Yellow starthistle	Filaree	Rabbitbrush
Crupina	Oxeye daisy		Small burnet	Service-berry
Curly dock	Pineappleweed			
Dandelion	Prickly lettuce			
Fireweed (Erechites)	Ragweed			

FIGURE 1.

Yellow starthistle Control with Transline Treatments at Rosette and Bud Stages

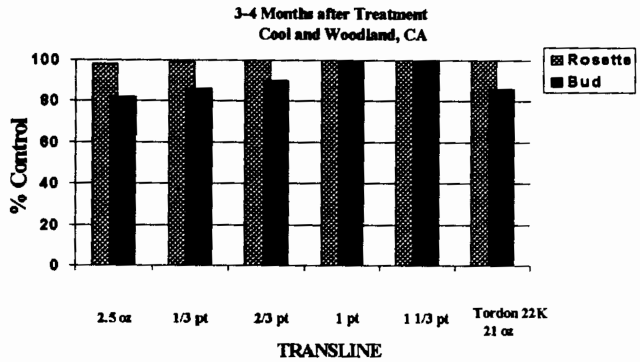


FIGURE 2.

Yellow starthistle Control with Transline Treatments at Rosette and Bud Stages

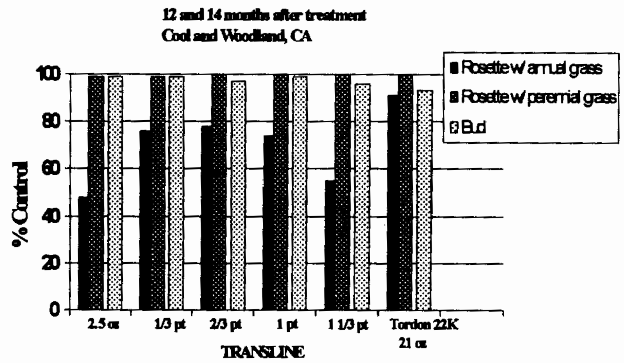


FIGURE 3.

Yellow starthistle Control with Transline Treatments at Fall Rosette Stage

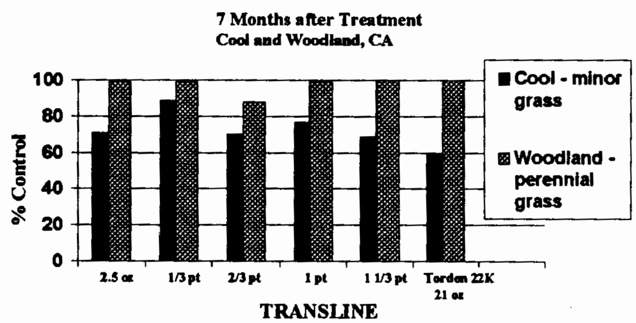


FIGURE 4.

Artichoke thistle Control with Transline Treatments Rosette Stage

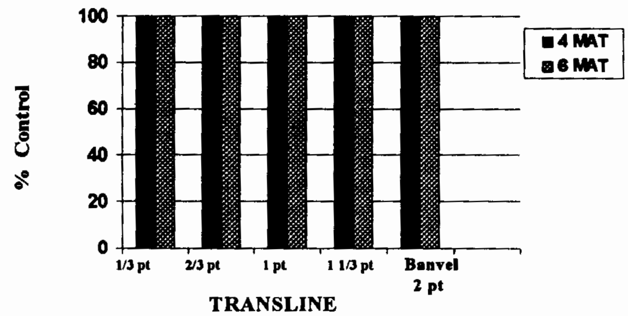


FIGURE 5.

Artichoke thistle Control with Transline Treatments at Bud Stage

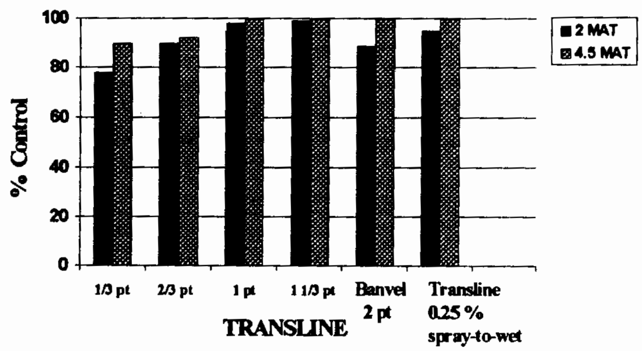
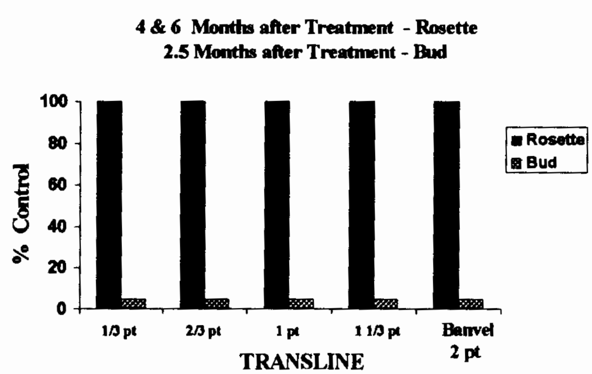


FIGURE 6.

Purple starthistle Control with Transline Treatments



THE BIOLOGY AND ECOLOGY OF BROOMS AND GORSE

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Brooms and gorse can form dense impenetrable brush fields that choke out nearly all other vegetation and prevent access to forests, recreational areas, and hiking trails. They can colonize nitrogen poor, seasonally dry, frequently soil-disturbed areas such as grasslands, sand dunes, gravel bars, river beds, fence rows, roadsides, overgrazed pastures, logged areas, and burned-over lands (26, 46). They represent a significant threat to native wildlands and forest regeneration efforts.

Taxonomy

The weedy brooms in California are represented by four species belonging to the genera *Cytisus*, *Genista*, and *Spartium*. Gorse (*Ulex europaea*) can occupy a similar habitat but is morphologically quite distinct from the broom species. All these species, however, are members of the Fabaceae (legume family). These five weedy brush species can be separated by stem, foliage, flower, and fruit characteristics (see table below). Portuguese broom (*Cytisus striatus*) is often misidentified as Scotch broom (*Cytisus scoparius*). Although it is locally abundant in the San Francisco Bay area and Southern California, it is not as widely distributed or as common as Scotch broom. Little is known of the biology and ecology of Portuguese broom, but it is thought to behave similar to Scotch broom. French broom (*Genista monspessulana*) is probably the most widespread and damaging of the broom species. In earlier taxonomic treatments, it was known as *Cytisus monspessulanus* (37), but more recent treatments have re-classified it in the genus *Genista* (21).

Morphological characteristics distinguishing weedy brooms and gorse.

Species	Stem	Foliage	Flowers	Fruit
Scotch broom (*Cytisus scoparius*)	5-angled, glabrous	lflts 1-3, sparse, deciduous	1-2 per cluster	hairy on margins only
Portuguese broom (*Cytisus striatus*)	8-10-angled, glabrous	lflts 1-3, sparse, deciduous	1-2 per cluster	appressed hairs all over
French broom (*Genista monspessulana*)	ridged, silky hairy	lflts 3, more abundant, evergreen	4-10 per cluster	hairy all over
Spanish broom (*Spartium junceum*)	round, glabrous	very sparse to lacking	several per cluster	glabrous
Gorse (*Ulex europaea*)	thorny, hairy	lflts 1, stiff or spiny, evergreen	1-2 per cluster	hairy all over

Introduction and Spread

Spanish broom (*Spartium junceum*) is native to the Mediterranean region and the Canary Islands. It was first introduced as a nursery plant in San Francisco in 1858 (29). In the 1930s, Spanish broom was planted along Southern California highways as an ornamental shrub (20). It has since become naturalized primarily along roadsides and in waste places in coastal counties, but can also be found in the Sacramento Valley and into the eastern foothills, primarily El Dorado County (33). It is not as widespread a problem as the other broom species and gorse, and has not significantly invaded native ecosystems.

Gorse is native to central and western Europe, where it is often cultivated as a hedgerow (41). It has been a major weed problem in Australia and New Zealand for over 150 years (35). It was first introduced into the United States from Ireland to Oregon some time before 1894 (22). Soon after its introduction, it was planted as an ornamental in Marin and Mendocino counties of California. Today, gorse is found in every coastal county in Northern California, but infestations are largest in Mendocino County (21). The California Department of Food and Agriculture (CDFA) lists gorse as a List B noxious weed.

French broom is native to the Mediterranean region, the Azores, and the Canary Islands (37). It was sold in California nurseries as early as 1871 (30) and escaped cultivation in central California by the 1940s (1). French broom is a major weed problem in California non-crop areas, and is found primarily along the coastal, but can occur as far east as the western foothills of the Sierra Nevada mountains (30). It has been rated a List C noxious weed by CDFA.

Scotch broom is native to central and southern Europe and the British Isles. In North America, it was first introduced into the east coast and Eastern Canada before 1850 (36). It was transported to California as an ornamental in the 1850's, and by the early 1900's was widely planted as a soil-binding roadside shrub (14, 23). It was recognized as a weedy problem by the 1930's (33) and today infests over a half million acres in the state (5). Two major areas of infestation include the coastal ranges from Monterey to Sonoma County, and in the Sierra Nevada foothills from Calaveras to Sierra County. Like French broom, Scotch broom is a CDFA List C noxious weed and a major weed problem in Australia and New Zealand.

Biology

Dormancy and Germination

Brooms and gorse have hard, water-impermeable seed coats that delay germination for months or years and enable seeds to survive in the environment for 25 to 80 years (5, 27, 34, 48). Although some seed will germinate soon after dispersal (20), the majority require mechanical scarification before germination can occur (9).

Scarified seeds can germinate throughout the year under suitable conditions. Typically, germination occurs after the first rains of fall through the last rainfall of late spring (5). Light does not appear to be necessary for germination, but few seeds germinate in the shade of established plants (24). Germination rates are highest at soil depth from 0-4 cm. Seedlings do not emerge when buried 10 cm or deeper (5). Seeds of Scotch broom germinate between 4-33°C, with maximum germination at 18-22°C (5). Similar temperature responses were reported for gorse (25). Short exposures to temperatures above 100°C are lethal to gorse seeds, whereas temperatures above 150°C destroyed the viability of broom seed (5). Thus, a hot prescribed burn in areas infested with these shrubs could greatly decrease the seedbank at the soil surface. However, prescribed burns may stimulate germination of seeds deeper in the soil profile, where soil temperatures would not reach the lethal level (27, 34). Changes in soil temperature could also play a key role in the flush of new germinating seeds when established plants are removed (25). Increased solar radiation could heat the soil and stimulate seed germination.

Growth

Broom plants grow rapidly in the first 4-5 years, but growth slows considerably thereafter (44, 45). Growth appears to be more vigorous in introduced habitats that lack native invertebrate predators (32). Individual broom and gorse plants typically live from 10 to 20 years (42, 44) and rarely survive longer than 30 years (10).

Brooms and gorse are relatively intolerant to heavy shade. Under low light conditions plants produce sparse foliage and few flowers. Although survival is greatest in high light areas, these species do not tolerate extreme high or low temperature conditions, nor can they grow at high elevation (48). Seedlings are sensitive to frost (46), but mature plants can tolerate fairly severe frosts, although they prefer habitats sheltered from cold winds. Brooms and gorse can tolerate some level of drought stress, but cannot survive in extremely arid regions in the southwestern United States (46). Gorse is more sensitive to drought stress than brooms.

All the invasive broom species and gorse have photosynthetic stem tissue (38). The leaves of Spanish, Scotch, and Portuguese broom are deciduous early in the season. These species rely heavily on stem photosynthesis during the hot summer months (6, 38). The leaves of gorse function primarily as defense spines. This characteristics makes them well adapted to the open high sunlight environments. However, drought stress severely inhibits photosynthesis of gorse and brooms (38).

Like many other members of the Fabaceae, invasive brooms and gorse have nitrogen-fixing bacteria located in nodules on their roots (48). This characteristic has allowed them to become established in low nitrogen soils.

The ratio of woody to green material increases as broom and gorse plants age. Dense infestations produce significant dry matter which can create a serious fire hazard. This is particularly true for gorse and French broom (2, 39).

Reproduction

Brooms and gorse can reproduce by seeds and stump sprouting (36). Vegetative regeneration occurs quickly following disturbance by fire, grazing, or other mechanism means (47). The primary means of reproduction is by seed.

Seed production

Flowers of these invasive shrubs are large, yellow and attractive. They are primarily pollinated by bumble and honey bees. Only a small proportion of flowers develop into fruit (<50%) with between 5-9 seeds per pod (42, 45). Unripe seeds and pods are largely free from predation (42). Outcross-pollinated flowers produce about four times as many flowers as self-pollinated flowers (40). Seed production is variable from year to year. Years of heavy pod production are generally followed by years of lighter pod production. Seed production can vary among species and locations. The number of pods and seeds produced in a drought year is about ten times less than in a normal year (7). Under optimum growing conditions, Scotch broom plants have been estimated to produce 13 million seeds over the lifespan of the shrub (46). Others estimate that Scotch broom thickets can produce 4,000 to 20,000 seeds/m^2 (19, 42, 49).

Seed dispersal

Scotch broom contains a structure called an eliaosome on the seeds that attracts ants. After the seeds are dispersed from the pods, ants gather them, carried them back to their nest, and eat the eliaosome (4, 5). This does not kill the seed, and Scotch broom plants often are found in high density around ant nests (4). Gorse seed are also collected by ants (10). Birds and animals can also play a part in broom and gorse seed dispersal (33), although seed predation by birds and other animals is considered negligible (42).

Broom seeds have hard seed coats which can survive long distance transport in rivers and streams (42, 46). In the Sierran foothills, Scotch broom has spread rapidly by movement of the seed in water sources. Short distance transport of broom and gorse seeds is similar to that of many other legume species and involves the explosive action of the mature dried pods (30, 34). This mechanism can only disperse seeds within 2 m of the parent plant (35).

Human activity can also account for long distance transport of broom and gorse seed. Seeds can be moved along roads where they are distributed by roof gutters or mud on external surfaces of passing vehicles. Seeds can also be transported on shoes of hikers (42). Construction crews can disperse seeds long distances when seeds contaminate gravel being transported from river bottoms.

Ecology

Brooms and gorse stands can become established after soil disturbance in both their native range in Europe or in introduced areas, such as New Zealand, Australia, and the United States (4). Broom species grow best in seasonally dry, sandy, nitrogen poor soils in full sunlight (26, 46). However, they will survive under a wide range of soil conditions, including acid soils at pH values as low as 4.5 (15, 31), nitrogen and phosphorus deficient soils (46), serpentine soils (11), soils high in boron (43), and, though rarely, on highly calcareous soils (10). In New Zealand, gorse readily invades low fertility pastures where the organic content of the soil is less than 4% (28). Gorse requires greater soil moisture than do most species of broom (12) and thrives where the water table is very high (8).

In low light or shaded areas, broom plants tend to form a single upright shoot (46). The brooms do not typically do well in forested areas but rapidly invade recently logged, cleared or burned sites (33, 46). Gorse, however, survives better on shady slopes than in high sunlight areas (3).

In older dense broom infestations, the lower vegetation dies and subsequently blocks light penetration to the soil surface. This can suppress the germination and growth of herbaceous plants and tree seedlings (42). The competitive ability of brooms and gorse is also linked to their ability to tie up nitrogen by accumulating it in the dried litter (18). The rate of litter accumulation under gorse is higher than most warm temperate species and is near those recorded in tropical rainforests (13). This litter can also acidify and lower the cation exchange capacity of moderately fertile soils (16, 17, 27), and prevent the establishment of competing species.

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USE OF FIRE TO CONTROL FRENCH BROOM

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Controlling exotic plants is a very difficult and sometimes impossible task. Any technique that effectively treats large populations is valuable. If the control method is also inexpensive its appeal increases dramatically. Prescribed burning can treat large areas inexpensively but unfortunately many exotic species are adapted to fire, possessing strategies which allow them to survive its effects.

French broom, Genista monspessulana, is an important weed species that is fire vulnerable. Pre-treatment is necessary and the physical layout of the sites must be such that burns can be conducted without undue risk or expense. Compared to other methods, however, burning can be very cost effective.

In 1994 a relatively large scale project began at Mt. Tamalpais State Park, Marin County, California, using this technique. In recent years dense stands of French broom had become established on the northeast side of the park downslope of the Panoramic Highway (Panoramic Unit)and in the vicinity of Muir Woods Road (Muir Woods Road Unit). At these locations the park borders a dense residential neighborhood in the City of Mill Valley. The sites are highly visible and traversed by well used hiking trails. Before treatment began approximately 70 acres of the 91 acre project area was occupied by broom. The Panoramic Unit was almost continuous broom while the broom stands in the Muir Woods Road Unit formed a mosaic with surrounding grassland and native shrubland. Significant stands of Scotch broom, Cytisus scoparius, were also present in portions of this unit. An aerial photograph taken in 1943 shows that these were grassland sites prior to the influx of broom.

The goal of this project is the restoration of this grassland plant community. This is being accomplished through a series of manipulations which begin with hand cutting the broom. Subsequent prescribed burning prevents resprouting of cut stems and seedling survival. The project's success to date and its relatively large scale allows new conclusions to be reached regarding the effectiveness of this technique.

Methods and Materials

All of the broom within the project area has now been treated. Work began first in April, 1994, on the Panoramic Unit. A crew from Sylver Trees of Potter Valley, California used chain saws to cut the broom, taking 800 hours to cut an almost impenetrable 27 acres. The broom was cut to within 6 to 12 inches of the ground. All cut stems were left in place, providing a two to three foot deep bed of fuel.

In December, 1994 an additional 12 acres of broom was cut by the Marin Conservation Corps (MCC) above Muir Woods Road. The Corps used both weed eaters and chain saws. The work proved to be challenging because of the density of the stands and the steep terrain. In December of 1995 and October of 1997 the Sylver Trees crews returned to cut an additional 30 acres, completing the phase of the project which targeted mature stands of broom.

The sites were broadcast burned after the cut material cured. The Panoramic Unit was burned on May 13, 1994. Cut broom in the Muir Woods Road Unit was burned on June 13 and June 20, 1995 and on April 25, 1996.

The broom burned in May, 1994 was very dry and extremely flammable. The weather conditions on the day of the burn were moderate (73° F, 52% RH) but very intense upslope headfires were possible. There was limited surface fuel to carry a backing fire. Due to the abnormally wet winter in 1995 a period for burning was not available until June of that year. Significant stem sprouting had occurred by that time and the fires were less intense but still resulted in complete consumption of all the cut material. The April, 1996 burn was conducted during relatively cool conditions due to rainfall the previous day, but again produced complete consumption.

Rainfall occurred soon after the May 13, 1994 Panoramic Unit burn and seedlings appeared and survived the summer. None of the cut broom stems sprouted. Native coyote brush, <u>Baccharis pilularis</u>, was scattered throughout the site and these plants, in contrast to broom, vigorously sprouted after cutting and burning. The burns on the Muir Woods Road Unit produced about the same results with complete cut broom plant mortality and vigorous coyote brush stem sprouting.

Because of the long term viability and abundance of the French broom seed bank, re-establishment of the broom stands must be prevented. A cost effective and efficient method is necessary to kill seedling plants before they reproduce, eliminating the seed bank over time. This is being achieved through the establishment of a cover of annual grass designed to provide a fuel source for the subsequent burns needed to kill broom seedlings.

In November 1994, the California Conservation Corps (CCC) seeded 90 pounds/acre of UC603 barley, <u>Hordeum vulgare</u>, to the Panoramic Unit. By the last week in November of that year it did not appear that the barley was becoming established at an adequate density to provide the necessary fuel load. At that time the CCC applied a mixture of blando brome, Bromus hordeacus, at 18 pounds/acre and zorro fescue, Vulpia myuros, at 6 pounds/acre to the site in an effort to provide a more even and dense fuel load. This blando brome/zorro fescue seed mix was later applied to the Muir Woods Road Unit in November and December of 1995 and December of 1996 and 1997.

In early summer 1995, after the annual grasses planted on the Panoramic Unit had cured, it become obvious that there were patches of densely spaced broom seedlings which would survive fire if left untreated. To ensure a good fire kill in these areas, 40 hours of CCC crew person time was spent cutting the plants with weed eaters equipped with tri-blades. A similar area of dense broom seedlings without adequate grass fuel to produce mortality was cut by the CCC in the summer of 1997 in the Muir Woods Road Unit.

The grass fuel on the Panoramic Unit was burned on July 26, 1995 and again on July 19, 1996. On October 15, 1996 a large portion of the Muir Woods Road Unit was burned and on September 4, 1997 the entire area under treatment was burned. These burns consumed a large percentage of the available grass fuel, killing most broom seedlings.

Results

None of the broom plants cut in the Panoramic Unit or the Muir Woods Road Unit sprouted after the cut material was broadcast burned. The fires effectively killed the cut stems. The height that the broom stems had been cut above ground varied between three inches and two feet.

The results of seeding grass to provide fuel was less uniform. In general, the density of agricultural barley used on the Panoramic Unit was not adequate to provide an ideal fuel load. The plants were too widely spaced even in the best locations. In addition, throughout the 27 acres seeded with barley, there were areas where only scattered plants became established. The blando brome/zorro fescue mix, however, filled in to improve the fuel load.

There have also been small areas which were entirely missed during seeding operations. Steep slopes and adverse weather conditions can be blamed for these un-seeded locations.

The fires that burned this grass fuel on both units killed almost all of the broom seedlings, even though many stems were not consumed. Fire did not carry through some small areas where grass seeding was inadequate but there has been an very high percentage of seedlings killed overall by each burn. Seedling size appears to influence vulnerability to fire with minimum heat needed to kill small plants. Limited basal sprouting of larger seedlings after burning has occurred but the sprouts have been very small in comparison to vigorous coyote brush and roadside fennel, Foeniculum vulgare, sprouting.

Discussion

The control of plants such as French broom which produce very long lived seeds is especially difficult. A technique is necessary to deal with the large seed bank as well as the mature plants. What this project has demonstrated is that large numbers of mature plants can be removed economically using prescribed fire. This is the same initial result that would have been achieved if these mature plants had been pulled one by one with weed wrenches or sprayed with herbicide. The direct cost of cutting stands of mature broom in preparation for burning is relatively low. The cost of labor is variable, but it is reasonable to expect that this work can be done for approximately $500 per acre.

What is yet to be determined is the magnitude of the long term effort needed to eliminate the seed bank. This project did not include seed bank measurements, however, so it is still unclear how quickly the seed bank is being depleted. Permanent transects were established on the Panoramic Unit in 1994 but current data is not available to evaluate the level of seed bank depletion. On both units a dense carpet of broom seedlings became established after the first burns removed the cut broom. This level of germination certainly appears to be fire induced. The number of seedlings that became established after the second grassland burns were greatly diminished so it can be presumed that significant seed bank reduction has occurred. The Panoramic Unit has been burned three times including the first burn which consumed cut broom. It was not burned in summer, 1997 because of the relatively few broom seedlings present. It is felt that a summer, 1998 burn will remove a high percentage of these seedlings. If some are too large to be vulnerable to a grass fire a low cost herbicide spot treatment may be necessary.

The two exotic grass species that were used when the barley proved to be inadequate are found throughout many grassland sites in this. As a result, their addition to this site was considered to be a reasonable price to pay for the removal of the broom. It would have been preferable to use native species but this was not possible. Even if genetic integrity concerns had not dictated the use of site specific seed, costs would have been prohibitive. Also, perennial bunch grass species could not have been established at an adequate density to meet fuel production objectives.

The future methods used to assure that broom does not re-occupy the site will be determined after considering various options. This project has taken an integrated approach, using mechanical treatments, prescribed burning and limited herbicide use outside of the burned area. Burning is not without its liabilities. The neighboring community has been very supportive of the project, primarily because of fire hazard reduction benefits. Even with this support, smoke management has been difficult. This is primarily because of the particular location of the site. The treatment areas extend up to a ridgeline which is the park boundary. Unless very specific burning conditions are met smoke travels at low elevation over this ridge and into residential neighborhoods. Annual or biennial burning must take place initially but as the number of broom seedlings which become established after burning become greatly diminished, smoke impacts must be balanced against the difficulty of using other more labor intensive control methods. Regardless of the method chosen, a continuing long term control program will be needed to sustain the gains that have been made.

Finally it should be remembered that burning has benefits that go beyond the control of exotic plants. Native grassland plant communities are very well-adapted to fire. A long term prescribed burn program, coupled perhaps with direct seeding, can result in the restoration of a grassland with a high representation of native species. Already there has been a definite increase in the number of native bunch grass species in the treatment areas. Trail side populations have expanded into areas previously occupied by dense stands of broom.

	Cut	Burned	Seeded	Grass burned
Panoramic Unit (27 ac broom)	4/94	5/94	10-12/94	7/95, 7/96
Upper Muir Woods Rd. Unit (12 ac broom)	12/94 to 3/95	6/95	11-12/95	10/96, 9/97
Lower Muir Woods Rd. Unit (20 ac broom)	11/95	4/96	12/96	9/97
Remaining Lower Muir Woods Rd. Unit (10 ac broom)	10/97			

Chemical Control of Brooms and Gorse

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Brooms and gorse are shrubs in the Fabaceae family. Most are natives to the Mediterranean region. They were mainly introduced as horticultural species and have since become established in many areas. Gorse, french broom, and scotch broom are now listed as noxious weeds. Control techniques for these plants include pulling, cutting, burning, grazing, biological control, and the use of chemicals. This paper will focus on the chemical control of these species in California. The second part of the paper is the results of an experimental eradication of spanish broom.

Scotch Broom

Glyphosate has been used as a foliar spray for Scotch broom (Cytisus scoparius) with good results. The problem with this method is drift to non-target species. 2,4-D in water-oil emulsion (2 %) applied in March will give excellent results. Triclopyr ester in oil (4 to 8 lb./100 gal of solution for basal, 2 to 4 lb./100 gal of solution for foliar application) has had excellent results when applied July - August (William et al 1996). Disking thickets and then burning debris promotes seed germination and then resprouting can be spot treated.

French Broom

Dr. Carla Bossard, in association with CalEPPC, has tested a variety of techniques for controlling French broom (Genista monspessulana). The most effective method she found was to treat the stems 5 cm above ground level with 30 % Triclopyr in 70 % Penevator oil, cut the dead stems and burn them on site, and then spray any new seedlings with Glyphosate (Bossard et al 1995).

Spanish Broom

Pathfinder II -- 13 % Triclopyr ester in vegetable oil -- provided excellent control spring through summer. Plants were treated at 1,10, and 20 % of the height of the plant. Small plants were killed at all treatments, medium plants show mixed results, and large plants were killed at the highest rate when applied in brown pod stage. Damage to the plant seems to be quickest when the plant is actively growing, but the best results occurred in mid summer with effects being slow to manifest themselves (Rusmore, this publication).

Gorse

Thomas Reed and Associates has been treating gorse and broom on San Bruno Mountain using a 2 % foliar spray of Garlon 4 and Surtec surfactant. They have been recording a greater than 90 % kill rate with this method. They have also reported some problems with drift.

A combination of Picloram and 2,4-D gives enough control for reforestation but not for eradication. Metsulfuron (2 oz ai/A at 10 gal spray/A) gave excellent control in New Zealand. Unfortunately, neither of these herbicides are registered for use in California. Also in New Zealand, Ivens (1979) found that treating with 2,4-D alone after cutting was the most effective method.

Scotch broom (*Cytisus scoparius*)

• Triclopyr ester (Garlon 4) or Triclopyr amine +2,4-D LV ester (Crossbow)	Rate:	0.5 to 1.5% concentration of Garlon 4 or Crossbow 1 to 1.5% concentration of Garlon 3 or Redeem
	Time:	Foliar, when actively growing
	Remarks:	Thorough wetting required
• Triclopyr ester (Garlon 4)	Rate:	4 to 8 lb./ 100 gal oil solution for basal; 2 to 4 lb. for foliar
	Time:	July-August for basal/foliar, March for broadcast
	Remarks:	Excellent control expected.
• Glyphosate (Roundup,Accord)	Rate:	1.5 to 2% solution
	Time:	Apply to actively growing plants in spring
	Remarks:	Addition of a recommended surfactant will improve results
• 2,4-D	Rate:	2 lb./ 100 gal water-oil emulsion
	Time:	March
	Remarks:	Excellent control expected

French broom (*Genista monspessulana*)

• Triclopyr ester (Garlon 4)	Rate:	25-30 % in Penevator oil applied to basal bark
	Time:	Spray green seed stage, cut summer, burn winter, spray seedlings following spring
	Remarks:	Not removing cut broom interfered with all control methods

Spanish broom (*Spartium junceum*)

• Triclopyr ester (Garlon 4)	Rate:	13 % in vegetable oil (Pathfinder) applied to basal bark up to 20 % the height of bush
	Time:	No statistical difference although kill time is quicker during active growth & higher at brown pod stage
	Remarks:	Must treat all stems

Gorse (*Ulex europaea*)

• Triclopyr ester (Garlon 4)	Rate:	2 % with surfactant, foliar
	Time:	All year
	Remarks:	Problems with drift
• 2,4-D	Rate:	Applied to regrowth at 50 cm
	Time:	Spring

Spanish Broom Eradication Test Plots
Effie Yeaw Interpretive Center
Ancil Hoffman Park
American River Parkway

John Rusmore
UC Davis, Environmental Horticulture
Eva Butler
Eva Butler and Associates

Study site

A large population of Spanish Broom (Spartium junceum L.) has become established on about 15 acres of land in Ancil Hoffman Park along the American River Parkway, Sacramento, CA. The site is a gravel bar along the river with scattered live oaks and some native shrubs.

Introduction

Despite more than eight years and hundreds of hours of hand- and wrench-pulling, the population of spanish broom continues to increase in size and stature. Recent findings (Bossard et al 1995) prompted the establishment of a series of test plots to test the efficacy of low volume basal bark spray in this species.

What is so appealing about this method is the small amount of active ingredient applied (about 1 ml), its being applied directly to the bark of the plant just above the soil line (thus reducing drift and runoff), and its high success rate (up to 100% of treated plants killed within 4 weeks).

Methods and Materials

The most commonly recommended timing for this application is after the seeds have been set, yet before they are mature. However, in another on-going spraying project on San Bruno Mountain by Thomas Reed and Associates, the time of year seems to have little effect on the outcome of the spraying. We addressed this question by applying the treatment at 3 times: (1) yellow flower stage--as the plant is actively growing at this stage, the herbicide may be transported to growing points and then back to the roots through translocation; (2) green-pod stage--the plant may be sending more of its resources to the root, so may carry the herbicide with the storage materials; (3) mature pod stage--the plants are withdrawing minerals and nutrients from the leaves to store them in the stem or roots and may carry the herbicide with them. Efficacy was rated as number of plants killed during each time period out of total treated plants.

While the size of the plant had no effect on the results in Dr. Bossard's study, some treatments have been affected by the size of the plant. We tested this aspect of the treatment by applying the treatment to three size categories: (1) less than 1m; (2) 1-2 m; (3) above 2 m.

The method has proved effective at the 25/75 rate of Garlon to oil. The above tests used a rate of 13/87 which came already prepared under the trade name of Pathfinder II and was donated by Dow Elanco.

Each treatment was applied to ten of the plants in each plot with 5 replications of plots. The plants were marked with spray paint and flagging to facilitate locating them for the study and for evaluation of the project.

A separate group of plants was also tested to see if moisture, position, or stress would influence the kill rate. Nitrogen was also applied to some of the plants to see if the kill rate would be affected.

Results

There was little statistical difference in any of the treatments except for the lowest amount of stem treated of the largest plants at the yellow flower stage [>2, 1%, Fl] (Figure 1). Plants that were less than 1 m tall were easily killed at all times and at all stem treatment heights.

While not statistically significant, there were several trends in the kill rates. Not surprisingly, it is more difficult to kill larger plants. Also, the more of the stem of the larger plants that were treated, the better the kill rate. However, in the larger plants, as the season progressed, the kill rates increased (Figure 2). Stress levels, as measured by a pressure bomb, increased through the day. The kill rates, although not statistically significantly different, tended to increase with the level of stress (Figure 3). Contrary to expectation, kill rates were not affected by watering the plants with or without nitrogen (Figure 4). In fact, dry plants had the highest rates, followed by wet and then wet with nitrogen.

The pressure bomb readings and kill rates were not significantly different in three environmentally different sites. The pressure bomb readings increased from shade to partial shade to open site. The kill rates also tended to increase from the shade to open sites.

Discussion

We expected the larger plants to be harder to kill and that the more Pathfinder applied, the higher the kill rate would be. What was unexpected was the increase in kill rate from flowering to green seed to mature seeds. From other studies, we had anticipated that that the green seed stage would have the best results (Bossard et al 1995).

If we assume that the plants are more stressed at this stage, then it would also follow that the kill rates are higher when the plants are more stressed during a single day.

Not only were the dry plants killed at higher rates than those plants watered only or watered with nitrogen, but the plants in the sun were also killed at higher rates than those in the shade and partial shade.

Recommendations

Since the differences are very slight, any treatment with Pathfinder at any time or any stage will be quite effective with our kill rate average at over 90%. Especially at the flowering stage, all stems need to be treated to get complete kill--and re-application may be needed. Small plants require treatment of only 1% of the stem while plants over 1m will require treatment of 20% of the stem. If only one application can be made, then a warm day when there are brown pods on the bush would probably provide the best kill rate.

Figure 1. Kill Rates of Spanish Broom from all Treatments. Fl represents the yellow flower stage, GP represents the green pod stage, and BP represents the mature pod stage. The error bars represent the confidence interval at .95.

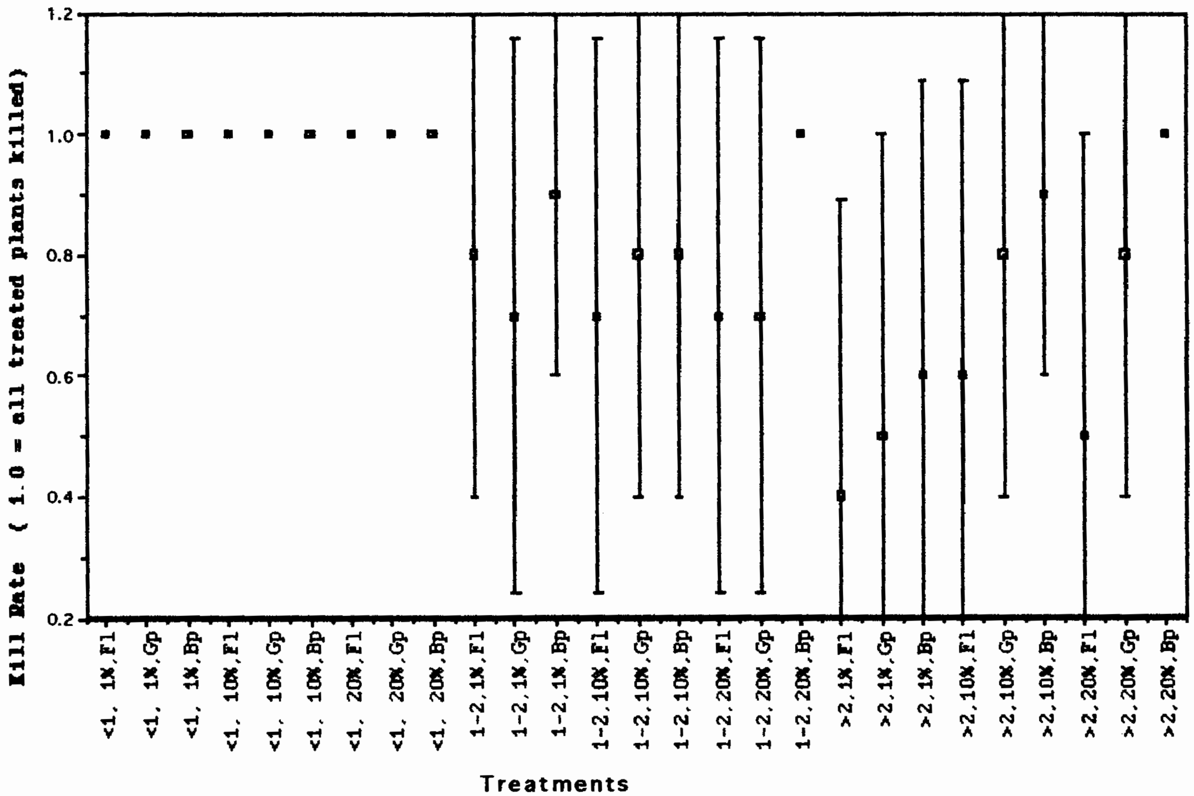


Figure 2. Kill Rates by Stage of Plant for plants > 2m. Diamonds indicate plants that had 1 % of the stem treated, squares indicate 10%, and triangles indicate 20%.

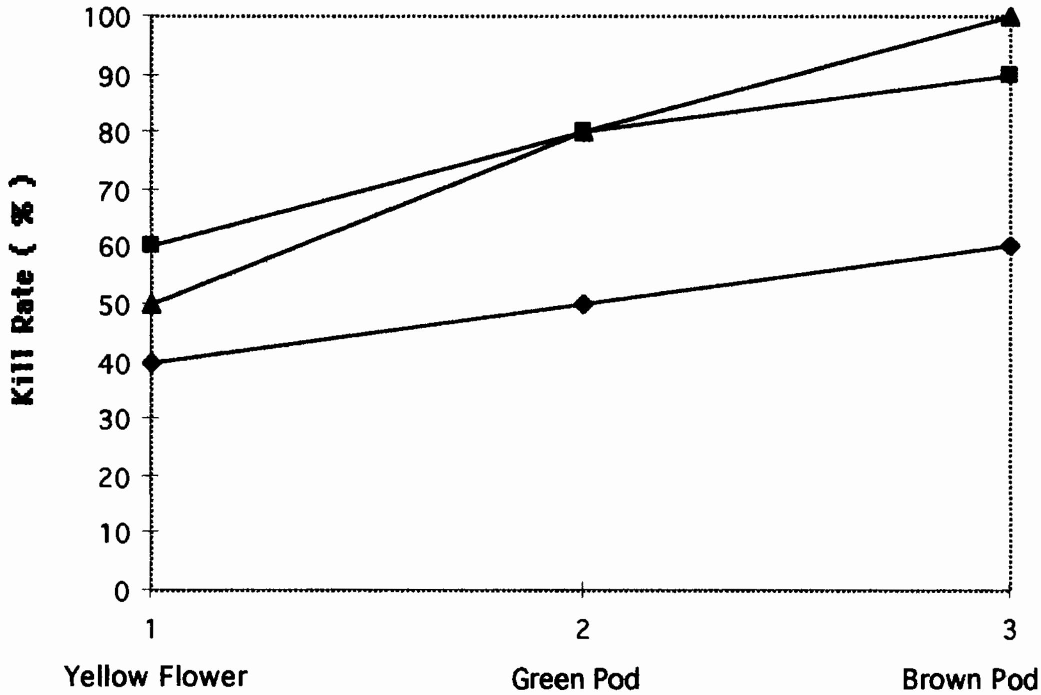


Figure 3. Average kill rates and pressure bomb readings. Diamonds indicate kill rates, and squares indicate bars of pressure.

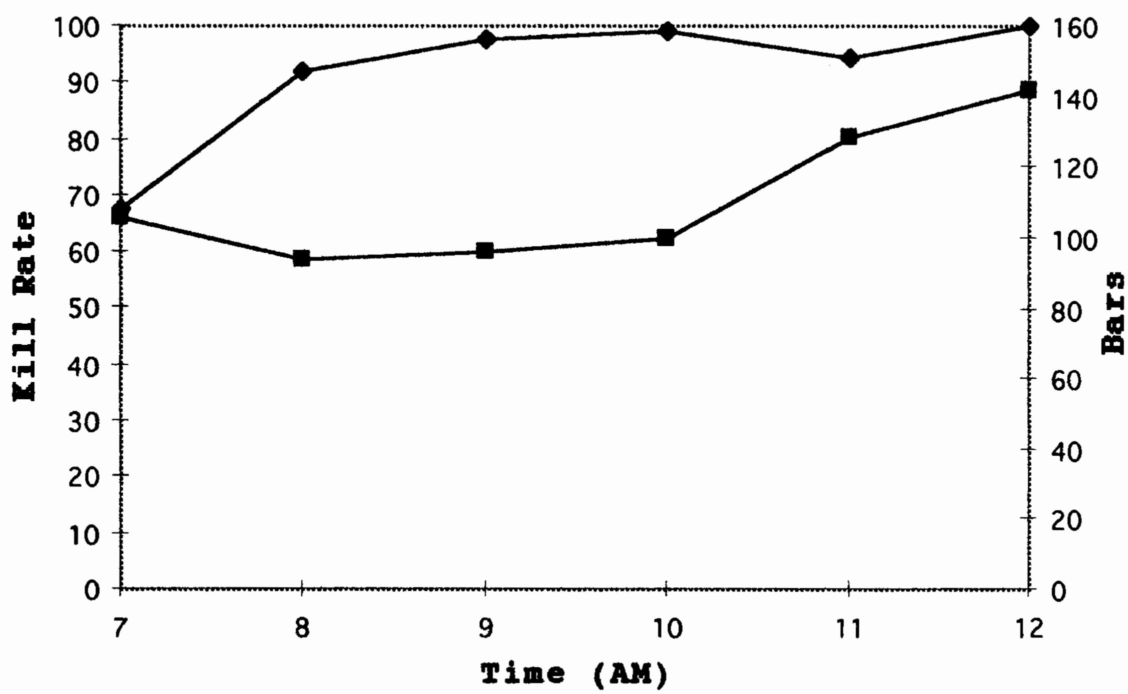
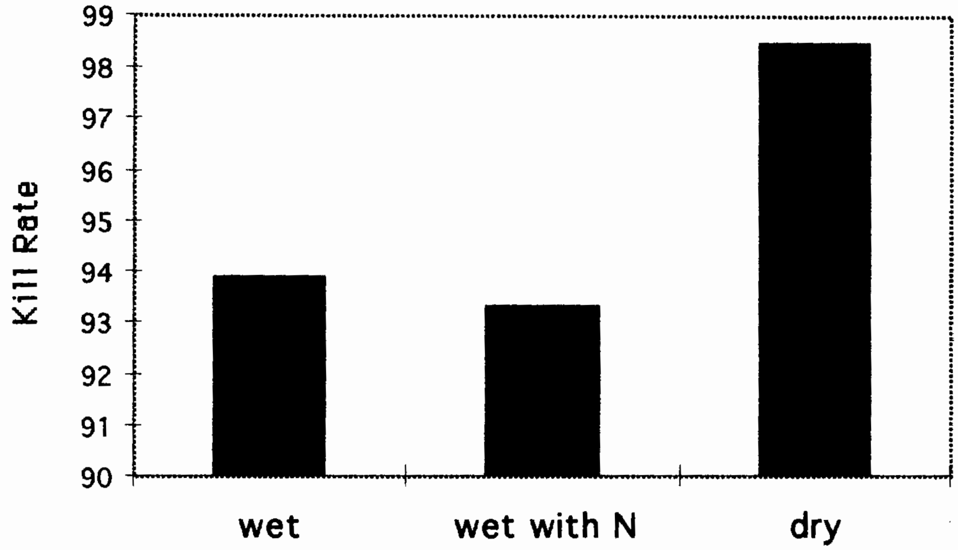


Figure 4. Kill rates by moisture. The bars represent the percentage of treated plants killed. The differences are not statistically significant at the .95 level of confidence.



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THE IMPACT OF THE FOOD QUALITY PROTECTION ACT ON FUTURE PEST MANAGEMENT OPTIONS

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Introduction

The Food Quality Protection Act of 1996 (FQPA) will bring a dramatic change to the regulation of pesticides under the Federal Insecticide Fungicide, Rodenticide Act (FIFRA) and the Federal Food Drug and Cosmetic Act (FFDCA). FQPA amended both FIFRA and FFDCA and contains diverse provisions. These provisions range from new standards for setting tolerances on raw and processed food, and incentives for supporting minor uses of pesticides, to a revision of the definition of pesticides for certain medical uses, and explicit procedures for registering antimicrobial pesticides. FQPA went into effect upon signature by the President, so its impact was felt immediately.

The New Safety Standard

FQPA eliminated the application of the Delaney Clause of FFDCA to pesticide residues on processed food. By rewriting Section 408 of the FFDCA to reconcile the so-called "Delaney Paradox", Congress created a new uniform standard for pesticide residues on all food, both raw commodities and processed food. There is no longer a differential cancer risk standard for raw and processed foods, as there was under the Delaney Clause. The new "safe" standard directs EPA to assure that residues on all foods meet the standard of "...a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue...". In describing how this new standard is to be applied, Congress used the contemporary toxicology terms "threshold" and "nonthreshold" to provide flexibility to EPA in judging cancer and other toxicity risks. Thus, as EPA better understands mechanisms leading to cancer causation, it can apply the principal of a threshold toxicity dose as appropriate.

FQPA directs EPA to consider a number of factors in applying this new safety standard. In some cases, these factors represent the leading edge of scientific understanding, such as endocrine disruption. In other cases, Congress was merely clarifying an assumed standard, such as the completeness and validity of available data. In implementing the safety standard of FQPA, EPA developed the conceptual framework of the "risk cup" to describe the lifetime acceptable exposure to a pesticide. EPA's challenge in applying the new standard is to determine how the "risk cup" will be filled for each pesticide.

The centerpiece of the new safety standard is the special consideration given to the exposure of infants and children to pesticide residues in establishing, modifying, leaving in place or revoking tolerances. These FQPA provisions pertaining to infants and children reflect the recommendations of the 1993 National Academy of Sciences report on the risks of pesticide residues in the diet to infants and children. In the absence of data that show no special health effects on infants and children, EPA is to apply up to an additional 10 fold margin of safety in setting or renewing a tolerance.

Aggregate exposure is another factor that EPA must address in establishing or renewing tolerances. Before FQPA, EPA focused on dietary exposure when setting tolerances. Now EPA must account for nondietary exposures from non-occupational sources, such as household use of a pesticide, and pesticide residues in drinking water.

Accounting for the cumulative exposure to chemicals with a common mechanism of toxicity is perhaps one of the greater challenges posed by the new safety standard. As EPA implements this new standard, they will be entering a new uncharted arena of regulatory toxicology. Establishing common agreement on what constitutes a "common mechanism of toxicity" is the first challenge. Subsequently, identifying the circumstances where multiple exposures will occur will be the next challenge. Finally, accounting for these exposures in risk assessment will be the final challenge.

EPA must now include endocrine effects in its safety determination. Congress recognized that endocrine disruption is a relatively new area of science, and directed EPA to develop a screening program in consultation with the Secretary of Health and Human Services. Congress provided a 3 year grace period for implementation of this requirement.

Approval of new uses of pesticides and new products by EPA has been slowed by the application of the new safety standard. This is an unintended consequence of establishing a more comprehensive safety standard for pesticide tolerances.

Tolerance Reassessment

Perhaps the greatest challenge of FQPA is the requirement that all tolerances and exemptions from tolerance be reassessed under the new safety standard over a 10 year period. There are approximately 9700 tolerances and exemptions that EPA must reassess. FQPA provides a specific timetable for the reassessment, namely 33% in 3 years, 66% in 6 years and 100% in 10 years. FQPA directs EPA to give priority to tolerances or exemptions that pose the greatest health risk. EPA announced late in 1996 that its first priority will be the B2 carcinogens, organophosphates and carbamates.

FQPA restricts the manner in which the benefits of pesticides can be used during tolerance reassessment. This provision is largely focused on pesticides identified as oncogens. Benefits can only be considered if the use of the pesticide protects consumers from a risk that is greater than the dietary risk of the pesticide, and use of the pesticide is necessary to avoid a significant disruption in domestic production of a wholesome food supply. There are additional conditions placed on assessing the risk of such residues in order to qualify. Finally, any tolerance left in place under this provision must be evaluated after five years to assure that the original conditions for retaining the tolerance still exist.

EPA's use of default assumptions in the absence of data is a key issue in tolerance reassessment. Because the new safety standard has a far broader scope than previous requirements, EPA is attempting to account for exposure factors for which there is little or no data. This use of default assumptions has been a contentious issue from the outset because FQPA references the use of "available information" when accounting for aggregate and cumulative exposure. EPA has assumed the position that in the absence of data, they must be protective in their risk assessment.

The first application of the "cumulative exposure to chemicals with a similar mechanism of toxicity" will likely be the tolerance reassessment of organophosphate (OP) pesticides. EPA has received a recommendation from the independent International Life Sciences Institute that the organophosphates share a common mechanism of toxicity as represented by the inhibition of cholinesterase. The recommendation contains a number of caveats about relative dose for toxicity endpoints and appropriate target organs, and the need for more data. If EPA adopts the recommendation, it will most likely be applied to 39 OP pesticides, and will have a tremendous effect on the availability of OP insecticides. Bensulide is one herbicide that will be affected by this evaluation. It is not clear how EPA may apply this "cumulative exposure" factor to other groups of pesticides like the triazine herbicides. Determinations on the application of "common mechanism of toxicity" are pending.

Tolerance Reassessment and Minor Crops

The reassessment of tolerances will likely have considerable impact on pest management options for minor crops. Despite the provisions of FQPA that provide incentives to registrants to support minor uses, tolerance reassessment may override the benefits of these provisions. Registrants may not experience considerable economic gain for minor uses of their pesticide, but the minor uses may consume a substantial portion of the risk cup for the pesticide as the result of food consumption patterns. Registrants will likely make economic decisions when selecting which uses of a pesticide to retain during the tolerance reassessment process. An example of this issue would be insecticide use on pears. While pears represent a minor tree crop in the U.S., pears' contribution in the diet of infants and children is considerable. If the insecticide's risk cup is "overflowing", the registrant is unlikely to retain the pear use unless that use provides financial benefit compared to other uses of the insecticide.

Will FQPA Affect Herbicides?

The extent to which FQPA affects herbicides will depend on individual chemicals. The occurrence of herbicide residues in harvested commodities will be one factor. Many herbicides are much less likely than insecticides or fungicides to leave significant residues on commodities at harvest. The propensity to leach into groundwater or move off the application site with runoff water, contributing residues to drinking water, will be another factor. Significant residential exposure may also be a factor for some herbicides that have considerable homeowner/landscaper usage. Whether the cumulative exposure factor will be applied to herbicides is unknown, but the triazine family of herbicides is one group for which "common mechanism of toxicity" may be applied. The contribution of endocrine disruption as a factor for herbicides is similarly unknown, but some herbicides have been tentatively identified as endocrine disruptors.

For a number of older herbicides, EPA had completed its reregistration prior to the passage of FQPA. EPA must now reexamine the tolerances for these herbicides to determine whether they meet the new safety standard.

Conclusion

FQPA's impact on pest management options remains uncertain as EPA learns how to apply the new safety standard in registering new products and reassessing old tolerances. The new standard will affect registrants' interest in retaining minor uses of pesticides or seeking new uses. How the factors that EPA must consider in applying the new standard will affect herbicide registrations is similarly uncertain, and will vary by chemical.

SPRAY DRIFT STEWARDSHIP PROGRAM

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Thank you for this opportunity to speak to you on spray drift mitigation and application stewardship. You may think this presentation redundant, and perhaps it is. But the cold facts demonstrate that drift still happens. And our industry still accepts that. While a bit of drift from one corn field to another might be okay, our industry is experiencing much more than that.

Just yesterday I listened to a very good PCA share a story on driving a county road next to almond orchard and watching an applicator flying on zinc. The wind was wrong, and a line of cars found their windshields covered with spray. The story took the normal turn of cars pulling over and people getting out and expressing alarm over having been poisoned. It was fortunate that this PCA could identify what was being applied, and share that information, which calmed a lot of people down. Consider the outcome if no one had helped to calm them...imagine the news story that evening.

Indeed, we don't even need to imagine such repercussions. In September of 1996, a drift incident in Kern County California resulted in national media coverage, complete with eye-witness accounts of vomiting blood.

We in the Sacramento River Valley have suffered through an experience of a new crop (cotton) being introduced into an existing cropping system of rice. Last year at this conference, I expressed concern over the off-target damage being alleged, and voiced an industry pledge to do everything we could to properly steward the phenoxy herbicide applications to rice. We worked closely with the Rice Industry Association, growers, UC Farm Advisors and researchers, the manufacturers and distributors, and the CA Ag Aircraft Association to assure proper applications were made. The industry felt comfortable that this effort was being made and would continue to supply phenoxy herbicides for use on rice. Comfortable right up to the time when the lawsuits and claims far outweighed the potential profit and the customer goodwill.

These stories help demonstrate a clear fact of doing business out there today. We have encroachment. Encroachment by urban dwellers seeking a nice grove of trees and the joy that rural living promises. Encroachment by crops and new compounds, that exhibit little tolerance for, "a bit of drift".

As a member of the Coalition for Drift Minimization, I participate in discussions with a large group of crop protection companies, ag application industry folks, and EPA and state officials. The first meetings were held so that we could be prepared to deal with the release of the Spray Drift Task Force findings. These findings basically support most of the existing knowledge and research conducted on drift. The findings clearly confirm that droplet size is the most important factor relating to drift minimization. Logically, the results also confirm that drift only occurs downwind. Copies of these results are available, and will be submitted to the California Weed Science Society.

The Coalition for Drift Minimization has evolved into something much more. A presentation made by a Midwest Insurance Company showed that most drift complaints were "handled" by the insurance company. Indeed, most drift complaints never made it to the state lead agency (DPR in the case of California). This led to a US-wide survey of all lead agencies on drift incidents. The results are startling...more than ninety percent of drift complaints are settled in the field. These costs are assigned to the insurance company, the applicator, distributors and the manufacturers. Setting aside the losses, the costs for investigating a drift complaint for advisors, and company personnel is astounding. Something like ten man-days of effort for each instance combining field visits, applicator debriefings, sampling and analysis. These costs are almost hidden, sapping the ability to generate income from more positive activities.

The other hidden cost is a rising awareness by regulators that they don't know about all of the drift instances. Most states surveyed expressed some plan to more accurately assess the problems. Here in California, DPR officials have noted their intent to more fully investigate all drift complaints. Even those that are settled amicably between parties. Bottom line, prepare for more scrutiny of each operation.

There is some good that comes out of all of this. An increase in outreach to improve applications. Many different groups are at work, but I would like to focus on a few that have local implications and value. The Western Crop Protection Association has had an Application Stewardship Slide set out for almost five years now. These two sets of slides address technical issues of "big drop/little drop" (lower pressures, larger nozzle orifices, etc.) which will have a direct use for equipment setup. It also addresses decision making for the applicator, (wind direction, application height, etc.). The second slide set specifically addresses decision making process between the grower, PCA, and applicator. It encourages awareness of sensitive areas, and decisions about improper application conditions. The sets are available for sale, or presentations may be made by an Association member.

The Coalition for Drift Minimization has defined a national training curriculum for drift awareness and mitigation education. Surprisingly, several states have little, if any, drift training requirements. The Coalition is developing a videotape for use with applicator and grower groups to impart the messages of managing drift before it happens. The Coalition is also working closely with the Spray Drift Task Force and USEPA on label language for drift management, definitions of "drift", and definitions of "buffer zones". All of these will be useful tools for applicators and PCA's, if done correctly.

The California Agricultural Aircraft Association has recently revised their Operations Guidelines and Best Management Practices manual for aerial applicators. These guidelines address every aspect of the aerial applicators business, including ethics. CAAA also is upgrading monitoring equipment to use in fly-ins to raise awareness of the movement of small droplets off-target.

The National Ag Aviation Association is in the midst of creating a performance based program called PAASS (Professional Aerial Applicator Support System). This program will focus on decision making during applications, and how pilots need to modify behaviors to improve performance.

The Spray Drift Task Force has basically completed its research. The next steps are for USEPA and peer scientists to consider the data, and develop risk assessments to be used for product registration. This may result in label modifications or changes. It will be critical that you as advisors and applicators have input into these labels so that they are meaningful and useful. Stay engaged with the various groups like PAPA and WCPA for these opportunities.

Lastly, a new organization called CURES (Coalition for Urban/Rural Environmental Stewardship), has been created. This organization is a a public benefit corporation seeking tax exempt status. The goal of the organization is stewardship and education outreach. Drift Mitigation and education is a key program for CURES to undertake. Several projects being considered are a ground applicator drift education program, a "DRIFT" web site that has access to powerpoint slide presentations, research articles on drift, and key messages to raise awareness of drift issues. CURES may also undertake awareness outreach by radio spot announcements during farm broadcasts, for example during cereal herbicide spray season in the Pacific Northwest. Keep your eyes peeled for more information on CURES!

In closing, I would remind you that there is increasing awareness of drift incidents. There will be increased regulatory scrutiny. There are stewardship programs out there for your use in education and training. But most importantly, there is you. You are the critical piece in the equation. You need to constantly analyze each application, looking for potential problems and solving them. You need to make drift mitigation a normal way of doing business.

Thank you again for this opportunity. I would entertain questions.

California Wildlife and Pesticides
A Booklet by the California Department of Fish and Game

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California is blessed with a tremendous diversity of fish and wildlife. More than 1,000 species of birds, mammals, and fish and more than 5,000 species of plants can be found within the state. Mountain lions, red-tailed hawks, and black bears make their homes from the Oregon border to Mexico. California also has many rare species like the salt marsh harvest mouse and the wolverine. All together there are over 380 distinct natural communities, many of which are found only in California.

Since statehood in 1850, California's natural world has seen many changes. During the last 150 years, a myriad of industrial and commercial enterprises have created an economy that surpasses those of most nations. Pesticides have played an important role in the development and maintenance of California's economic investment. According to the California Department of Pesticide Regulation, over 190 million pounds of pesticides are used annually in California in a wide variety of situations such as crop production, landscape maintenance, and mosquito abatement. Over the years, pesticides have proven to be valuable tools for maintaining the quality of human life in California. These benefits, however, have not come without some risk to fish and wildlife resources.

From 1984 to 1993 more than 100 pesticide-related fish and wildlife losses were documented by the California Department of Fish and Game. Approximately 30% of the losses involved 50 or more animals, and approximately 10% involved more than 1,000. The larger losses typically involved fish, however birds such as ducks, sparrows, and doves have also been involved. Other animals killed by pesticides in recent years include red-tailed hawks, black bears, and Canada geese. When compared to other factors such as habitat loss, pesticide-related fish and wildlife losses have been relatively few in number. However, some of the losses have been significant, and many of them were preventable.

The booklet being presented today is to be used as a resource to help farmers, ranchers and commercial pesticide applicators make informed decisions about the ways they use pesticides. It includes information about potential impacts on fish and wildlife and ways to reduce those impacts. More importantly, this booklet is intended to encourage those who use pesticides to consider fish and wildlife resources when they make pest management decisions. With few exceptions, pesticides can be used without harming fish and wildlife resources. The key to this, however, is having the knowledge necessary to make good decisions.

As California's population continues to grow, agricultural lands will play an increasingly important role in sustaining California's fish and wildlife populations. Additionally, many non-agricultural lands like parks, flood control channels and road right-of-ways have wildlife habitat value. Applicators need to be aware of how the pesticides they use may affect the nontarget environment. Using the information in this booklet will help pesticide users make informed decisions about using pesticides near fish and wildlife habitats and help ensure the conservation of fish and wildlife resources for generations to come.

EFFECTS OF RIMSULFURON ON TRANSPLANT TOMATOES

Krista L. Felix; Graduate Student, CSU Fresno

Abstract

Rimsulfuron (DPX-E9636) has been tested in California as a tomato herbicide since 1991. Rimsulfuron has proven to be effective in weed control programs when applied preemergence or postemergence by itself, or when used in combination with other herbicides. The application rates range from 0.25 to 0.50 ounces active ingredient per acre pre or post with a maximum total application rate of 1 ounce active ingredient per acre per year.

Postemergence tests, such as this one, have shown that rimsulfuron must be applied with surfactant when weeds are less than 1 inch in height or 1 inch in diameter for consistent postemergence weed control.

Studies have shown the mode of action of rimsulfuron to be a potent inhibitor of acetolactate synthase enzyme in both tomato and weeds. The basis of selectivity has been found to be the rapid metabolism in the tomato. It is because of this rapid metabolism that residue tests conducted in California have shown that there are no detectable residues in the harvested tomato fruit when the rimsulfuron is applied 45 days or more before harvest.

Crop response tests, such as this one, show the high tolerance and safety of postemergence applications of rimsulfuron under normal environmental conditions. When under environmental stress, tomatoes can exhibit a temporary chlorosis and stunting after rimsulfuron application. However, the crop response tests have not shown any long term stunting or chlorosis, as well as no negative effect on tomato yield or quality which was also the case in this particular transplant test with Bos 3155.

Introduction

Rimsulfuron (DPX-E9636) is a new herbicide for tomato weed control and has been tested in California as such since 1991. Rimsulfuron has proven to be an effective herbicide when applied preemergence, postemergence by itself, or when used in combination with other herbicides in a weed control program. The rates of application range from 0.25 to 0.50 ounces active ingredient per acre pre or postemergence, with a maximum total application rate of 1 ounce active ingredient per acre per year.

Mode of action studies have shown that rimsulfuron is a potent inhibitor of acetolactate synthase enzyme in both tomato and weeds, and that the basis of selectivity is rapid metabolism in the tomato. This rapid metabolism in the tomato has been the reason for conducting residue tests in California and around the world. These tests have shown that there are no detectable residues in the harvested tomato fruit when rimsulfuron is applied 45 days or more before harvest. Both direct seeded and transplant tomatoes have also been shown to be highly tolerant of postemergence applications of rimsulfuron in crop response tests.

The objective of this test was to evaluate the effects of rimsulfuron applied to Bos 3155 transplanted tomatoes at 3 different intervals after transplanting. This trial will determine if the transplants exhibit phytotoxicity to rimsulfuron as well as its effectiveness in controlling the target weeds of Rough Redroot Pigweed (*Amaranthus retroflexus* L.) and Common Purselane (*Portulaca oleracea*).

Materials and Methods

The surface width of each treatment was 3.30 feet and the length was 90 feet. The tomatoes were transplanted onto 60" beds with a single row mechanical transplanter pulled behind a small tractor. The planting wheel was configured such that the tomatoes were planted on a spacing of approximately 17" between plants. At time of planting, the transplants were healthy.

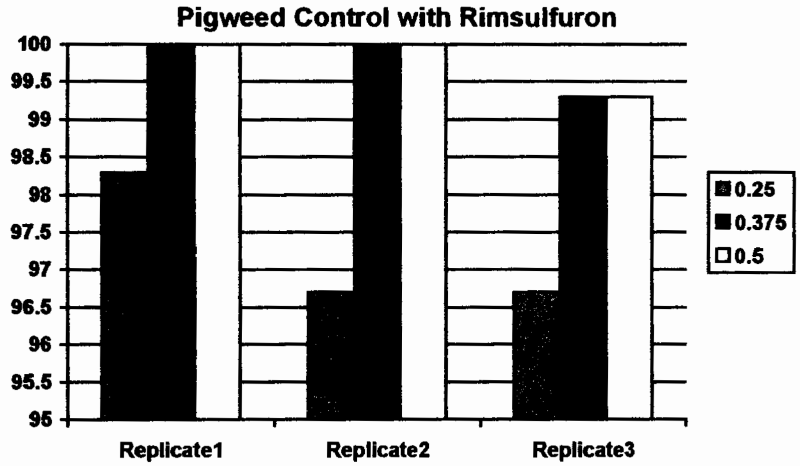
Three rates of rimsulfuron were applied on each of 3 application timings. The application timings were: 1) immediately after transplanting, 2) 7 days and 3) 14 days after transplanting.

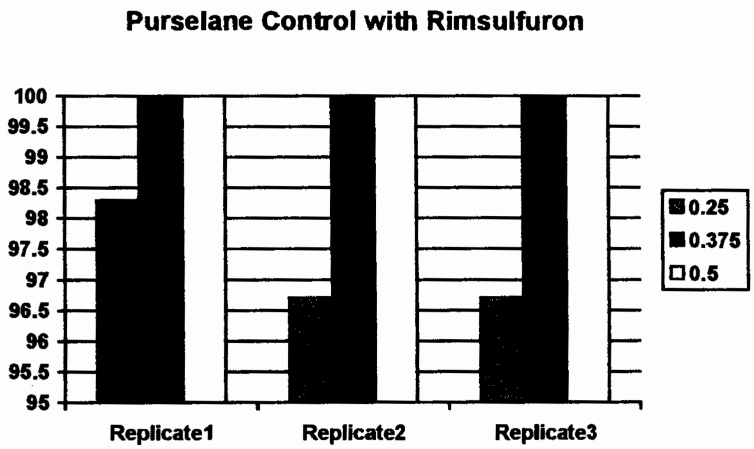
All three applications of rimsulfuron were made with a CO_2 backpack sprayer. The material was broadcast at a height of 20" over the transplants using two 8003 Tee Jet nozzles with a 20" spacing. The rimsulfuron was applied at rates of 0.25, 0.375 and 0.50 ounces active ingredient per acre at a volume of 25 GPA and 30 PSI for all three applications. The solution was diluted in water in conjunction with a non-ionic surfactant at 1/2% by volume mixture.

Approximately 1 inch of water was applied through solid set sprinkler lines within 4 hours of the rimsulfuron application. Sprinklers were set to provide full, complete and uniform application of water. Irrigation amounts were monitored with an in field rain gauge.

Results

The evaluations from this trial indicate that rimsulfuron at the rates evaluated has excellent safety and weed control to this variety of tomatoes. There was no difference in crop safety from applications made the day of transplant and those made 7 and 14 days after transplanting. Potential crop yield was observed and there were no differences in the fruit due to any treatment effect. The untreated checks were full of weeds resulting in small, weak looking plants due to the competition for sun, nutrients and space.





Discussion and Conclusions

This test along with others has proven the effectiveness of rimsulfuron as a new herbicide for tomato weed control in California. Rimsulfuron is a versatile herbicide which makes it a valuable one. With rimsulfuron there are the options of applying preemergence, postemergence or in combination with other herbicides in a weed management program on tomatoes with application rates of 0.25, 0.375 or 0.50 ounces active ingredient per acre pre or postemergence. These options allow the grower to choose to apply herbicide prior to planting or immediately following transplanting while the target weeds are in small cotyledon stage of growth. Any regrowth of weeds later in the season can easily be managed by timely hand hoeing or light cultivation.

In conclusion, rimsulfuron exhibited effective weed control at the various rates used on this variety of transplant tomatoes and there were no visible signs of phytotoxicity such as chlorosis or stunting of the plants.

POSTEMERGENCE CONTROL OF PERENNIAL GOOSEGRASS AND YELLOW FOXTAIL IN ALFALFA WITH PRISM®

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Weed control is necessary in alfalfa to ensure stand establishment and improve forage quality. Weed management strategies were developed that will aid in the removal of Perennial Goosegrass and Yellow Foxtail from alfalfa. Postemergence applications of Prism were conducted to demonstrate the affects of Prism on Perennial Goosegrass and Yellow Foxtail. Field studies were established to evaluate weed control and crop injury with Prism at two application timings; June 20 and July 14, 1997.

Single and double application treatments were made comparing two rates of Prism, 0.125 Lb/A and 0.25 Lb/A. Two adjuvants were also compared, an Esterfied Vegetable Oil (Hasten®) and Crop Oil Concentrate (Herbicide Activator®). Applications were made using a CO_2 pressurized backpack sprayer, applying a spray volume of 30 gpa at 35 psi.

Perennial Goosegrass control was highest with the two applications of Prism at 0.25 Lb/A with the EVO, reaching 84%. Yellow Foxtail control was best with the two application timings with no difference between adjuvants, both reaching 90% control. A single application of the 0.25 Lb/A rate provided 45% suppression of Perennial Goosegrass and 75% control of Yellow Foxtail 83 days after treatment. There was a 8% increase of Yellow Foxtail control using the EVO compared to the COC at the 0.25 Lb/A rate. Perennial Goosegrass control with the EVO had an increase of 18% compared to the COC at the 0.25 Lb/A rate. Two applications provided better control of both weed species. The EVO provided increased control over the COC in all but one treatment (two applications on Yellow Foxtail). The 0.125 Lb/A rate did not give acceptable control of Perennial Goosegrass and gave only temporary suppression of Yellow Foxtail. Crop injury was 0% for both application timings.

TOLERANCE OF VEGETABLE CROPS TO HALOSULFURON

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There are few options for nutsedge control in most vegetable crops. Halosulfuron is a selective herbicide that we have found to be effective in controlling yellow and purple nutsedge. Several varieties of vegetables were tested for tolerance to pre-emergent treatments of halosulfuron. Tolerant crops included carrot and the warm-season crops: melon, snap bean, pepper, cucumber, squash, and okra. Most of the cool-season vegetables were intolerant of halosulfuron. The difference in tolerance between warm-season and cool-season crops has important management implications. Summer nutsedge control is the primary application for halosulfuron. Rotations of warm-season vegetables or field crops followed by cool-season vegetables are common in many vegetable producing regions. Soil carryover of halosulfuron could lead to crop injury when fields are subsequently planted to cool-season vegetables.

However, we found the current label restrictions for plant-back to be overly cautious. Current label restrictions do not permit the planting of many vegetables for 1-2 years. Our experiments found that waiting 6-12 months after applying halosulfuron would provide more than adequate safety. We recommend a reduction in the plant-back interval for halosulfuron.

Table 1. Tolerance of vegetable crops to halosulfuron. Injury ratings are based on visual observation using a scale of 0-10, where 0 equals no injury and 10 equals complete death of the plant. Means followed by the same letter are statistically equal.

Crop Species	Variety	Crop Injury @ 4 weeks	Crop Injury @ 6 weeks	Dry weight, as percentage of untreated
Carrots	Goldmine	0 **j**	0 **l**	94.91 **ab**
Lettuce	Paris Island	7.75 **c**	7.5 **c**	26.36 **gh**
Onions	Southport White Globe	7.5 **c**	6 **e**	21.48 **h**
Spinach	Bassanova	6.5 **d**	7.75 **c**	27.52 **g**
Melon	White Crenshaw	2.75 **e**	3 **f**	77.98 **dc**
Cantaloupe	Topmark	2.5 **e**	1.25 **g**	79.07**cd**
Melon	Honeydew Green	.75 **gh**	1 **h**	83.28 **cd**
Green Bean	Strike	2 **f**	.75 **I**	79.42 **cd**
Bell Pepper	Keystone R.Giant	.25 **ij**	.25 **k**	83.56 **c**
Red Cabbage	Red Sun	8.75 **a**	8.75 **a**	4.44 **i**
Red Cabbage	Azzuro	8.25 **b**	8.75 **a**	4.42 **i**
Red Cabbage	Primero	8.25 **b**	8.25 **b**	5.1 **i**
Cucumber	Superset	1.75 **f**	.5 **j**	99.86 **a**
Cucumber	Celebrity	.5 **hi**	.25 **k**	48.51 **f**
Chinese Broccoli	N/A	8.75 **a**	8.75 **a**	3.37 **i**
Squash	Zuchlong	1 **g**	.5 **j**	97.61 **ab**
Squash	Prelude 2	.75 **gh**	.5 **j**	92.15 **b**
Okra	Clemson	2 **f**	.25 **k**	73.25 **e**
Lsd value at alpha.05	N/A	**.273**	**.2187**	**5.513**

ABSTRACT

Broad Spectrum Weed Control in California Rice with a Pinpoint Application of V-10029 80 WP plus Thiobencarb 8 EC[1]

Thomas DeWitt, Valent USA Corporation, Fresno, CA;
Ernie Roncoroni, Jr, United Agri Products, Woodland, CA

V-10029 80 WP (bispyribac-sodium) is a post-emergence herbicide which has excellent efficacy against certain grasses, sedges and broadleaf weeds with selectivity for rice. It inhibits the plant enzyme acetolactate synthase (ALS), thus blocking branched-chain amino acid biosynthesis. V-10029 controls sensitive species with a cessation of growth followed by chlorosis, necrosis, and plant death. This usually occurs in 3 to 4 days.

V-10029 80 WP has excellent activity on barnyardgrass, ***Echinochola crus-galli,*** watergrass ***E. oryzoides***, and ricefield bulrush, ***Scirpus mucronatus*** with minimal phytotoxicity to the rice plant. Slight stunting of the rice may occur within 3 to 5 days of application. The rice plant recovers within 10 to 14 days. Slight to moderate root pruning may appear within 5 to 7 days. Root growth recovers with 10 to 14 days after application. Phytotoxic response can be minimized with a good fertility program. Phytotoxicity does not have a negative effect on maturity or yield.

V-10029 80 WP has a wide application window for control of barnyardgrass and watergrass. The herbicide can be applied from 1st leaf to 1st tiller stages of growth. Use rates range from 10 to 18 grams ai/A. Optimum use rates are 10 to 12 grams ai/A with the grass being at the 3 to 5 leaf stage. Higher use rates may be necessary for larger grass sizes. A non-ionic silicone based surfactant is required at rates of 0.125 to 0.25% v/v.

In 1997, joint testing was conducted between Valent USA Corporation and United Agri Products, to determine the tank-mix activity of V-10029 80 WP and thiobencarb 8 EC with various rates of Silwet L-77, a 100% Silicone-polyether copolymer, applied at pinpoint in water seeded rice. Thiobencarb at 4 lbs ai/A plus12 grams ai/A of V-10029, was investigated. Silwet L-77 was tank-mixed with V-10029 plus thiobencarb at concentrations of 0.0, 0.5, 0.25, 0.1875, 0.125, 0.0625, 0.0313% v/v. All treatments were applied at pinpoint flood when the rice and watergrass were at the 3 to 5 leaf stage. Additional treatments included: Thiobencarb 8 EC at 4 lbs ai/A, and V-10029 80 WP at 12 grams ai/A plus Silwet l-77 @ 0.25% v/v.

Weed control ratings for watergrass, taken at 30 days after the application, indicated that individual applications of thiobencarb and V-10029 provided 87.5% and 98.5%, control respectively. The tank-mix of V-10029 plus thiobencarb provided 100% grass control regardless of Silwet L-77 concentration. All treatments of V-10029, provided 100% control of ricefield bulrush. Thiobencarb provided good control of smallflower umbrellaplant (91.3%). Economic control of smallflower umbrellasedge from V-10029 was not observed. The tank-mix provided economic control of all three weed species.

The concentration of Silwet L-77 did not have any effect on the efficacy of the tank-mix of V-10029 plus thiobencarb. There were no statistical differences between concentrations of Silwet L-77 for control of any of the weeds species in the trial. However, V-10029 alone does require a silicone surfactant for activation.

In conclusion, the tank-mix of V-10029 plus thiobencarb provided excellent control of watergrass, ricefield bulrush and smallflower umbrellaplant throughout the growing season. Concentration of Silwet L-77 in the tank-mix of V-10029 plus thiobencarb did not influence weed control.

1. Thiobencarb 8 EC is sold as Abolish 8 EC by United Agri Products in California

Efficacy of CottonQuik™ in California for Cotton Boll Opening and Defoliation.

Stephen Colbert, Griffin Corporation, Escalon CA.

CottonQuik is a new generation ethephon based cotton boll opener and defoliant. It contains a proprietary synergist (1-aminomethanamide dihydrogen tetraoxosulfate, AMADS) which maximizes the activity of ethephon and other defoliants. CottonQuik has been registered and used outside of California for the past two growing seasons. Field research and grower use outside California has shown lower rates of ethephon as CottonQuik tank mixed with lower rates of defoliants such as Ginstar , Dropp , and Def /Folex are equivalent to standard rates of other ethephon containing products tank mixed with defoliants. Research was conducted in 1996 and 1997 to determine if CottonQuik tank mixtures would perform similarly under California conditions.

CottonQuik was tested alone and in combination with other defoliants for boll opening, defoliation, desiccation, and regrowth where present. Replicated small plot tests were conducted in 1996 and 1997 by the University of California Cooperative Extension (Bruce Roberts, UCCE Kings Co.; Steve Wright, UCCE Tulare Co.; Ron Vargas and Tomé Martin-Duvall, UCCE Madera Co.) and Griffin Corporation. Large demonstration plots were conducted by Griffin Corporation in cooperation with production consultants and growers in 1997.

Results of field trials conducted in 1996 and 1997 confirmed the boll opening and defoliation efficacy of CottonQuik in California In the 1997 UCCE Acala cotton defoliation study, CottonQuik alone provided statistically equivalent defoliation and boll opening and statistically less regrowth compared to Prep alone and Finish at equal ethephon rates (1.5 lb ai/A). In the same study, CottonQuik (1.5 lb ai/A) plus 6 oz/A of Ginstar was not statistically different from Ginstar alone at 10 oz./A for defoliation and provided statistically greater boll opening. In addition, CottonQuik (1.5 lb ethephon/A) plus 1.5 pt Folex was statistically equal to Prep (1.5 lb ai/A) plus 2 pt/A of Def for defoliation and boll opening. CottonQuik consistently provided equivalent activity with reduced ethephon and defoliant use rates compared to standard defoliation and boll opening treatments in Griffin Corporation small plot and grower applied demonstration field trials. CottonQuik also performed well as a tank mix partner with Ginstar for defoliation and boll opening of Pima cotton.

CottonQuik is now registered in California and will be commercially available in 1998. CottonQuik was the first "synergized" ethephon product registered and has become widely accepted as a tank mix partner with Def/Folex, Dropp, and Ginstar. Although CottonQuik is both a defoliant and boll opener for senescent cotton, it is generally recommended that it be used in combination with another defoliant. Under California conditions, the manufacturer (Griffin Corporation) recommendations for CottonQuik are that it be used at timings and in tank mixes similar to currently used with other ethephon containing boll openers. However, the enhanced activity of ethephon and defoliants in tank mixes with CottonQuik allow use of lower overall active ingredient rates per acre. Specifically, approximately 1.5 to 2.0 qt per acre of CottonQuik plus approximately 1.0 to 1.5 pt/A of Def/Folex, 0.1 to 0.2 lb/A of Dropp, and 4 to 6 oz/A of Ginstar have proven effective. These rates and tank mixes will vary in efficacy with each use season due to environmental and cultural conditions. Where faster and greater boll opening are desired, higher rates of CottonQuik should be used. Lower rates have proven just as effective as high rates of CottonQuik for enhanced activity of tank mix partners.

THE EFFECTIVENESS OF MOWING & HERBICIDES TO CONTROL PERENNIAL PEPPERWEED IN RANGELAND & ROADSIDE HABITATS.

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Perennial pepperweed (tall whitetop) can establish large monocultural stands in many different habitats throughout the west. Experiments were initiated to evaluate the use of mowing and herbicides as a potential new control strategy in rangeland and roadside habitats. These experiments consisted of mowing perennial pepperweed once or twice per season at the flower bud stage, and then applying a herbicide to the recovering stems when they returned to the flower bud stage. Unmowed areas were treated with herbicides at the flower bud stage. In rangeland situations the use of herbicides with one mow generally increased the level of control and significantly reduced the amount of litter present from 10 to 5 cm. Chlorsulfuron at 0.052 kg/ha provided excellent control (98%) after one year. Along roadsides, first year data indicates that imazapyr at 0.138 kg/ha, and one to two mows followed by glyphosate at 3.33 kg/ha or chlorsulfuron at 0.052 kg/ha will also provide excellent control ($\geq$ 91%). 2,4-D at 2.109 kg/ha did not provide adequate control (< 72%) even when used in conjunction with mowing in either habitat. These data indicate that mowing can increase the effectiveness of some herbicides in controlling perennial pepperweed by depleting below ground energy reserves.

BERMUDAGRASS CONTROL IN NON-BEARING GRAPES WITH PRISM HERBICIDE®

Mike Hemman and Mike Ansolabehere
Valent USA Corporation, Fresno CA

Abstract. Bermudagrass (*Cynodon dactylon*) is a widespread problem during grape vineyard establishment in California. Perennial grasses such as bermudagrass may compete with developing vines for water, nutrients, and space. Applying a selective grass herbicide such as Prism Herbicide® (*Clethodim*) may greatly reduce the impact of grasses on young vines.

Seven different treatments were applied as broadcast applications to non-bearing vines. The first three treatments consisted of Prism applied at 0.125, 0.200, and 0.250 lb ai/A, followed 21 days later by Prism at 0.125 lb ai/A. The next three treatments were tank mixes which consisted of Prism at 0.125 lb ai/A with UN32 at 1% v/v, Prism at 0.200 lb ai/A with UN32 at 1% v/v, and Prism at 0.250 lb ai/A with UN32 at 1% v/v, followed 21 days later by Prism at 0.125 lb ai/A with UN32 at 1% v/v. The final treatment included was Fusilade DX® (*Fluazifop- P-butyl*) applied at 0.300 lb ai/A, followed 21 days later by Fusilade DX at 0.250 lb ai/A. All treatments included a crop oil concentrate at 1% v/v.

At 14 and 21 days after the initial application and 7 days after the second application Prism at 0.200 lb ai/A with UN32 at 1% v/v exhibited significantly greater control of bermudagrass than Prism at 0.200 lb ai/A without UN32. There were no other significant differences between corresponding rates of Prism with and without UN32. When the final rating was performed at 21 days after the second application, there were no significant differences among any of the treatments. At all evaluations, with the exception of the final evaluation, Prism applied at 0.200 lb ai/A with UN32 performed significantly better than Fusilade DX at 0.300 lb ai/A. No visible crop phytotoxicity was observed during any of the evaluations.

DEVELOPING A PROGRAM FOR THE CONTROL OF YELLOW NUTSEDGE

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Fresno County

Yellow Nutsedge and its Biology

Cyperus esculentus (yellow nutsedge) is one of the most troublesome weeds, infesting thousands of acres of irrigated annual and perennial crops in California. The reproduction and dissemination of this wide-spread perennial is primarily by means of underground vegetative propagules (tubers or nutlets). These underground tubers are produced from spring through early fall and are most commonly found in the upper six to eight inches of the soil profile. However, it is not uncommon to see tubers sprout and give rise to above-ground plants from as deep as 10 inches or more. It is prevention of new tubers that is essential for control. Therefore, knowing when and how yellow nutsedge tubers are formed will help one to determine when and what measures could be taken for the most effective control.

When conditions are favorable for mature tubers to sprout, they produce rhizomes and fleshy bulbs near the soil surface. These bulbs give rise to the above-ground foliage, roots and rhizomes terminating in single tubers, unlike purple nutsedge which has its tubers formed in continuous chains. As a rule-of-thumb, new tubers begin forming when plants have three or four leaves and will survive adverse conditions when mature. Mature tubers are impervious to most herbicides, but are susceptible to chemical and mechanical control once they break dormancy and begin to sprout.

Cultural and Physical Control Available

Cultural or physical practices are available that can reduce the population of yellow nutsedge. Properly timed diskings can be used to destroy young plants prior to new tuber development. Similarly, using sectioned rolling cultivators, knives, or sweeps can be used in cultivated crops like cotton, tomatoes, and peppers. Care should be exercised so as not to move plants on equipment into areas not previously infested with yellow nutsedge. Reducing the number of viable tubers can also be accomplished using a moldboard plow (like the Kverneland or Wilcox plow) for deep burial into the soil. Burying tubers to depths of 11 inches or more for a couple seasons will help decompose them. Once plowed, the field should not be plowed again for at least two or three years to allow sufficient time for the buried tubers to be killed, and so viable ones are not brought back to the soil surface. This method of control can also be effective on small seeded annual weeds. Whichever type of cultural or physical control is used, the most effective management strategy is to prevent the formation of new tubers, so time of control in relation to nutsedge stage of growth should be monitored closely.

Chemical Control Available

There are several herbicides available to control yellow nutsedge in several crops. Glyphosate (Roundup®), a nonselective postemergence translocated herbicide, applied to young nutsedge plants (three-four leaf stage) on fallow ground, or at least seven days prior to crop emergence, will control plants and prevent new tubers from forming. Repeat applications will be needed during the summer fallow period as new plants emerge. Timely applications of glyphosate during the year can also be used effectively in orchards and vineyards. Care should be taken to avoid spray drift onto foliage or new wood to prevent injury. Although paraquat can be used, control is limited to the above-ground foliage and will not kill the bulb, rhizome, or developing tubers. Organic arsonates (like MSMA) are also used for postemergence control in many nonbearing orchards and vineyards or as directed applications in cotton.

Soil applied residual herbicides, such as norflurazon (Solicam®), and to a lesser extent, napropamide (Devrinol®), can provide yellow nutsedge control in established vineyards and most varieties of orchards. A preplant incorporated application of pebulate (Tillam®) can control yellow nutsedge in tomatoes. To be effective, it should be disked in at least four inches, followed by a bed-top incorporation for shallow germinating weed seeds. Ro-Neet® in sugar beets, alachlor (Lasso®), metolachlor (Dual®), EPTC (Eptam®), and Sutan® in corn can provide effective control. Timely cultivations may be required along bed shoulders or furrows where control may be reduced.

Metham (Vapam®, Soil Prep®, etc.), a widely used soil biocide, applied through injector blades or knives 4 to 12″ deep, 14 to 21 days before planting, can provide several weeks of suppression, helping in stand establishment. Nutsedge emerging from outside the treated zone can then be controlled with cultivation or a postemergence directed herbicide when appropriate.

EPTC applied on fallow ground during the summer, can provide effective nutsedge control in cotton. This combination of tillage, irrigation, herbicide application, and hot temperatures during the summer months, may provide effective control.

Herbicide effectiveness will depend on several factors, including method and time of application. To be effective, follow all label recommendations carefully. The herbicides listed herein are registered trade names and those not mentioned are also effective when properly used.

Although nutsedge continues to be a serious weed problem throughout the state, several cultural, physical, and chemical options are available to enable growers to develop economical strategies that work for them. Regardless of the crop grown or method(s) of control selected, it must be stressed that preventing the formation of new tubers is central in any nutsedge control program.

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CONTROL OF YELLOW STARTHISTLE WITH MOWING: EFFECTS OF TIMING, REPEATED CUTTINGS, AND GROWTH FORM

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Yellow starthistle is the most widespread non-crop weed in California. When used properly, mowing can offer an economical and effective option for control. However, successful implementation depends upon proper timing and plant growth form. We examined the effects of one or two cuttings at the bolting, spiny, or early flowering stage on plants with either a high (>10 cm) or low (<10 cm) branching pattern. Experiments were conducted in Calaveras, Shasta, Butte, and Siskiyou counties in northern California. Experiments were established in areas were yellow starthistle plants were in competition with grasses. Plants competing with grasses developed a more erect growth form with few basal branches. Low branching plants were produced when plots with yellow starthistle in the rosette stage were mowed, thinned, and treated with a postemergence graminicide. The efficacy of mowing was determined by measuring seedhead production per unit area at the end of the season. In all cases, mowing was most effective when conducted at the early flowering stage. Repeated mowing at the bolting stage was ineffective for the control of yellow starthistle. Mowing once at early flowering was just as effective as mowing twice at the spiny stage. Mowing erect plants with a high branching pattern provided better control than mowing low branching plants at all comparative stages of development. When plants developed a low branching pattern, mowing was not effective, regardless of the timing or number of cuttings.

DEGRADATION AND DISTRIBUTION OF SIMAZINE UNDER DRIP IRRIGATION IN A GRAPE VINEYARD

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Introduction

Contamination of groundwater from herbicides puts important weed control tools at risk and potentially increases risks to human health. Movement of simazine into groundwater has been documented by the California Department of Pesticide Regulation. Simazine has been found in over 30% wells sampled in Fresno and Tulare counties. Dating of water with CFC's indicates the contaminated groundwater is less than 10 years old (Frank Spurlock, California Department of Pesticide Regulation. personal communication). In California, simazine use is predominately in citrus and grapes within the area of concern. DPR statistical analyses of their data suggest grapes and citrus are primary sources of contamination from these herbicides.

One route of groundwater contamination by agricultural chemicals occurs through recharge of groundwater whereby water moves from the surface through the soil profile to a groundwater aquifer (Wehtje et al., 1984; Freeze and Cherry, 1979). Recharge may result from natural rainfall or irrigation events (Bouwer, 1987). Alternative ground-floor management is needed to prevent movement of herbicides into groundwater. Drip irrigation is an irrigation method that results in irrigation water moving through herbicide - treated soil. Difficulty in evaluating downward movement of herbicides under the drip irrigation is that water application is not uniform over the surface of the field and, as a result, both water and herbicide may move downward, laterally or both. In a previous study (Troiano et al., 1990), an attempt was made to evaluate atrazine leaching directly under the drip emitters. Very little solute or tracer was recovered in cores taken below the drip emitters, even at the lowest level of irrigation (irrigation depth $\approx$ 0.75 ET calculated over entire plot area). This study concluded that more frequent and detailed sampling of soil located from both beneath and between drip emitters is needed in order to adequately describe solute movement in low volume systems where horizontal movement to non-irrigated areas could occur. While drip is a low-volume irrigation method that should allow a high degree control over total water application and timing, it is possible that, relative to furrow irrigation, enhanced herbicide transport may occur under the drip emitters because water application is not spatially uniform and directly contacts treated soil. Therefore, field observations are needed to evaluate the downward and lateral movement of simazine. The objective of this study was to determine simazine dissipation and distribution in a soil profile under drip irrigation, while maintaining acceptable crop health and weed control.

Materials and Methods

The study was conducted in a vineyard near Sanger, Fresno. The soil at the site is mapped as Hanford fine sandy loam (SCS, 1971), with about 50% sand and 6% clay content throughout soil profile. Soil organic carbon content is 1.1% in 0 - 15 cm soil depth.

Experiment 1: The experimental design was a randomized complete block with four replications. The list of treatments for this experiment is summarized in Table 1. Under drip irrigation, three irrigation models - Growers standard, Historic ET, and Current ET, were used. Historic ET and Current ET models have been derived to relate the amount of water in ET irrigation according to crop requirements and climatic conditions (Synder et al, 1985). For growers standard, water was applied by the grower according to his experience. Data for daily ET_0 values were acquired from a CIMIS weather station located in Fresno, California for Current

Table 1. Summary of treatment under drip irrigation.

Irrigation	ET model	Chemicals	Additive
Drip	Growers	2.0 lb ai simazine ac^{-1} + 2.0 lb ai diuron ac^{-1}	surfactant
	Historic	2.0 lb ai simazine ac^{-1} + 2.0 lb ai diuron ac^{-1}	surfactant
	Current	2.0 lb ai simazine ac^{-1} + 2.0 lb ai diuron ac^{-1}	surfactant

ET model. Yearly average ET_0 values were used for Historic ET model (Cooperative Extension, University of California, 1986). A water flow meter was installed for each irrigation model. Herbicides were broadcast over the soil surface with a sprayer on 2/18/97. Herbicides were applied in a 1.7 m swath down vine row on the soil surface. Irrigation began on 4/2/97 and usually irrigated once a week. Soil simazine concentration and distribution in soil profile was only determined for grower standard, and current ET model. Soil cores were taken directly under the emitter on 4/10/97, 1.0 m west between the vine row and the emitter on 4/17/97, and 1.0 m east between the vine row and the emitter on 5/1/97. The samples taken were immediately frozen on dry ice and kept at -4^0 C until submission to laboratory. Simazine in soil was analyzed using the ELISA immuno-assay method.

Experiment 2 - : Simazine was applied at a rate of 1.21 lb ai ac^{-1} on 09/18/97 in a 1.7 m swath down the vine row. The first irrigation was made three days later. Soil cores were taken under the emitter, 0.33 m west and east between the vine row and the emitter for simazine analysis one week (9/18/97), two weeks (9/24/97) and four weeks (10/8/97) after application.

Results and Discussion

Herbicide Concentration and Distribution as affected by irrigation model

Simazine concentration profiles for two ET models- Growers standard and Current ET, are listed in Table 2. Simazine distribution in soil profile under the emitter was influenced by both irrigated water and rainfall. The amounts of recorded rainfall events were 0.13 cm on 2/23, 0.33 cm on 2/27, 0.03 cm on 3/10, 1.04 cm on 3/22, and 0.18 cm on 3/23. The total amounts of irrigated water were 2.4 cm and 2.0 cm (calculation based on entire area) for growers standard and current ET, respectively. Simazine was only detected on the soil surface (0 - 15 cm). Irrigation levels did not significantly affect simazine distribution. The recoveries of simazine were very low (Table 2), indicating either a rapid dissipation of simazine, or that much of the simazine had passed beyond the depth sampled. However, simazine has not been detected under 15 cm soil depth. Under the normal climatic conditions, loss of simazine from soil by photodecomposition and/or volatilization is considered insignificant (Humburg et al., 1989). The low recovery could be attributed to microbial degradation. Organic carbon content was 1.1% in 0 - 15 cm soil depth and 0.6% in 15 - 30 cm soil depth. A positive correlation between organic carbon content of soil and biological degradation has been found (Morrill, et al., 1982).

Table 2. Simazine concentration with soil depth as affected by irrigation model.

			Concentration		
ET Models	Soil depth	Total rainfall and irri. water	Under emitter	1 m west of emitter	1 m east of emitter
----	--------------- cm	-----------------	----------------------	ug kg^{-1}	-----------------
Growers standard	0 - 15	4.11	30 (2.3%)†	5	9
	> 15		nd‡	nd	nd
Current ET	0 - 15	3.71	6 (0.4%)	4	nd
	> 15		nd	nd	nd

† Recovery of applied simazine. ‡ Not detected.

According to organic carbon content of the soil at the site, higher rate of degradation would be have been expected in the first 0 - 15 cm. The soil was predominantly sand with value near 50% and 6% clay throughout the profile. Lateral movement of simazine was also studied under drip irrigation. Soil core samples were taken 1 m west between vine row and emitter (55 days) and 1 m east between the vine row and the emitter (73 days) after simazine application. These areas received no simazine application and were out of the wetting edge of the emitter. There were trace or nondetectable amounts of simazine throughout soil profile (Table 2). The detected trace amounts of simazine on the soil surface may have resulted from previous simazine application.

Simazine degradation and distribution as affected by sampling time

Soil samples were collected 7, 14, and 28 days after application (Table 3). The

Table 3. Simazine concentration with soil depth related to sampling time

		Concentration		
Sampling time	Soil depth	Under emitter	West of emitter	East of emitter
---- day ------	----- cm -----	---------------------------------- ug kg^{-1}	------------------------	
7	0 - 15	105	461	359
	15 - 45	22	17	30
	45 - 76	8	0	0
	> 76	0	0	0
		(23.7%)†	**(68.7%)**	**(58.5%)**
14	0 - 15	26	476	464
	15 - 45	0	8	19
	> 45	0	0	0
		(3.7%)	**(68.4%)**	**(69.9%)**
28	0 - 15	0	166	175
	15 - 45	0	0	6
	> 45	0	0	0
		(0)	**(23.0%)**	**(25.9%)**

† Recovery of applied simazine (0 - 152 cm soil depth)

corresponding cumulative water input were 0.97, 2.14, and 3.05 cm. For the first sampling date, core depth was taken to 152 cm. Analysis of the soil core data reveals that only 23.7 % of the simazine under the emitter and 68.7 % at 0.33 m between the vine row and the emitter were recovered. On the second sampling time, simazine recovery in the soil profile was 3.7 % under the emitter and remain about 68 % at 0.33 m between the vine row and the emitter. On the third sampling time, simazine remarkably decreased in the soil profile at 0.33 m between the vine row and the emitter. Even under the emitter, the soil sample data do not indicate that a large amount of applied simazine was displaced depth into the soil by matrix water flow. As a result, the field-scale degradation would be the mechanism responsible for simazine loss. The rapid degradation of simazine minimized the potential for its presence at lower soil depths.

Conclusion

In conclusion, a few generalizations can be made that are critical to determining the environmental fate of herbicide under drip irrigation.

1. Recovery of simazine was very low under drip irrigation The most important processes accounting for simazine disappearance from this field study could be microbial degradation. The rapid degradation of simazine minimized the potential for it to move to lower soil depths.

2. Percolation of simazine to groundwater in grapes under drip irrigation was not a factor.

3. Distribution of simazine with the soil profile differed markedly depending on the uniformity of water application.

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INFLUENCE OF TIMING AND CHEMICAL CONTROL ON YELLOW STARTHISTLE

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Yellow starthistle (*Centaurea solstitialis*) is one of the most aggressive and invasive weeds encountered in non-irrigated range and non-crop areas. For any yellow starthistle control program to be effective, it should be designed to ultimately deplete the starthistle soil seedbank. This will require at least three years of persistent management with no or minimal new seed production. An integrated approach using mechanical, cultural and chemical control measures is typically the best way of managing this noxious weed. However, in many situations, control options are limited by physical, political, or economics constraints. Important considerations for the proper use of herbicides in a yellow starthistle management program are discussed in this pamphlet.

A limited number of herbicides are registered for use in California rangelands and pastures. Of these, the majority are applied to the foliage of target plants, including yellow starthistle. Most of these compounds, including 2,4-D, triclopyr, dicamba, and glyphosate have little or no soil activity, and thus will not control seedlings emerging after herbicide application. In contrast, the newly registered herbicide clopyralid (Transline), has excellent soil (preemergence) and foliar (postemergence) activity. This paper provides information on the use of these herbicides for control of yellow starthistle seedlings and mature plants in California rangelands and pastures, as well as important precautions and considerations for the development of long-term control strategies.

POSTEMERGENCE HERBICIDES

Yellow starthistle is difficult to control with *postemergence herbicides.* This is primarily due to the ability of starthistle seeds to germinate throughout much of the year when sufficient soil moisture is present. The majority of seeds, however, germinate in fall and early winter. While a single application of a growth regulator herbicide (2,4-D, dicamba, or triclopyr) will provide excellent control of seedlings, it typically will not control yellow starthistle for the duration of the season. These herbicides lack residual soil activity and will not provide control of plants germinating after the herbicide treatment.

Growth regulator herbicides only control broadleaf species and can be used in late winter or early spring to control yellow starthistle seedlings without harming grasses. Excellent postemergence control of seedlings can also be achieved at 2 pt of Roundup (glyphosate) per acre or spot application with 1% solution. However, glyphosate is a broad spectrum herbicide and will injury germinated grasses and other broadleaf species. The addition of a surfactant to amine formulations of 2,4-D and triclopyr can enhance yellow starthistle control. Yellow starthistle that has emerged by the time of herbicide application is controlled, but more starthistle emerges with subsequent rains.

Herbicide	Trade name	Product per acre	Rate per acre (lb ae/A)
2,4-D	Weedar 64 and many others	2 to 4 pt	1 to 2
dicamba	Banvel, Vanquish	1 to 2 pt	0.5 to 1
triclopyr	Garlon 3A or 4	1.5 to 3 pt	0.75 to 1.5
glyphosate	Roundup Pro	2 pt	0.75

A single late application, at the end of the rainy season, is not sufficient as many plants are too large and escape injury. The most effective strategy for yellow starthistle control with these compounds is to use repeated applications throughout the season. However, this is expensive, increases herbicide load in these sites, and may prove ineffective should late-season rains occur. Clopyralid is also a very effective postemergence herbicide. However, it also has excellent preemergence activity. Thus, it is discussed separately below under the section PREEMERGENCE AND POSTEMERGENCE ACTIVITY.

PREEMERGENCE HERBICIDES

A number of selective or broad spectrum *preemergence herbicides* control yellow starthistle, including simazine (Princep), diuron (Karmex), atrazine (Aatrex), sulfometuron (Oust), chlorsulfuron (Telar), bromacil (Hyvar), tebuthiuron (Spike), and oxyfluorfen (Goal). All these compounds are registered for use on either right-of-ways or industrial sites, and cannot be used on rangelands and pastures, or by homeowners. These compounds are not as effective for the control of yellow starthistle as clopyralid and will injure a number of desirable species, including natives and important forage species.

PREEMERGENCE AND POSTEMERGENCE ACTIVITY

Clopyralid is a growth regulator herbicide. It is very effective for the control of yellow starthistle, as well as other invasive composites (Sunflower family), but does not injure grasses. The effectiveness of clopyralid on yellow starthistle can be partially attributed to its postemergence and preemergence activity. Hence, a single application at the appropriate rate will control emerged yellow starthistle and prevent more seedlings from emerging for a season. It is important to note, however, that clopyralid is a slow-acting herbicide and may require two months to kill susceptible species. A few composites, such as spikeweed (*Hemizonia pungens*) are not injured by clopyralid. In addition to composites, clopyralid injures most legumes, particularly annuals such as clovers and vetches. Injury to perennial legumes can be avoided when clopyralid is applied when legumes are dormant. Other plant groups which may be susceptible to clopyralid include some members of the nightshade family (Solanaceae) and the knotweed or smartweed family (Polygonaceae). In contrast, many other broadleaf species, including mustards and filarees, appear to be relatively tolerant to the herbicide (see table).

Since clopyralid is a relatively narrow spectrum herbicide, it is important to be aware of the species which may replace yellow starthistle following application. In some cases, these species may be equally undesirable and additional management strategies should be employed to prevent their establishment.

Clopyralid can be applied aerially (helicopter or plane) or by ground equipment. Under optimal conditions, 1/6 pt/acre (1 oz ae/A) of Transline can provide excellent control of yellow starthistle when applied from December through April. However, under drought conditions, higher rates are necessary. Thus, for consistent control of yellow starthistle, rates between 1/4 and 2/3 pt/acre are preferable. The higher rates are needed for aerial applications. When dead erect stems are present from previous years infestation, control can still be achieved with labeled use rates. Higher rates may provide measurable control for a second season. When the objective is to enhance rangeland forage while reducing yellow starthistle, early application dates (January to February) are preferred. Although clopyralid kills starthistle up to the bolting stage (April or later), the competitive effects of starthistle this late in the season will result in low quantities of grass forage.

The addition of a surfactant to the treatment solution may enhance the activity of clopyralid on plants in the late rosette, bolting or spiny stage, but is not necessary for the control of seedlings or for preemergence activity.

CONTROL OF MATURE PLANTS

In the rosette and bolting stage, higher rates of dicamba, 2,4-D, triclopyr, clopyralid, and glyphosate will control yellow starthistle. However, once bolted plants have produced spines and begin to flower, 3 to 4 pt/acre Roundup is the most effective herbicide. Unlike seedlings, 2 pt Roundup Pro per acre may not effectively control large rosettes or more mature plants. The best time to treat with glyphosate is after annual grasses or forbs have died but prior to yellow starthistle seed production. Applications after more than 5% of the spiny heads are in flower will not completely prevent seed production. Control is less effective when mature plants show physical signs of drought stress. When clopyralid has been previously applied, glyphosate can be used in a broadcast or spot treatment follow-up program to kill uncontrolled plants before they produce seed, or to prevent the proliferation of potential clopyralid-resistant plants (see below). Glyphosate is not recommended when desirable perennial grasses or broadleaf species are present, except when used as a spot application.

LONG-TERM CONTROL

Any control program should be continued for at least three years to reduce the yellow starthistle seedbank. Whenever possible, make every effort to expose an infested site to high light during the germination period of yellow starthistle germination. This will deplete the seedbank more rapidly by increasing the rate of germination. Fall or winter grazing, burning, or mowing will provide increased soil surface light during the germination period. By comparison, tillage will bury seeds and prolong the dormancy period.

The presence of high populations of biological control agents (weevils and flies) does not appear to significantly impact yellow starthistle populations when used as the sole means of control. Although no evidence is available, the presence of these organisms in combination with clopyralid applications may provide more long-term or sustainable control. Thus, landowners are encouraged to sustain high levels of the biocontrol organisms.

Reseeding infested areas with competitive perennial grasses and legumes may provide long-term sustainable control of yellow starthistle and higher forage quality. Another possible long-term approach is to alter grazing management strategies to maintain increased grass vegetative cover during the critical period when yellow starthistle rosettes are prepared to bolt.

PRECAUTIONS

Continuous clopyralid use will likely have a long-term detrimental effect on the legume population in the treated area. Consequently, other control options should be rotated in the overall yellow starthistle management program. In addition, the development of clopyralid-resistant yellow starthistle is possible. A Washington population of yellow starthistle developed resistance to repeated use of picloram (Tordon). This population was also resistant to clopyralid, which has a similar mode of action. The potential exists for the development of resistance to clopyralid if the herbicide is used year after year, with no other method employed. Resistance can be minimized by incorporating other control strategies or by utilizing late season applications of glyphosate to control escapes due to application skips or resistant plants.

CLOPYRALID SUSCEPTIBILITY CHART. (N = no control, P = partial control, C = control).

Species or Plant Group	**Susceptibility**
Grasses (annual and perennial)	N
Chickweed (*Stellaria media*)	P to C
Fiddleneck (*Amsinckia menziesii*)	N
Mustards and other crucifers	N
Common lambsquarters (*Chenopodium album*)	N
Russian thistle or tumbleweed (*Salsola tragus*)	N
Filarees (*Erodium* spp.)	N
Teasel (*Dipsacus* spp.)	C
Puncturevine (*Tribulus terrestris*)	N
Prostrate knotweed (*Polygonum arenastrum*)	N
Smartweed or ladysthumb (*Polygonum* spp.)	P
Red sorrel (*Rumex acetosella*)	C
Curly dock (*Rumex crispus*)	P to C
Jimsonweed (*Datura* spp.)	C
Nightshades (*Solanum* spp.)	C
Annual clovers and other annual legumes	C
Perennial legumes	P or N during dormancy
Lupines (*Lupinus* spp.)	C
Burclovers and medics (*Medicago* spp.)	C
Alfalfa (*Medicago sativa*)	P or N during dormancy
Vetch (*Vicia* spp.)	C
Thistles	C
Knapweed (spotted, diffuse, Russian)	P to C
Tarweeds (except *Hemizonia pungens*)	C
Ragweed (*Ambrosia* spp.)	C
Mayweed (*Anthemis cotula*)	C
Sagebrush (*Artemisia* spp.)	C
Pineappleweed (*Chamomilla suaveolens*)	C
Oxeye daisy (*Chrysanthemum leucanthemum*)	C
Chicory (*Cichorium intybus*)	C
Horseweed and marestail (*Conyza* spp.)	C
Sunflower (*Helianthus* spp.)	C
Prickly lettuce (*Lactuca serriola*)	P to C
Common groundsel (*Senecio vulgaris*)	C
Dandelion (*Taraxacum officinale*)	P to C
Salsify (*Tragopogon* spp.)	C
Cocklebur (*Xanthium strumarium*)	C

"THE WEEDS ARE STREET WISE"
Poems by David Haskell

WATSONVILLE

At Hansen's the Amigos give Ruben a beer,
to tell them the story they always love to hear.
How he caught a Chevy with the big John Deere.
"Ay, I was discing the home ranch on one twenty-nine,
when I saw this cabron, coming in his low-ride.
So I made my next turn a little wide,
and I buried that disc deep in his side.
He fought hard, spun us both around.
He must have weighed at least three thousand pounds".

Bobby's bragging again down at the Trucker's Cafe,
about his last fishing trip to that Monterey Bay.
"Well, I saw that bobbing orange antenna ball,
so I switched on the diesel engine stall.
I set the hook with a hard right swerve,
and my trailer drove that car up over the curb,
and the sound of folding metal was all I heard.
Now I was a little worried to tell you the truth,
until that driver popped up, out of the sun roof.

Down at the Junction, the engineers have always thought,
that Casey's fifty-footer was the largest ever caught.
They still talk about the trophy that he got.
He hooked that tired trucker one morning at five,
when the gates were stuck on Riverside Drive.
Gaffed with the coupler behind the driver wheel,
gutted him on the spot, peeling back the steel.
And the berries and cherries spilled out of that van,
like fruit cocktail from a forty-foot can.

I told you about the "best fishing" hole,
I know.
But beware,
they might catch you there.

MY FIRST VOYAGE ON THE GOLDEN BEAR

It was a foggy morning at the harbor,
when I saw that "Help Wanted" sign.
"Navigator Trainee Wanted",
It was an offer I couldn't decline.

So up the gang plank I trotted,
swallowing all of my "land-lovers" pride.
Stashed my gear behind the galley,
the Golden Bear sailed on the morning tide.

The boatswain introduced me to the curious crew,
he's a "free enterprise" refugee.
He doesn't have any sea experience,
but he says he has a bachelor's degree.

Now laden with a News Year's cargo,
of regulations and red tape.
We entered the hazardous seas,
just off the Big Sur Cape.

I searched for the safest channel,
and we put out our stormlines.
But a storm of public protest,
failed to materialize.

Then Tuesday morning,
a sailor's warning,
red in the morning sky.

The East wind freshened,
into a thunderous squall,
when EPA gave us,
an unexpected call.

We have lost our pesticide tolerance,
we have lost our Special Local Need*.
Halt all commodity treatments,
the EPA telegram decreed.

I can't find a compass point for steering,
I didn't know where the ship is bound.
"Captain, we have lost our legal ballast.
We could capsize or run aground.

But the captain was a veteran,
he had sailed the seven seas.
And he gave a fatherly grin,
as he said these words to me.

"Son, the regulatory world is round,
not flat.
So relax,
and remember that,
and you will always land,
just like a cat.

---

*A pesticide registration that permits a minor deviation of the uses on the pesticide label.

THE WEEDS ARE STREET WISE

Born in the Valleys sugar beet slums,
enduring the Eptam water-runs.
Dodging hand-hoes and bed knives,
the weeds grow-up street wise.

With lillistons chasing them down the beds,
survival is the only thought that's left in their heads.
So they learn to hide out in the planted crop rows,
and hang out in the ditches where the tail water goes.

Now those shady Solanaceaes, Harry and Black,
lead an army of seedlings on a coordinated attack.
Soon army fatigue green covers every bed top,
They've just mugged another germinating crop.

You see them high on ammonium nitrate prill,
and their pockets are stuffed with chlorophyll.
Their leaves lock together to steal every ray of sunlight.
The crop knows it's going to lose this street fight.

Now the weeds know all the ghetto rules.
They're dropouts from the UC herbicide schools.
Decorated veterans of many weed wars,
they terrorize their cultivated ancestors.

YOU CAN'T FARM WITH AN AEROSTAR

Well, I bought this piece of ground ten years ago,
to build some city-boy dreams.
I cleared the sage and planted the seed,
this farming can't be as hard as it seems.
And I got the name of a local hay farmer,
someone I might try to be friend.
To answer all my crazy questions,
and the things I couldn't comprehend.

Now he always acts surprised,
every time that I drive up.
Because everybody he knows,
drives a pickup truck.
So he hides in his shop,
hoping I will just drive away.
Until he realizes it me,
and not tourist from the highway.

When he finally offered me some neighborly advice,
he didn't mean me any harm.
David, buy the pickup first,
then start the farm!

Well, I prayed for the snow and the spring rain.
I learned that water was precious indeed.
And I learned that a farmer has to experiment,
if he is ever going to succeed.
But after four years of worry and sweat,
I going to have to concede.
The only crop that I can seem to grow,
is a new kind of jackrabbit feed.

So I asked him, "what am I doing wrong?"
Is there something I cannot see?
He stared at the ground and took a deep breath,
and he told me.
ITS THE CAR!
YOU CAN'T FARM WITH AN AEROSTAR!

Now you better stay off the highways,
when those cold winds start to blow.
Because this is a California car.
It doesn't like the snow.
Or always carry your tire chains,
flashlight and pancho.
Unless you like driving sideways,
wherever you try to go?

And I know that sliding door opens wide,
and those seats they do come out.
And you can just fit a pair of calves inside,
from the tail to the snout.
But if desecrate the family car,
your wife she is going to shout.
And you better not drive in the car pool,
till all that poop dries out.

And when you take those rear seats out,
there's plenty of room in back.
For your tool box, pesticide cans,
and your handyman jack.
But you better pray the Lord is with you,
if you ever get in a wreck.
Because that load you've been acarryin,
you'll be wearing around your neck.
So you better hire a good lawyer,
Write a brand new will.
Because if you tools don't getcha.
That 2,4-D will!.

Ah tell ya, ITS THE CAR!
YOU CAN'T FARM WITH AN AEROSTAR!!

CALIFORNIA NOXIOUS WEED CONTROL PROJECT INVENTORY

Steve E. Schoenig
Integrated Pest Control Branch
California Department of Food & Agriculture

In 1995 through 1997 a Memorandum of Understanding was signed by sixteen State and federal agencies to create the California Interagency Noxious Weed Coordinating Committee(CINWCC). The CINWCC also includes many stakeholder groups such as the Cattelmens Association, CalEPPC, California Native Plant Society, Nature Conservancy and the Nuserymen's Association. The CINWCC holds quarterly meetings, and has formed six subcommittees: 1) Weed Project Database; 2) Education; 3) Research & Monitoring; 4) Funding & Grants; 5) Regulatory Streamlining; and 6) Regional Working Groups.

The CINWCC Weed Project Database Subcommittee has designed the California Noxious Weed Control Project Inventory (CNWCPI). The Committee is led by California Department of Food & Agriculture staff, and has been additionally funded by the California office of the United States Bureau of Land Management. The project inventory is an Internet-based searchable database. The technical coding of the database and its housing is contracted to the Information Center for the Environment at the University of California at Davis. Information about a noxious weed control projects is entered into the database by having a person affiliated with the project fill out a three page dataform and submit the form. Once in the database, projects can be viewed with an Internet browser. One can search the project database for projects selected on many criteria such as; county, weed species, treatment, agency, etc. The database will also contain an on-line encyclopedia of noxious weed biologies and control methods, as well as links to other weed control related Internet sites. The Internet address of the database is http://endeavor.des.ucdavis.edu/weeds/.

CALIFORNIA WEED SCIENCE SOCIETY
FINANCIAL STATEMENT
NOVEMBER 1, 1996 THROUGH OCTOBER 31, 1997

CAPITAL

1996 Balance Fwd	$171,825.43
Current Income	17,773.04
	$189,598.47

DISTRIBUTION OF CAPITAL

Merrill Lynch Reserve	$114,874.00
Merrill Lynch Operating Account	26,246.81
Merrill Lynch Scholarship Fund	20,452.00
Merrill Lynch Education Fund	10,412.00
Checking Account	17,613.66
	$189,598.47

INCOME

Conference Income	$ 49,809.00
Proceedings	4,133.92
Poster/Exhibit Session	4,000.00
Textbook 2	4,842.31
Interest (accrued 1995-date)	3,014.67
	$115,799.90

EXPENSES

Office Supplies	1,153.80
Telephone	553.65
Postage	1,690.08
Storage	273.00
Secretary of State & Franchise Tax Board	20.00
Tax Accountant	325.00
Business Manager	11,800.00
Newsletters, logo on name badges, etc.	1,426.57
Programs	334.03
Proceedings	2,510.00
Textbook Rev 3	2,706.28
California Weed ID Book	30,000.00
Merrill Lynch Annual Dues	295.04
Stan Strew Education Fund	2,500.00
CAST Membership Dues	100.00
50th Anniversary Conference Promotion	16,485.75
1997 Conference	
Award Plaques	96.88
Refunds-Registration Fees	515.00
Student Scholarships	500.00
Student Poster Awards	1,000.00
Student Travel Expense & Breakfast	1,381.44
Computer/Printer Rental	411.35
Guest Speakers	1,213.98
Executive & Steering Committee Expenses	2,905.24
Urban Session-Advertising	297.50
Business Meeting-Luncheon	11,713.23
Audio Visual	1,799.10
All Conference Social Session	4,019.94
	$ 98,026.86

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