# California Weed Science

## Information on Weeds and Weed Control from the California Weed Science Society

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**Vision:** The CWSS will be the premier authoritative source of information on weed biology and weed management in California and will serve as a forum for all individuals interested in these disciplines.

**Mission**: the California Weed Science Society provides information exchange on weed science and technology through an annual conference, publications, and other activities; advises stakeholders on matters pertaining to weeds; facilitates cooperation among individuals, agencies, and organizations; encourages careers in weed science; and promotes professional growth and interaction for its members in California.

## Welcome from the Board of Directors



Welcome to the inaugural issue of **California Weed Science**, the new, more informative newsletter from the California Weed Science Society (CWSS). At the annual business meeting in January 2004, the members of CWSS adopted a revised Constitution and By-Laws. This change was part of the strategic plan to re-organize and re-vitalize our society to better serve the members and to carry out the mission of CWSS. One of the newly created Director positions is assigned as Chair of the Non-conference Education Committee. This committee is charged, on behalf of CWSS, with being the educational source on weeds and weed science outside of the conference to people throughout California.

California Weed Science will be published 3 to 4 times per year and will have educational sections and materials on a wide range of weed science subjects and issues, in addition to having information relevant to the members of CWSS. There will be regular sections on publications of interest, new technologies, and employment opportunities, along with feature articles on an important aspect of weeds or weed control. Feature articles will typically be taken from the Proceedings of previous

conferences. In this issue are articles by two of our distinguished retired members; a comprehensive guide to diagnosing herbicide injury by Clyde Elmore and a timely review of mechanical weed control (considering the new changes to hand-weeding rules) by Harold Kempen. The following section is Research Reviews, which provide a summary and review of scientific papers relevant to weed control in California that were published in peer-reviewed journals. Dr. Milt McGiffen and Dr. Anil Shrestha are in charge of providing these reviews.

We are also soliciting paid advertisements of products and services relevant to members; please contact Bruce Kidd or Judy Letterman for information on purchasing advertising space. This publication will be available printed or electronically. Membership in CWSS will include a subscription; it will also be available to non-members for an appropriate subscription fee. The Non-conference Education Committee chair is Carl Bell; other members of the committee include Milt McGiffen, Jr., Anil Shrestha, and Bruce Kidd.

# Feature Articles

## Diagnosing Herbicide Induced-Injury[1]

*Clyde L. Elmore, Extension Weed Specialist*
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Diagnosing a tree or vine problem can be fun and/or frustrating. It is difficult to see all situations or be familiar with them and know all possible combinations of things that can happen, thus trying to formulate a plan to obtain all the information available to solve a problem is difficult but rewarding. It can also help the grower, so the problem will not happen again and reduce the need for costly and unpleasant court proceedings. I would like to propose a thinking process to get to the right solution, rather than show all the possibilities.

If there is a need to confirm a diagnosis, especially in court action cases, it is required that there be a chemical analysis of the cause, whether it is herbicide, other pesticide, nutrient excess or deficiency or combinations of these. Laboratory analyses are expensive however, and it is necessary to be close to the right answer, or know the answer, then confirm with the analysis. An additional section could be prepared on what and where sampling is to be taken to show the results necessary. Suffice it to say that if the sample isn't taken and processed (stored, transported and submitted) properly, the results are worthless. It is critical to know if leaves, shoots or roots are needed and where, when and how much sample is to be taken. After the sample results are obtained, one needs to be certain that the quantity found would be able to "cause" the symptom.

It should be remembered that not all symptoms found on plants are caused by herbicides. There are many other causes of disruptions in plant functions that will cause

[1] Proceedings of the California Weed Science Society. 1999, (Volume 51) pages 56-59.

symptoms, some of which may look like herbicides because the same plant functions (photosynthesis, respiration, amino acid synthesis, etc.) will be affected.

What are some of the necessary prerequisites for solving a problem?

- Keep an open mind!
- Ask questions!
- Use tools (shovel, magnifying glass, auger)
- Observe patterns!
- Look at all the plants present!
- Know the "normal" plant!
- Know how different herbicides work in plants!

It is necessary to gather as much information as possible. If one doesn't have all the information, it is easy to make the wrong diagnosis. Often it is desirable to "eliminate possibilities" as it is to go to the right answer. In fact, it is part of the method of reaching the correct answer. Some of the information needed is, conditions before the symptoms developed [temperature, wind (speed and direction), rainfall or irrigation]. The same information is needed at the time of any application of pesticide. The same is true for the time right after the application of a pesticide. One needs to know the location of the problem and characteristics of the site including the soil type (sand, silt, clay) organic matter and pH. It is also helpful to know the conditions of the planting as to whether it is a vigorous orchard or is it currently under stress from some factor (nutrients, water, frost).

At the location there are certain factors that one can look for.

These include:

- Obvious symptoms,
- Patterns (edge, roads, drainage, even distribution by row or by varieties)
- Outside influences or associations with other surroundings such as other fields nearby, railroads, roads, ditches)

Often there are patterns of symptoms in an orchard or vineyard. If there is a single source, this will become apparent as you move from one side of the orchard to the other. If the symptoms are uniform over the total area, then it is likely that a misapplication was made or a pattern from a weather front or inversion occurred.

When looking for patterns there are several possibilities. These include:

- Is it a single plant? Or sporadic plants?
- Is it over the whole orchard? Or single rows, or an edge?
- Is it on a single species or variety?
- Does it occur on a single part or side of the plant?
- Is it associated with a single species of weed?
- Is it related to topography?

Within the site are the symptoms associated with a certain part of the plant such as leaves, or stems (shoots or canes)? If it is found on the leaves, do the symptoms show as?

- Marginal chlorosis?
- Spotted chlorosis?
- Veinal or interveinal chlorosis?
- Overall leaf yellowing?
- Marginal necrosis (burning)?
- Spotting necrosis?
- Whole leaf necrosis?
- Petiole or new leaves twisting?
- Stunting-without color change (if anything, they may be greener)

Though it would not be common, symptoms could show on the limbs or canes without showing much effect on the leaves. It is also feasible that you were not able to see the foliar symptom when leaves were on the vine. In limbs or canes do the symptoms appear as?

- Tip dieback?
- Limb dieback?
- Flagging of the stem (a dead area on one side of the stem that causes the stem to turn at an angle)?
- Stems swelling at the nodes?
- Stem cracking?
- Advantageous growth?

Then finally, where are the symptoms in the tree or vine?

- Tops of the canopy?
- A side of the tree (which side?).
- New growth/new leaves
- Old growth/old leaves
- Roots (newly planted trees and vines)

All of these factors can be placed on a form that can be carried into the orchard at the time of evaluation. It can even be used as a check-off list, or to help remember all the components to find the required information. This is not planned to be a complete list and other information should be added as needed.

Often diagnosing a problem is not a simple, straight-forward practice. There should be a logical method of determining an answer but there are always quirks. Some of these would include:

- Species of plants react differently to an herbicide.

- Environmental differences cause response differences.
- Plant growth stages will give different symptoms.
- Plant stress alters plant response.
- Combinations of herbicides may give different symptoms, or some of both materials but doesn't look like either alone.

On perennial crops the symptom on the crop often will be different depending when the contact of the herbicide occurs and the how the herbicide works. Symptoms of contact herbicides will look different on new leaves compared to old leaves. They can even look differently if the leaves are dry when the contact is made compared to wet leaves or if a rain or irrigation occurs shortly after the contact. Translocated herbicides will also show a different symptom if the contact is on new leaves or buds compared to old leaves or woody bark contact. Herbicide symptoms from different herbicides will take a different amount of time from contact to symptom at different times of the year. This difference can be either altered by temperature (high temperature equals faster) and how fast the plant is growing. If the plant is stressed at the time of contact the symptom will be slower in appearing. It may make the symptom more severe if the material is a contact herbicide, but if the herbicide is translocated it often will be less severe.

As an example we could use glyphosate as the herbicide and determine what symptom might occur at different times of application and when and what symptom might occur.

If the application was in the late summer or fall, there might not be any symptom observed until next spring as the plant starts budding. New foliage would show symptoms of feathering (decreased internode length and many new buds pushing). If rates were high in the summer, there could be killing (necrosis) of the mesophyll cells of the leaf giving an appearance of parts of the leaf dying. If the plant were continuing to grow, then new leaves would be affected after the application. If the application was applied in the spring on new growth of the plant, then the new leaves could be chlorotic early with necrotic leaves and stems later. If the rates increase then the stems could be killed with new emerging growth that was not contacted appearing almost normal, or the new growth would eventually be normal, with no lasting effect. The amount of leaf or stem damage would be proportional to the rate.

Another method of analysis could soon be worthwhile as a positive test for an herbicide. This method is with an immunoassay. Currently, several herbicides including 2,4-D, atrazine, simazine, alachlor, metolachlor, triclopyr, imazapyr, chlorsulfuron, metribuzin, metsulfuron-methyl, molinate and paraquat can be found at different levels in water using this method. Though they may not work with tissue currently, it may be feasible to make them work in this manner.

In summary, there are several major factors to keep in mind when working on a diagnosis. First, keep an open mind. Don't overlook the obvious. Consult or seek advice from others but don't let someone lead you to a decision which you are not comfortable that it is right answer.

# WEED CONTROL IN CALIFORNIA CROPS[2]

**Harold M. Kempen, Farm Advisor**
**Kern County**

## Mechanical Techniques for Control of Weeds

As chemical herbicides have come on the farming scene, less attention has been directed toward older, proven mechanical weed control techniques. In fact, the skills required to properly set up implements as well as the management experiences required to sequence farming operations in a manner that will bring successful weed control are diminishing. One has only to remember that herbicide usage before 1960 was hardly existent; yet, farmers generally succeeded in growing crops without too much loss.

Because mechanical weeding techniques are usually less expensive than herbicide systems, a successful weed manager must know the capabilities and limits of mechanical techniques so that optimum (least cost) integration of both techniques can be made. He must also recognize that every program has its shortcomings. Curing one can induce another.

For optimum success with mechanical techniques on irrigated cropland, land preparation is a must. Land leveling will later allow precision tillage and cultivation because irrigation will be more uniform, crops will grow off uniformly and because equipment will guide appropriately. It is easy to cultivate row crops, orchards or vineyards with wide spacings to allow for driver error or poor equipment setups, but the objective is to allow very close tillage. Then hand weeding costs, if needed, can be reduced. For example, a 4" band of weeds might cost $75.00 per acre to be hand weeded, but a 2" band could reduce that cost to $50.00 per acre, a substantial savings.

Mechanical techniques kill weeds by burial or uprooting. In row crops and grapes soil can be thrown over small weeds emerging after an irrigation, burying them. Obviously, the row crop must be taller than the weeds to permit "killing." Uprooting is accomplished by many tools which slice, cut or turn the soil in which the root system grows. The roots and shoots will desiccate before weed re-establishment. In wet periods, winter annual grasses may re-root. Certain succulents such as purslane, and rhizomes of perennial weeds such as johnsongrass and bermudagrass, can regrow also if soil is slightly moist.

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[2] Proceedings, California Weed Conference. 1983, volume 35, pages 76-77.

Mechanical tillage or mowing is often done for the earlier periods until crop competition is adequate to shade out later emerging weeds. Knowledge of proper timing of tillage or mowing is critical to success in controlling the weeds, not to mention the impact on soil structure or compaction.

General tillage equipment used for controlling weeds, as well as for soil preparation and herbicide incorporation, include the disk harrow, springtooth harrow, powered rotary tillers and ground driven rotary harrows.

Row crop cultivations are accomplished with sled-mounted cultivators, rolling cultivators, springtooth cultivators and wheel cultivators carrying varied tillage tools. These tools carry names such as plant hoe, V-sweep, cultivator knife, bed knife, irrigation shovels, vegetable knives, Alabama sweeps, duck-foot and furrowers.

Special cultivator tools often enhance control of weeds in the drill row. The Bezzerides spring hoe weeder is an example. The Buddingh weeder and the Texas rod weeders have been used for row crops for more than three decades.

Mowing is a weeding technique widely used in orchards for keeping weeds under control. It can reduce frost in the winter and keep orchards cooler in the summer; however, more water and nitrogen (about 30% more) are needed.

## Hand Weeding

Hand weeding is usually the last choice of mechanical techniques available. Cost is the primary reason, but the drudgery of it is reason for avoiding it when necessary. Hoeing is logical for removing occasional but potentially very competitive weeds.

## Noncrop Areas

Noncrop areas permit mechanical control. As a rule of thumb, areas of an acre or more usually can be more efficiently tilled or mowed than chemically treated. Obstacles and uneven terrain detract from the potential of using mechanical techniques.

Open areas are very difficult to keep free of vegetation if soil moisture is present. Tillage or mowing after all winter rain moisture is extracted will reduce need for subsequent control.

# Research Reviews

Weed control in carrots: the efficacy and economic value of linuron. HortScience 35(6):1089-1091. 2000. C.E. Bell, B.E. Boutwell, E.J. Ogbuchiekwe, and M.E. McGiffen, Jr. and

Efficacy and economic value of weed control for drip and sprinkler irrigated celery. HortScience 36(7):1278-1282. 2001. E.J. Ogbuchiekwe, and M.E. McGiffen.

These two papers are reviewed together because they have similar objectives and results. Both experiments collected data on weed control efficacy, weed control costs, and yield. These data were used to compare gross and net return on investment between treatments. The celery experiment compared hand-hoeing to five registered herbicide treatments (prometryn, linuron, trifluralin, sethoxydim, and glyphosate) and an untreated (non-weeded) control. All treatments in the celery experiment were repeated in side-by-side sites using sprinkler irrigation and drip irrigation. In the case of the carrot study, linuron was the only herbicide tested because one objective of the experiment was to provide data to the U.S. Environmental Protection Agency on the continued value of this herbicide for carrot production nationally. Linuron was used at three different timings/rate combinations in comparison to hand weeding (because of the density of the crop, hoes cannot be used, weeds have to be removed by hand) and to a non-weeded control. The conclusions drawn from these experiments are as follows:

1. Weed control produces higher yield than no weed control. In the carrot experiment, the untreated control lost about $1100 per acre averaged over the two years of the study. The lowest net return for any of the treatments (herbicide or hand-weeding) was about $300 per acre and the highest net was over $2600 per acre. Weed competition in the celery trial was so bad that no marketable crop was harvested in the two years of the experiment from the untreated control plots, so all of the production costs were lost..
2. Herbicide treatments generally provided a greater net return than hand hoeing or hand weeding. In the carrot study, the increase in net return of the linuron treatments ranged from $96 to over $1300 per acre more than the hand weeding. One of the herbicides, prometryn, used in the celery experiment consistently produced a higher net return than the hand hoeing treatment. Results with the other herbicides were more varied but were often better than the hand hoeing.
3. In the celery experiment, but not in the carrot trial, hand hoeing was used to remove weeds that were not controlled by the herbicide. The two most effective herbicides, prometryn and linuron, required about one tenth the amount of time to weed as the hand hoed plots.
4. In no case did an herbicide treatment alone control all of the weeds present in the experimental plots. Hand hoeing or hand weeding in densely planted crops like carrots will apparently always be required for weed-free crops and maximum yield.

Genetic and morphological analysis of two novel nutsedge biotypes from California. Weed Science 51:731-739. 2003. R.I. Tayyar, J.H.T. Nguyen, and J.S. Holt.

Two new perennial nutsedge biotypes were collected by Harold Kempen UC Cooperative Extension Farm Advisor Emeritus in agricultural fields in Kern County and identified using isozyme and RAPD genetic markers, along with morphological traits such as number of bracts, spikelets, and length of anthers. The two biotypes were designated as *Cyperus rotundus* cv. 'Kempeni' (due to its resemblance to purple nutsedge) and *Cyperus esculentus* cv. 'Robusta' (which resembled yellow nutsedge). Both biotypes grew more vigorously than is typical of either nutsedge species. Populations of *Cyperus esculentus* cv. 'Robusta' were genetically and morphologically within the normal range of yellow nutsedge, and *Cyperus esculentus* cv. 'Robusta' may be a biotype of yellow nutsedge introduced from another location. *Cyperus rotundus* cv. 'Kempeni' was distinctly different from both yellow and purple nutsedge. Because purple nutsedge (*Cyperus rotundus*) reproduces through tubers, each new plant is similar to the previous generation, and there is little genetic variation. Thus, *Cyperus rotundus* cv. 'Kempeni' might be a sexually reproducing ecotype of purple nutsedge or a hybrid of purple and yellow nutsedge. This research illustrates the need to be observant and not to assume that we know all there is to know about common weed species in California.

## Opportunities

University of California, Riverside,
Department of Botany and Plant Sciences

Assistant Professor in Physiological Ecosystem Ecology

The Department of Botany and Plant Sciences invites applications for an assistant-level physiological ecosystem ecologist. Individuals should work at the forefront of plant ecology to bridge the areas of physiological and ecosystem ecology. Research topics may include functional responses of plants and ecosystems to changing CO2, air pollution, nutrient levels, climate change, invasive species, or other aspects of environmental change in wildland or agricultural ecosystems. The successful candidate will join an active faculty within both the B&PS Department and the College of Natural and Agricultural Sciences with interests ranging from population and physiological genetics to landscape ecology, theoretical ecology, and environmental sciences. Applicants will be favored who will have the ability to join or initiate interdisciplinary research efforts across campus, such as in the Environmental Research Institute and the Center for Conservation Biology. The candidate will be expected to participate in undergraduate and graduate teaching. The position includes an appointment in the Agricultural Experiment Station.

The position will be available July 1, 2005. Applicants must hold a Ph.D. in ecological or environmental sciences or related fields and at least three years post-graduate research experience is essential. Salary will be commensurate with education and experience. Evaluation of applications will begin January 10, 2005 and continue until the position is filled. Interested individuals should submit (1) a curriculum vitae, (2) a statement of research interests, and (3) three letters of reference to: Dr. Jodie S. Holt, Department of Botany and Plant Sciences, University of California, Riverside, CA 92521-0124.

For additional information on the Department and the campus visit http://www.plantbiology.ucr.edu.