ECOLOGICAL WEED CONTROL IN COOL SEASON SPORTS TURF

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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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