California Weed Science Society

Journal

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

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IN THIS ISSUE

Introduction

Richard Smith, Editor

The California Weed Science Society meeting in Monterey in January of this year offered many great sessions on many aspects of weed control. One session that caught my attention was the aquatic weed control session. This is a particularly difficult area for weed control with issues that range from irrigation district with miles of canals to small ponds used for recreation or irrigation that may be less than an acre in size. Regardless of the situation, aquatic weeds are very difficult to control. In addition, other issues must be taken into consideration such as the presence and type of fish, as well as subsequent uses of the water. In this issue of the CWSS Journal we decided to focus on aquatic weed control and have included three articles from the speakers at the session in January. In addition, we have articles on roadside and vegetable weed control.

The CWSS Journal is now all electronic. If you know someone that wants to be on the email list to receive the Journal as well as other communications from CWSS, please contact Celeste Elliott at the CWSS managers office: manager@cwss.org.

Be sure to mark your calendars for the CWSS annual meeting in Santa Barbara on January 23-25, 2012.

Weeds of One-Two Acre Vineyard Irrigation Pond

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Sufficient clean water is, and will continue to be, a concern for California agriculture, even with abundant rain years like this one. I work in California's North Coast Vineyards (Napa, Sonoma, Lake and Mendocino Counties) where vines are irrigated exclusively (if at all) by drip irrigation. Many of these same vineyards use overhead sprinklers for frost protection in the early spring when the young shoot tips are most vulnerable. In response to this need for a clean, consistent source of water many vineyards have developed irrigation/frost protection ponds. Many of these ponds have developed algae and weed problems that can clog drip emitters and sprinkler heads. In other cases the ponds have been incorporated in to the 'vineyard experience' that has become important to the tourism of this and other regions throughout the state. An unattractive or bad smelling pond will not provide the desired experience.

I have received several inquires from growers about controlling weeds and algae in their ponds. After making some inquires on my own I found that there were only a handful of people who were working with the growers on this problem, and many of the growers didn't know where, or with whom to start. The needs of these 1 or 2 acre irrigation/frost protection ponds are different than seasonal irrigation ditches, or golf course ponds, or large bodies of

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water. Control methods vary from dredging to mowing to chemical treatments that can cost as much as $1000 per acre for the chemical alone.

What are the algae and weeds that cause the most problems for the growers in this part of California? Below is a description of this years (because it will no doubt change) worst weeds and algae in North Coast ponds.

Filamentous Algae: Filamentous Algae forms dense mats in the pond (Figure 1). These mats are either free-floating or are attached to the side of the pond. We usually think of filamentous algae as just one species but in California is most commonly made up of three: Spirogyra that is bright green and slimy to the touch; Cladophora that has the texture of a cotton mat; and Rhizoclonium that entangles itself with other algae is often referred to as 'hair algae.'

Blue-green algae or *cyanobacteria*: The murky green color in a pond (Figure 2), or that 'bad pond smell' and the occasional fish kills and even more rarely livestock poisoning are usually caused by the microscopic blue-green algae *Anabena, Aphanizomenon, or Microcystis* (know affectionately as 'Annie, Fanny and Mike') or Nostoc.

The above problems are not really considered weeds and the study of Algae and related organisms is a science unto its own. Below are the aquatic plants that make up the majority of the pond weed problems in descending order in the North Coast (as determined by grower calls and observation.)

1. ***Azolla*, or Mosquitofern**(<u>*Azolla filiuloides*</u> Lam.). Easily the aquatic weed for which I receive the most calls. Azolla appears to cover an entire pond overnight during the cool season (Figure 3). It doesn't really grow that fast but can cover the pond in a relatively short time. *Azolla* will turn a red color because of the cynobacteria (<u>*Anabaena azollae*</u>) that colonizes the upper lobes of *Azolla* in this symbiotic relationship. Azolla provides a home for the cynobacteria, that in turn provides nitrogen for its host. *Azolla* is a desirable native that provides food for waterfowl, but can become a problem when conditions are right, such as high phosphorous concentration. The Azolla population can explode and exclude other plants, clog pumps and interfere with livestock drinking. Azolla can be skimmed off the pond, composted and used in gardens.
2. **Duckweed** (<u>Lemna minor</u>*)*. Most of the calls I get for duckweed are actually Azolla. But if a pond has *Azolla* it will probably have duckweed when the weather warms up and the Azolla population shrinks. Duckweed is similar in many ways to the *Azolla*, except that it does not have a symbiotic relationship with a cynobacteria, thus does not produce its own nitrogen (Figure 4).
3. **Creeping Waterprimrose** (<u>*Ludwigia spp*</u>.). This weed grows along the side of the pond and can break off and form large floating mats (Figure 5). If part of these mats land on another side of the pond that has available soil they can root (at the nodes of each stem) and reconnect, and then break off again and float to another side**-** the weed can eventually cover most of the pond. There appear to be 2 or 3 species of creeping water primrose with varying degrees of aggressiveness that are appearing in North Coast ponds.
4. **Eurasian Watermilfoil** (<u>*Myrioqhyllum spicatum*</u> L.). Eurasian Watermilfoil is a noxious perennial with rhizomes (Figure 6). It forms large mats that can impede the movement of water and interfere with pumps and irrigation. Eurasian Watermilfoil can live in water up to eight meters deep if fairly clear. Unlike most of the other weeds of more tropic regions it survives, and thrives, well in colder climates. Reproduction is mainly by auxiliary buds. Many seeds can be produced but seedlings are rarely found. These seeds can last up to seven years under dry conditions and can be dispersed great distances by waterfowl.
5. A close relative of Eurasian Watermilfoil is **Parrotfeather** (Myriophyllum aquaticum). Parrotfeather is found in the North Coast, but is not nearly as widespread, or nearly the problem that Eurasian Watermilfoil is. Parrotfeather is easier to see because much of the foliage of the plant will grow above the waterline and may even attach to the bank.
6. **Pondweeds.** There are several native pondweeds that can be found in North Coast irrigation ponds. The two that I have seen the most in ponds here are American Pondweed(potamogeton nodosus) (Figure 7) and Sago Pondweed(Stuckenia pectinatus) (Figure 8). These pondweeds look completely different. American pondweed looks like a bunch of tree leaves were thrown onto the pond and can cause physical interference with water movement or habitat for mosquitoes, while Sago pondweed looks much like grass, or fishing line. Both of these perennial pondweeds have rhizomes but Sago pondweed produces tubers that can survive 3-5 months in a drawn-down reservoir.
7. **Brazilian Egeria (**<u>*Egeria densa*</u> Planch.). Three monocot weeds in the Hydrocharitaceae (Waterweed) Family are often discussed at the same time. Of these three, Hydrilla (Hydrilla Verticillata), Common Elodea (Elodea Canadensis) and Brazilian Egeria, the only one commonly found in my area is Brazilian Egeria (Figure 9). While it does not strike fear when it is found like its relative Hydrilla, it can be a serious weed that can infest an irrigation pond and make water movement difficult. From the shore it looks much like Hydrilla, but has a relative large white flower that distinguishes it from Hydrilla. Egeria can still be found in Aquarium stores.
8. **`Common Cattail** (<u>*Typha latifolia*</u> L.). I commonly say to my growers 'Everybody wants 3 feet of cattail,

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nobody wants 12 feet' (Figure 10). A small infestation of cattail around the entire pond is usually desired by the manager, or more often the owner of the vineyard. This small, attractive growth of cattails provides food and protection for a number of wildlife. It is when the rhizomes of this perennial plant start to push well into shallow ponds that the problem starts. In deep ponds with steep sides will rarely have this problem.

These are just a few of the many plants that can be found in and around irrigation ponds. I purposely did not discuss in detail Hydrilla, Water Hyacinth, Giant Salvinia, or Sponge plant, which are, or have the potential to become problems in large bodies of water or the California Delta, to concentrate on weeds in 1-2 acre irrigation ponds in California's North Coast Vineyard Region.

I want to thank Dr's Lars Anderson, David Spenser, Doreen Gee and Brenda Grewell of the USDA Aquatic and Invasive Plant Unit at UC Davis for all their help in my understanding of aquatic weeds. I also want to thank Dr. Joe DiTomaso of the UC Davis Department of Plant Sciences for helping me in his own way to get interested in aquatic weed control.

Figure 1. Filamentous Algae
J. Roncoroni

Figure 2. Bluegreen algae bloom
D. Spencer

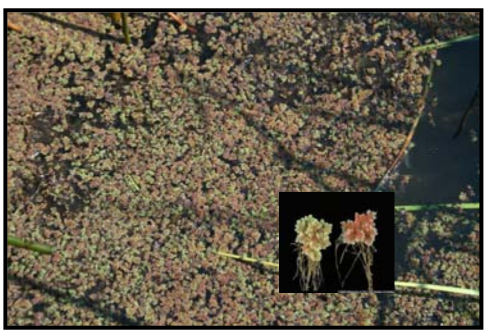

Figure 3. *Azolla*, or Mosquitofern(*Azolla filiuloides* Lam.)
J.M. DiTomaso and J.K. Clark

Figure 4. Duckweed (Lemna minor)
J.M. DiTomaso and J.K. Clark

Figure 5. Creeping Waterprimrose (*Ludwigia spp*.)
J.M. DiTomaso

Figure 6. Eurasian Watermilfoil (*Myrioqhyllum spicatum* L.)
J.M. DiTomaso

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Figure 7. American Pondweed (potamogeton nodosus)

Figure 8. Sago Pondweed(Stuckenia pectinatus) J.M. DiTomaso and J.K. Clark

Figure 9. Brazilian Egeria (*Egeia densa* Planch.) J.M. DiTomaso

Figure 10. Common Cattail (*Typha latifolia* L.) J.M. DiTomaso

Reference:
Aquatic and Riparian Weeds of the West. DiTomaso, J. M and E. A. Healy. 2003. University of California Agriculture and Natural Resources Publication 3421. (Publication of this book was sponsored by the California Weed Science Society)

Characteristics and Modes of Action of Aquatic Herbicides

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Herbicides are an effective part of integrated plant management programs. The United States Department of Environmental Protection, Office of Pesticide Programs has approved registration of approximately 300 herbicides for use sites such as agriculture, rights of way and aquatics. Today, there are 10 herbicide active ingredients currently approved for aquatic use in California.
Of the 10 active ingredients below, many have multiple labels for terrestrial uses as well as aquatic applications.

1. Acrolein
2. Copper
3. 2,4-D
4. Diquat Dibromide
5. Endothall
6. Fluridone
7. Glyphosate
8. Imazapyr
9. Na_2CO_3 Peroxyhydrate
10. Triclopyr

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Unique data is required in registering an aquatic herbicide. The amount of residue in such things as potable water, fish and irrigated crops must be determined. Metabolism studies in both aerobic and anaerobic sites must be established. How quickly does the product dissipate from water and aquatic sediments? Establishment of fish and shellfish tolerances as well as accumulation studies in non-target aquatic organisms are just some of the additional work required.

Utilization of herbicides for the control of nuisance and invasive plants in and around water can be challenging. Baseline knowledge of herbicide characteristics and mode of action is essential when evaluating the use of herbicides as part of any plant management program.

Best Management Practices is necessary to reduce development of plant resistance. Herbicide rotation or combination is recommended and implemented in many situations and should be done proactively.

This can be challenging in aquatics due too: Modes of Action in aquatics is significantly limited to site conditions, water use, herbicide selectivity properties, permits, etc. which can limit opportunity for product rotation.

Distribution of the products into the aquatic environment must also be considered. Aquatic applications are in a 3-dimensional environment. If possible, the site should have temperature stratification, currents, wind, depth, dilution – flow or edge effect and plant density determined. Choosing the proper formulation i.e.; liquid or granular, is important. If the application of aquatic herbicides dissipates too rapidly, poor results of submersed aquatic weed control will occur.

Whatever the intended use of a water body is, recreational, fishing, irrigation or simply aesthetics, aquatic weed control can be done safely and effectively. The correct product and timely application can return water bodies back to their intended use.

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The Ever Changing California National Pollutant Discharge Elimination System (NPDES) Aquatic Pesticide Permit: What Now?

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Aquatic weed specialists working for drinking water, flood control, irrigation interests manage algae and a variety of aquatic weeds including submersed, floating, emergent and riparian species. These weeds can create flow restrictions in irrigation canals and flood control structures and pose taste, odor and aesthetic problems in drinking water storage and conveyance facilities.

Use of chemicals to control these weeds in surfacewater in California is limited to the following: 2,4,D, triclopyr, glyphosate, imazapyr, sodium peroxyhydrate, endothal, diquat, copper, acrolein and non-ionic surfactants.

In 2002, California began regulating the use of aquatic pesticides in virtually all waters in the state with a National Pollutant Discharge Elimination System (NPDES) permit. The history of the permit can generally be summarized as follows:

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Year	Action	Permit Required?
1996	Talent Irrigation District Acrolein/Copper 90,000 juvenile steelhead dead	No
1998	Headwaters Suit; Alleged CWA Violation	No
2001	9th Circuit Court Decision Overturns Lower Court; CWA violation cited; NPDES Permit Required. Permit Required	Yes
2002	CA issues Emergency General Permit for Discharge of Aquatic Pesticides	Yes
2002	Forsgren Case: Permit Required	Yes
2004	New 5 year Permit Issued by CA	Yes
2005	Fairhurst Case: Permit NOT Required	No
2007	EPA states that Permit NOT Required	No
Jan 2009	6th Circuit Court: Permit Required	Yes
June 2009	6th Circuit Court: 2 Year "Stay" Granted = Permit NOT Required	No
Mar 2010	Supreme Court will not hear the case	Yes
Aug 2010	Congress introduces bill to overturn 6th Circuit Court	Maybe
Apr 2011	EPA issues final aquatic pesticide permit	Yes

Four conditions are required for an NPDES permit. Discharge (1) of a pollutant (2) from a point source (3) to waters of the US (4). Application, or discharge, of a pesticide from a boom or nozzle can be considered a point source and can not reasonably be done without excess or residual pesticide entering the water. This excess residue is considered a pollutant for purposes of NPDES compliance. For all practical purposes, waters where these applications occur are either waters of the US or are tributary to waters of the US.

The content of either the USEPA or the California permit is not well understood at this time. However, the following content for each permit is anticipated:

USEPA

- Restrictions on 303(d) listed water bodies
- Permit need may be "triggered" based on acreage/linear miles treated or amount used
- Applicators and dischargers need to file NOI

California

- vector control permit requires toxicity testing
- Group approach maybe reconsidered
- Past compliance data being considered

Past compliance data being considered by California regulators includes the following data gathered from 2002-2007 from irrigation and flood control districts located on Central and Northern California. This data maybe used to evaluate the necessity and frequency of sampling in the new permit.

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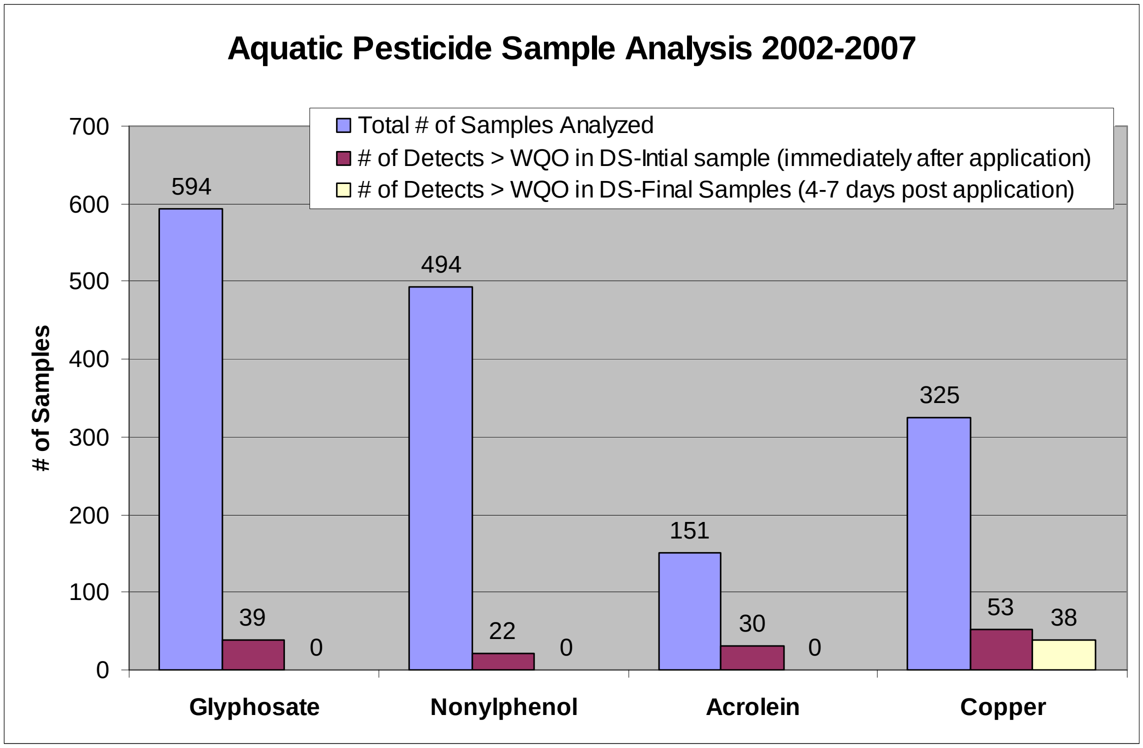

The current status of both the USEPA and California permits are in flux. Although expired, the existing California permit is still available for use and may provide permittees coverage against Clean Water Act citizen lawsuits. Accordingly, it is recommended that organizations in California that are applying pesticides to waters of the US maintain their existing permit or obtain one.

For more information and to track the progress of both permits, refer to the following:

- Red-Legged Frog Injunction
  http://www.cdpr.ca.gov/docs/endspec/rl_frog/index.htm
  http://www.epa.gov/espp/litstatus/redleg-frog/rlf.htm

- Salmonid Injunction
  http://www.epa.gov/espp/litstatus/wtc/maps.htm

- USEPA NPDES Aquatic Pesticide Permit
  http://cfpub.epa.gov/npdes/home.cfm?program_id=410

Additional important information related to the use of aquatic pesticides is associated with endangered species.

In October 2006, the USEPA agreed to a stipulated injunction to restrict the use of 66 pesticides near red legged designated habitat. Of these 66 pesticides, the following 4 are aquatic pesticides: 2,4-D, Glyphosate, Triclopyr, and Impazapyr. Approximately 40,000 acres in 33 California counties are potentially affected. Exceptions include public health vector control and invasive species and noxious weeds.

In 2009, the U.S. EPA was sued by the Center for Biological Diversity regarding the failure of EPA to properly consult with federal fish and wildlife agencies during the registration process for 74 pesticides regarding potential impacts to endangered species. The three aquatic pesticides in the group of 74 are 2,4-D, Acrolein and Diquat. The suit involves the following 11 species: Tiger salamander, Sna Joaquin Kit Fox, Alameda Whip Snake, San Francisco Garter Snake, Salt Marsh Harvest Mouse, Clapper Rail, Freshwater Shrimp, Bay Checkerspot Butterfly, Valley Elderberry Longhorn Beetle, Tidewater Goby and the Delta Smelt.

Alternatives Roadside Weed Control in Santa Cruz County

Steve Tjosvold and Richard Smith
University of California Cooperative Extension

The County of Santa Cruz maintains approximately 600 miles of public roads. Of those, approximately 340 miles are actively managed for weed control. The diverse and discontinuous vegetation in the country or mountains presents a challenge for the Count Public Works Department suffering from budget constraints and personnel shortages. The Department goals are to: (1) maintain sufficient sight distances for drivers, pedestrians, and cyclists, (2) Prevent vegetation encroachment that might infringe on the safe use of the roadway and (3) Reduce fire hazard. Traditionally management has consisted of an initial mowing where necessary to reduce biomass, followed by a carefully timed Roundup® (glyphosate) application to the vegetation regrowth. A correctly timed application of glyphosate often eliminated the need for additional vegetation control measures for the remainder of the year. Roundup®, however, has received considerable attention by groups and individuals questioning its safety in the environment. On May 17, 2005 the Santa Cruz County Board of Supervisors the Board of Supervisors established a moratorium on roadside spraying of herbicides on county maintained roadways. Mowing was left as the only viable option for roadside vegetation management. In a recent cost analysis by Public Works (October 2010), mowing was more than 275% the cost of a comparable glyphosate application. French broom (*Genista monspessulana*) is one of the most common and important invasive weed found growing on these roadways, as well as other areas of the central coastal area and other parts of California. It resprouts readily from the root crown and is a prodigious seed producer. In light of the budgetary constraints that the County faces, it is the intention of this research to evaluate the use of alternatives to Roundup®, especially those herbicides that are organic, biorational, or exhibit characteristics that could be used for vegetation management in a sustainable way.

The trial was established along Empire Grade Road near Bonny Doon, California. Plots were selected that had predominantly French broom, California blackberry (*Rubus ursinus*), perennial pea (*Lathyrus latifolius)*, and various other broadleaf and grass weeds. Each plot was 15 feet long by 5 feet wide (0.00172 acre). Treatments were applied on May 4, 2010. Applications were made with three passes of a wand with one 8005VS air induction nozzle applying the equivalent of 50 gallons of water per acre. Air temperatures peaked at 75º F on the day of application. Weed control evaluations were carried out 7, 14, 28, 56 and 112 days after application by rating the percent of weed control on the following scale: 0 = no weed control to 10 weed completely dead. Treatments (Table 1) were selected to contain organic, biorational, and other herbicides that had the "caution" safety category and therefore meet the County of Santa Cruz IPM pesticide use policy without specific exemption. The exception was WeedPharm (acetic acid) which is labeled with a "danger" category and Finale (glufosinate) which is labeled with a "warning" category. Roundup® was included as the former herbicide standard used by the County. Some treatments had contact activity and were effective by essentially desiccating weeds, while others had some systemic activity and therefore absorbed by weeds and resulted in weed control by other modes of action.

Table 1 Treatments in trial

Product Trade Name	Active Ingredient	Activity	lb a.i. / A	Product/A	Safety Information
Greenmatch EX	lemongrass oil	Contact	15% v/v	7.5 gals	organic "caution"
Weed Pharm	acetic acid (20%)	Contact	100% v/v	50 gals	"danger"
Matran	clove oil	Contact	15% v/v	7.5 gals	organic "caution"
Scythe	pelargonic acid	Contact	9%	4.5 gals	"caution"
Milestone VM Plus	aminopyralid triclopyr	Locally systemic	0.22 ae	9.0 qts	"caution"
Finale	glufosinate	Locally systemic	3%	1.5 gals	"warning"
Roundup	glyphosate	Systemic	2%	1.0 gal	"caution"
Untreated			---	---	

Surfactants: Nufilm P, 0.25% v/v added to Greenmatch, WeedPharm, and Matran. Dynamic added 0.25% v/v to Milestone VM Plus.

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Roundup was found to be very effective in controlling French broom and other weeds. Its use as the standard and effective product by the County was justified in this trial. Products that had locally systemic properties, Milestone and Finale were effective in killing some smaller French broom plants (basal diameters less than 9 mm) and inhibiting growth of larger plants. Organic and other contact herbicides do not kill French broom. French broom recovery occurred quickly and was demonstrated in almost all cases just 2 weeks after herbicide treatment. Of those that were contact herbicides Scythe and Matran desiccated foliage most effectively (Tables 2 to 5).

Table 2 Overall vegetation control

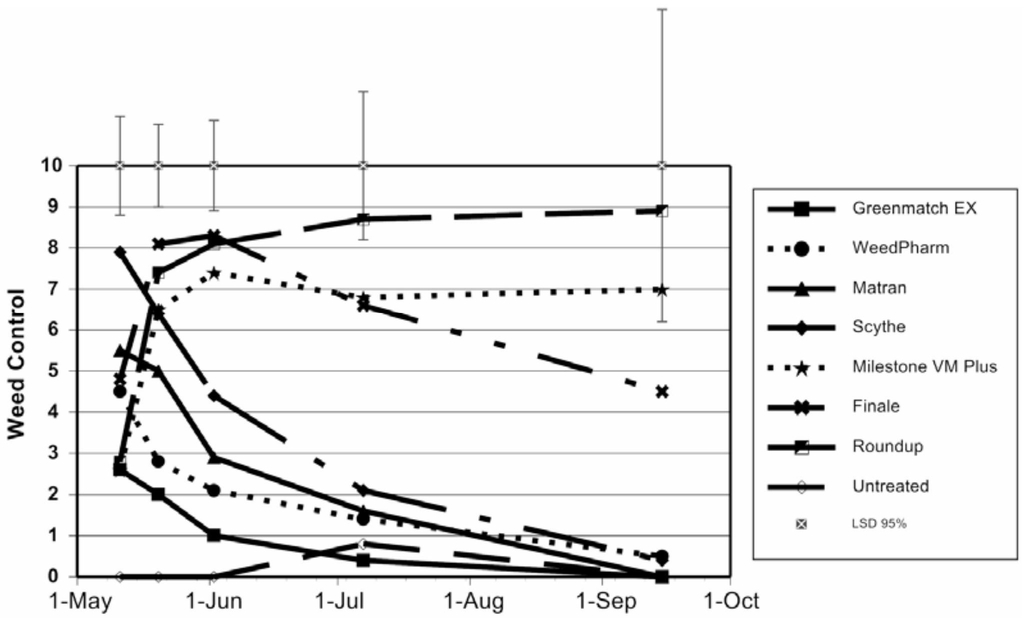

Table 3 French broom control

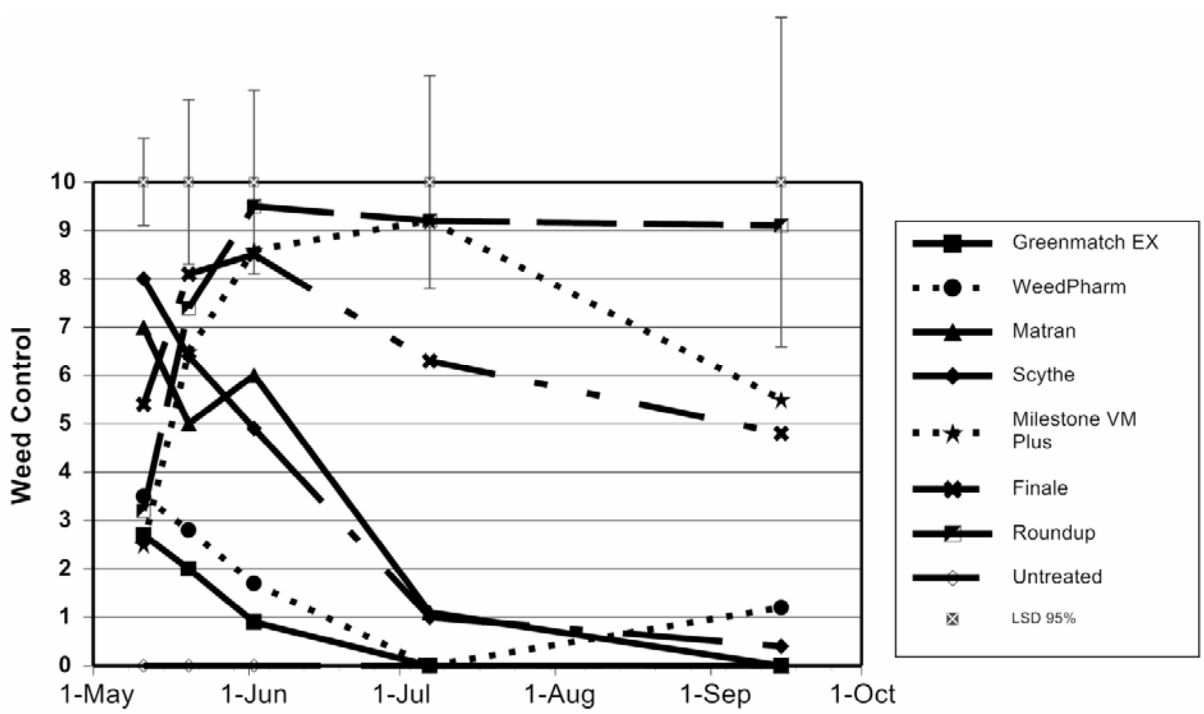

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Table 4 Blackberry control

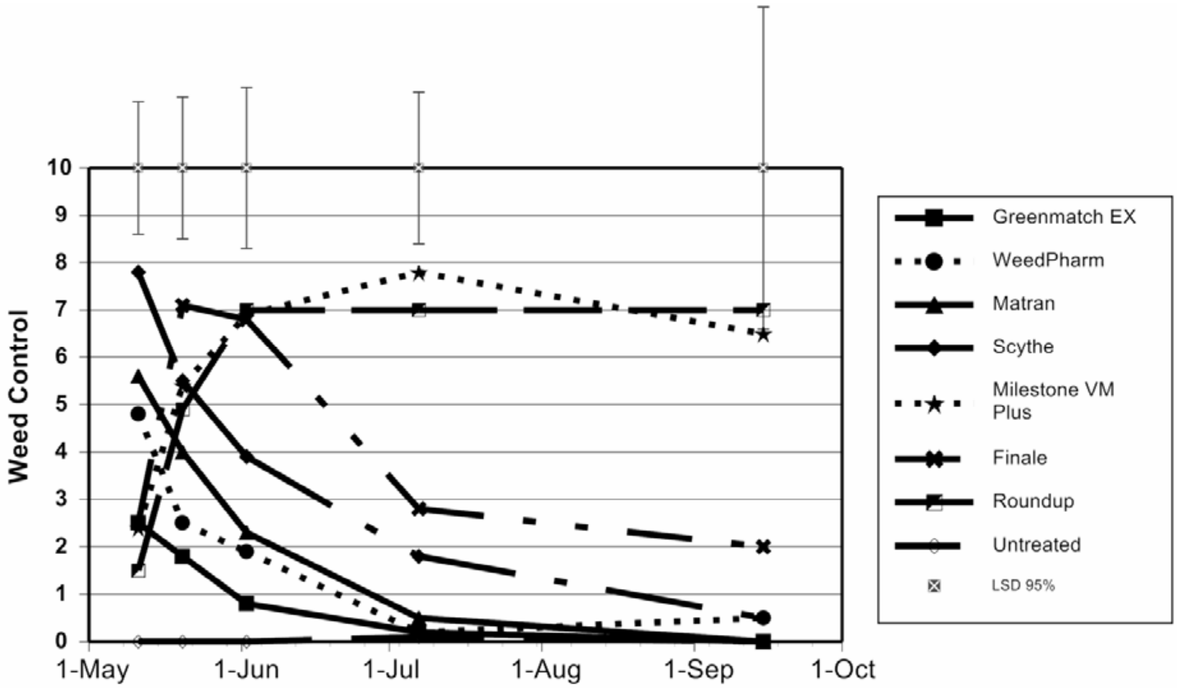

Table 5 Perennial pea control

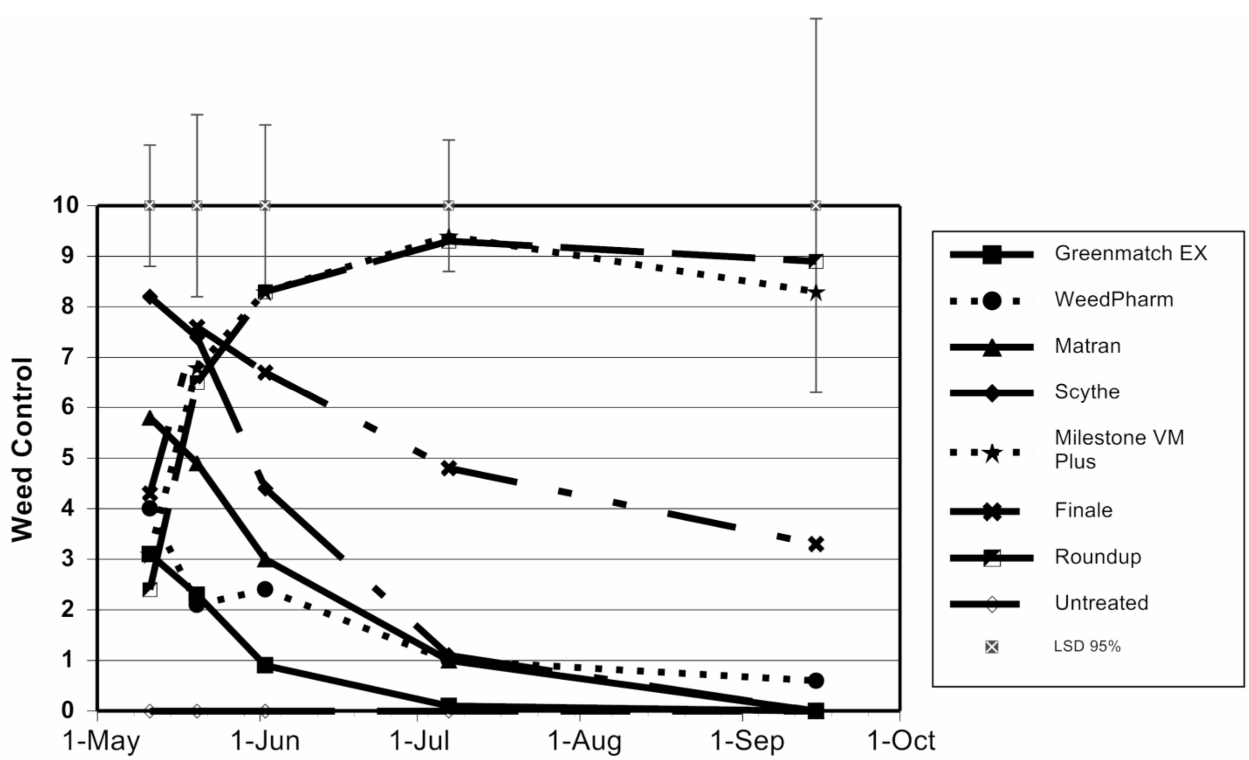

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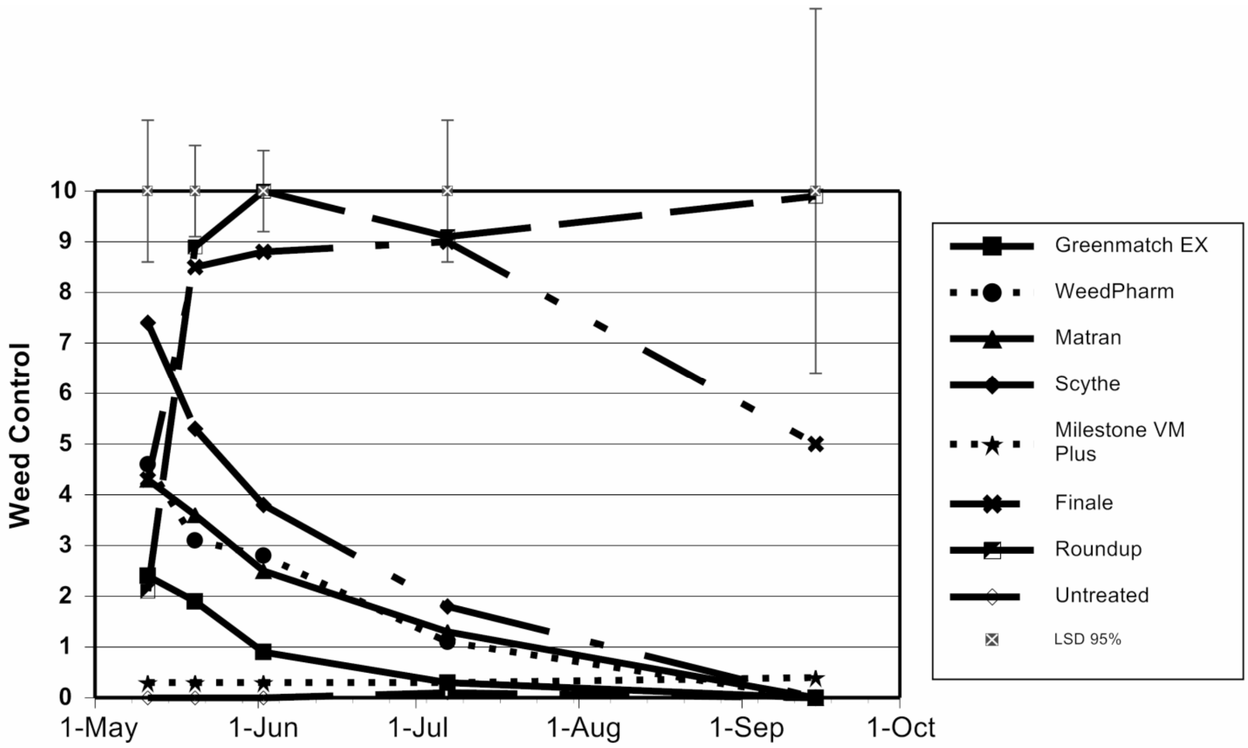
Table 6 Grass control



Spinach Weed Control: Where We Have Been and Where We Are Now

University of California Cooperative Extension, Monterey County
Richard Smith, Farm Advisor and Steve Fennimore, Extension Vegetable Weed Control Specialist

Weed control is a critical part of spinach production. This is particularly true now that much of the spinach is produced on high density 80-inch wide beds that are mechanically harvested. Therefore, weed-free spinach is essential. There is no opportunity to utilize mechanical means of weed control such as cultivation on 80-inch beds, and the only non-chemical options that are available to growers are cultural practices such as the use of preirrigation followed by shallow cultivation to kill a flush of weeds, crop rotations, field selection, and field sanitation practices that minimize weed seed production. These practices can be very useful in reducing weed populations to manageable levels in production fields.

Herbicides provide further weed control in conventionally produced production fields that help to make subsequent hand weeding operations more efficient and economical. The situation with herbicides registered for use on spinach has been a bit of a roller coaster ride over the past several years:

A number of years ago a key highly effective preemergent herbicide, Antor, was removed from the market. Efforts to register Dual Magnum were initiated in the mid-1990s and in 2008, it was finally registered under a 24c registration. However, the registration has the following restrictions: 1) a 50 day preharvest interval (PHI) and 2) a 12 month plant back restriction to lettuce. Given that the majority of the spinach acreage is clipped baby and teenage types (grown for the bagged spinach market) which mature in 25-35 days during the summer production season, the 50 day PHI, is too long. There are efforts to reduce the PHI of Dual Magnum on spinach, and we will have to see how successful these efforts will be. The 12 month plant back restriction to lettuce is also a problem in the Salinas Valley where lettuce is the dominant crop.

Several years ago, Helm Agro Chemical Corporation took over production of RoNeet. In 2008 they announced that they were suspending production of RoNeet. Fortunately, within a year, RoNeet was returned to the market and it continues as the key preemergence herbicide for use on spinach.

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Other weed control options for use on spinach include the broadleaf postemergence herbicide Spin-aid. However, its use is restricted to freezer spinach production which has more days to harvest than clipped spinach. Blading Vapam or Kpam at 3 inches below the crop surface is done by some spinach growers. This technique provides useful weed control, but its use is limited by the additional cost, buffer zone issues, and the additional days needed to wait before the crop can be planted.

Finding new potential herbicides for use on spinach has been very difficult because spinach is very sensitive to most preemergence materials. Recently, we have been examining the use of Lorox which has been shown to have some safety on spinach, but the safety varies by soil type and soil characteristics.

As a result of all of these challenges, we thought it useful to explore ways to try to work with the Dual Magnum PHI in order to expand the weed control options available to growers on the Central Coast. An initial study conducted in 2009 in which we applied Dual Magnum to shaped 80-inch beds 3 weeks prior to plating. Results indicated that rates of Dual Magnum greater than 0.5 pint/A were needed to get good weed control (Table 1). In 2010, we followed up on this work and examined applications 14-day preplant and at-planting applications of Dual Magnum. It also provided an opportunity to observe the loss of weed control by Dual Magnum if it sits on the soil surface for 14 days prior to planting.

The trial was conducted in San Ardo. Preplant applications were applied to shaped beds on September 1. The materials remained on the bedtop until planting on September 14. The at-planting treatments were applied immediately following planting on September 15. All treatments were incorporated into the soil with the germination water on September 15. The soil type was Metz complex which had a loamy sand texture. Each plot was one 80-inch bed wide by 10 feet long for at planting treatments or 15 feet long for the preplant treatments; all treatments were replicated three times in a randomized complete block design. Applications were made with a backpack CO_2 applicator with 4 passes of a one-nozzle wand with an 8008E tip pressurized at 30 psi applying the equivalent of 78 gallons of water per acre.

All treatments had acceptable phytotoxicity ratings (<2.0) except for Dual Magnum at 1.0 pint/A applied preplant and Lorox at 0.6 lb/A (Table 2). All materials reduced total weeds over the untreated control, and Lorox at 0.6 lb/A provided complete weed control. Dual Magnum applied 14 days prior to planting had more weeds than the at-planting applications at the same rate. The untreated control, 14-day preplant applications of Dual Magnum at 0.3, 0.5 and 0.75 pint/A, at planting applications of Dual Magnum at 0.3 and 0.5 pint/A and RoNeet at 1.25 pint/A all had yields >8.0 tons/A. The 1.0 pint/A rate of Dual Magnum applied preplant did not provide further weed control than the 0.75 pint/A rate and had a lower yield. In general, applying Dual Magnum 14 days preplant reduced weed control by this material over at-planting applications. Lorox at 0.4 lbs was safer on spinach than the 0.6 lb/A rate and provided good weed control in this trial.

Summary: The results indicate that there is a significant reduction in weed control in the Dual Magnum treatments that sat on the soil surface 14 days prior to planting. Applications of Dual Magnum applied 14 days before planting did provide a measure of weed control, but it is clearly a less desirable method of providing weed control for spinach than at-planting applications.

Table 1. 2009. Evaluation of Dual Magnum applied three weeks prior to planting to comply with the 50 day preharvest interval. Weed counts taken on August 6 - sixteen days after planting.

Treatment	Material Per Acre	Lbs a.i./A	Purslane	Malva	Other weeds	Total weeds	Phyto
Dual Magnum	0.50 pint	0.48	41.3	0.8	1.3	43.3	0.0
Dual Magnum	0.75 pint	0.72	4.0	1.8	2.3	8.0	0.8
Dual Magnum	1.00 pint	0.96	1.0	2.8	4.3	8.0	1.3
Untreated	----	----	3.0	11.8	21.8	36.5	0.0
Pr>Treat			<0.001	<0.001	<0.001	0.002	0.005
LSD 0.05			16.4	3.7	5.7	17.0	0.7

(Continued on next page)

Table 2. 2010. Weeds counts (per 25 ft^2) and phytotoxicity ratings on September 30

Treatments	a.i. lbs/A	Material/A	Application Timing	Phyto[1]	Malva	Purslane	Other Weeds	Grass[2]	Total Weeds	Yield T/A
Untreated	---	---	---	0.0	5.5	4.2	1.9	1.1	12.6	8.5
Dual Magnum	0.3	0.31 pint	14 days preplant	0.3	3.6	2.0	0.6	0.0	6.2	8.6
Dual Magnum	0.3	0.31 pint	At planting	0.0	2.9	0.4	0.0	0.0	3.3	9.1
Dual Magnum	0.5	0.52 pint	14 days preplant	0.3	3.9	3.7	0.3	0.0	7.9	8.7
Dual Magnum	0.5	0.52 pint	At planting	0.3	1.7	0.4	0.0	0.0	2.2	8.5
Dual Magnum	0.75	0.78 pint	14 days preplant	1.3	3.0	1.3	0.6	0.0	4.9	8.0
Dual Magnum	0.75	0.78 pint	At planting	1.3	1.7	0.1	0.3	0.0	2.2	7.7
Dual Magnum	1.00	1.05 pint	14 days preplant	3.0	4.0	0.6	0.7	0.0	5.3	7.3
Lorox 50W	0.5	0.4 lb	At planting	2.0	0.9	0.4	0.3	0.1	1.7	7.8
Lorox 50W	0.3	0.6 lb	At planting	6.3	0.0	0.0	0.0	0.0	0.0	5.3
RoNeet 6E	0.93	1.25 pt	At planting	0.0	2.2	1.0	0.6	0.1	3.9	9.8
			Pr>Treat	<0.001	0.007	0.013	0.003	<0.001	<0.001	0.005
			Pr>Block	0.041	0.186	0.453	0.269	0.736	0.741	0.577
			$LSD_{0.05}$	0.9	2.4	2.4	0.8	0.2	3.6	1.7

1 – Scale: 0=no crop damage to 10= crop dead; 2 – barnyard grass and lovegrass

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