Forty-Mile an Hour Alfalfa

**I still wonder what my old man was thinking.
Why he bought this ground at the bottom of a crease.
With the Sierra Nevadas to the west,
And five hundred miles of desert to the east.**

**The down sloping wind really owns this land.
She's a cruel landlord always asking for more.
And you know it's her coming to collect the rent,
She starts banging on the back porch screen door.**

**She stampeded my wheel lines late yesterday,
One mile of sprinkler pipe was on the roll.
She ran them till they jumped all of my fences.
I found them wrapped around their favorite power pole.**

**Now I own one mile of "hippe" pipe art,
with a big "wowie" in every piece.
I guess I call "Scrape Iron Eddie".
He might pay extra for a nice mantle piece.**

**And my bales are FOB[1] at the neighbors again.
I can't help it if he's downwind from my ranch.
And I know he gets tired of selling my hay.
I'll return the favor if I ever get the chance.**

**Why I keep farming,
I just don't even know.
Because forty-mile an hour alfalfa,
It is the toughest hay to grow.**

**Now some storm clouds are moving up from the south,
A little moisture would help settle the dust.
But the promise of rain was just a joke.
She swept it away with a fifty mph gust.**

And she lets the dust devils, play on the ranch.
Her juvenile nephews are rotten to the core.
And when they get done running in my windrows,
I have nothing but an alfalfa eyesore.

Now the harvest ants and the horned toads,
They've got it figured, no doubt.
Just let her blow till she's tired,
And then you can just dig yourself out.

And I wish I could join those lucky horned lizards.
At least they've got somewhere to go!
Because I'm trapped up here in my pickup,
Till the landlord collects the rent that I owe.

Now I just loaded twenty tons of discounted hay,
As more TDN[2] disappeared in the wind.
And now my eyeballs need a good washing out.
And my brain just wishes it would end.

How can one place have, this much wind?
Isn't there somewhere else it needs to blow?
Because this forty-mile an hour alfalfa.
It's gotta be the toughest hay to grow!

Now the roof on the hay barn left last night.
And tumbleweeds are pushin my fences down.
I think the landlord is trying to tell me something!
I think it's finally time to move into town!

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1 FOB –Freight On Board, the price of hay at the ranch.
2 TDN –Total Digestible Nutrients, A grading system for hay. Most of the digestible nutrients are present in the leaves.

By

David Haskell

Common Turf Weeds Commonly Confused

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The following table (Table 1) provides characteristics for recognizing 13 common turf that may be easily confused with one another. The weeds are divided into three categories. The first category is broad-leaved turf weeds with dissected weeds (pineapple weed, southern brassbuttons, lawn burweed, and less swinecress). The second is clover-like broad-leaved turf weeds (clovers, California burclover, black medic, and creeping wood sorrel). The third category is grass turf weeds, and these are divided into rhizomatous grasses (kikuyu grass, St. Augustine's grass, Bermuda grass) and tufted grasses (smooth/large crabgrass, Dallis grass). Characteristics were taken from the Jepson Manual of Higher Plants of California (Hickman ed., 1993) and Weeds of California and Other Western States (Ditomaso and Healy, 2007).

References:

Hickman, J. (editor). 1993. The Jepson Manual of Higher Plants of California. University of California Press, Berkeley, California.

Ditomaso, J. and E. Healy. 2007. Weeds of California and Other Western States. University of California Division of Agriculture and Natural Resources, Oakland, California.

Table 1. Characteristics of commonly confused turf weeds in three categories: dissected broad leaves, clover-like broad leaves, rhizomatous grasses, and tufted grasses.

Scientific Name	Common Name	Distribution in CA	Growth Form	Leaves	Flowers	Fruits/Seeds
Broad leaved forbes with dissected leaves						
Chamomilla suaveolens Asteraceae	Pineapple weed	Throughout CA.	In turf, a low annual.	Leaves without obvious hairs. Leaf blade divided into pinnately arranged segments that are then divided into narrow, pinnate segments. No fragrance to the leaves.	Yellow-green, egg-shaped, stalked heads that smell of chamomille when crushed.	Many-sided, ribbed, dry fruits without any obvious appendages or spines.
Cotula australis Asteraceae	Southern brassbuttons	Mostly coastal turf/gardens.	Low annual.	Leaves with sparse, spreading hairs. Leaf blade divided into pinnately arranged segments that are either unlobed or pinnately lobed. Leaves sometimes fragrant when crushed.	Yellow, inconspicuous heads at the end of slender stalks.	Flattened, dry fruits without any appendages.
Soliva sessilis Asteraceae	Lawn burweed	Mostly coastal.	Low annual.	Leaves soft-hairy, the blade with pinnately-arranged segments that are then palmately dissected. No fragrance.	Very inconspicuous, unstalked, green heads hidden in the leaves.	Flattened, winged, dry fruits with spines at the top.
Coronopus didymus Brassicaceae	Lesser swinecress	Throughout CA.	Low annual.	Leaves hairless. First stem leaves arranged in a rosette. Leaf blades with pinnately arranged segments that are then divided again with more lobes on the side toward the leaf tip. The smell of the crushed leaves is like a pig barn.	Very inconspicuous, arranged along either side of an elongate axis. The fruits develop quickly and are the conspicuous part.	Small, balloon-like fruits.

Scientific Name	Common Name	Distribution in CA	Growth Form	Leaves	Flowers	Fruits/Seeds
Broad leaved forbes with clover-like leaves						
Trifolium spp. Fabaceae	Clover	Throughout CA.	Turf weed clovers tend to be rhizomatous perennials.	Leaf blade divided into three leaflets with finely serrated edges. Usually the leafstalks of all three leaflets are the same length. The leafstalk is attached at the base of the leaf.	Flowers of various colors in small to large heads.	Fruit is a small legume pod with small seeds that are usually retained in the pod.
Medicago polymorpha Fabaceae	California burclover	Throughout CA.	Annual.	Leaf blade divided into three leaflets that are serrated near their tips. The small stalk connecting the terminal leaflet is longer than the other leaflet stalks. The leafstalk is attached at the base of the leaf.	Yellow flowers with typical pea-flower look. These in a few-flowered group.	Small seeds in a coiled pod. Pod is usually spiney.
Medicago lupulina Fabaceae	Black medic	Throughout CA.	Annual.	Leaf blade divided into three leaflets that are mostly unserrated at their edges. The small stalk connecting the terminal leaflet is longer than the other leaflet stalks. The leafstalk is attached at the base of the leaf.	Yellow flowers with typical pea-flower look. These are arranged in small heads.	One small seed in a small kidney-bean shaped pod that is black at maturity.
Oxalis corniculata Oxalidaceae	Creeping wood sorrel	Throughout CA.	Perennial from rhizomes that root at the nodes.	Leaf blade divided into three heart-shaped leaflets that are attached to a leafstalk at the center of leaf. Leaflets exhibit sleep movements (fold down at end of day). Leaflets do not have serrated edges.	Yellow flowers with 5 petals.	Small seeds with white appendage in cylindrical capusules.

Scientific Name	Common Name	Distribution in CA	Growth Form	Leaves	Flowers	Fruits/Seeds
Grass turf weeds						
Pennisetum clandestinum Poaceae	Kikuyu Grass	Southern California and coastal California. Not as common yet in the valley.	Perennial from thick stolons with swollen nodes, forming dense mats; internodes are relatively short and covered by brownish leaf sheaths.	Leaf blade often folded, short and pointed at the tip; leaves short hairy (especially on the sheath); top of sheath with long hairs; ligule hairy.	Inflorescence is hidden in leaf sheath and just styles or stamens show.	
Stenotaphrum secundatum Poaceae	St. Augustine's Grass	Used as a turf species in south and central coastal CA; rarely an escape.	Perennial from long, thick stolons, forming dense mats. The swollen nodes often have multiple branches emerging from one node; the internodes tend to be longer than in kikuyu grass and often uncovered.	Leaves usually folded, relatively short and wide with a blunt tip; ligule hairy.	Inflorescence a short, thick, finger-like axis.	
Cynodon dactylon Poaceae	Bermuda Grass	Throughout CA.	Perennial from long, very narrow rhizomes/stolons, forming loose mats.	Leaves not folded, narrower than in kikuyu grass, sparsely hairy; ligule hairy; top of sheath with very long hairs.	Inflorescence with several narrow branches coming from a single point (an umbel).	
Digitaria ischaemum and *sanguinalis* Poaceae	Smooth crabgrass/ large crabgrass	Throughout CA. Smooth crabgrass is the more common turf species.	Tufted annuals; in turf the stems lie close to the ground and form a circle.	Sheaths flattened, ligule a membrane 1-3 mm long, the leaf blade has a prominent midvein. In smooth crabgrass, the leaves and sheaths are mostly hairless. In large crabgrass, the leaves and sheaths are hairy.	Inflorescence with several very narrow and elongate branches that alternate up the inflorescence axis.	

Paspalum dilatatum Poaceae	Dallisgrass	Throughout CA.	Tufted perennial with short rhizomes; in turf, the stems lie close to the ground and form a circle.	Sheaths flattened, leaf blades without hairs, leaf sheath with some long hairs, ligule a membrane, 2-8 mm long.	Inflorescence with several elongate branches alternating up the main axis.	

Poa Biology and Control in Turf

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Annual bluegrass (*Poa annua*) is one of the most troublesome weeds in cool season golf turf. It's growth characteristics and taxonomically close relationship to desirable turf species such as Kentucky bluegrass (*Poa pratensis*) makes selective removal very challenging. *Poa annua's* ability to rapidly and prolifically produce seedheads means it can spread quickly, forming ever widening "colonies" that out compete the desirable turf species. Generally, P*oa annua* has a paler colored leaf blade than most desirable cool season turf species, which makes the plant noticeable when growing among a mix stand of turfgrass.

Poa annua can be identified by a distinct boat-shaped leaf tips (common to several species in the *Poa* genus), lack of auricles, folded vernation, long, membranous ligule, and bunch-type growth. According to the book "Poa annua" by Vargas and Turgeon, seeds can ripen on the panicle in just one day. This characteristic along with the ability of certain biotypes to flower continually throughout the growing season means the plant can rapidly expand it's initial point of infestation. *Poa annua* also adapts readily to different growing environments leaving cultural control techniques such as lowering or raising the mowing height and changing the irrigation frequency ineffective as a tool to manage this weed.

The chemical control choices are limited and, if not used properly, can injure the desirable turf species. Commonly, there are two windows to initiate herbicide control of *Poa annua*. Preemegence applications are made prior to the plant germination, while postemergence control targets the plant after it has germinated and in most cases has at least 2 true leaves present. The choices of preemergence herbicides are especially limited in situations where perennial ryegrass is overseeded on semi-dormant or dormant bermudagrass. In this case, poa germinates along with the ryegrass and has a very similar emergence pattern. Thus there is no "window" where a preemergence herbicide can be applied with little to no injury to the ryegrass. In terms of postemerge control, there are a few options but an understanding of P*oa's* germination patterns and growth habits is necessary to maximize control. As is the case with almost all postemergence herbicides, applications initiated when the target plant is small and vegetative growth is occurring will result in a higher level of control than if the target plant is in the reproductive growth phases.

According to studies conducted by Ron Calhoun at Michigan State University, P*oa annua* germination peaks at soil temperatures (0 to 2") of 68° to 72° F. Germination drops significantly when soil temperatures are below 58° and above 78° F. This means that about 3 weeks following a period of time when soil temperatures (2" level) are 60° or greater, a control measure targeting young P*oa* plants should begin.

A fairly new entry into the *Poa annua* control market, Velocity (bispyribac-sodium) selectively reduces *Poa annua* populations and is minimally harmful to perennial ryegrass or creeping bentgrass. Velocity is a systemic herbicide and inhibits the production of certain branched chain amino acids. Once in the plant, the active ingredient is moved to the location in the plant that has the highest metabolic activity. In young P*oa annua* plants, this means most of the chemical is translocated to the growing point, where it will prevent the formation of new plant tissue, and eventually, to plant death. Once *Poa annua* has begun to form a seedhead, the metabolic focus of the plant is to ensure the seeds complete development. Velocity symptoms on *Poa annua* targeted in the reproductive stage is shortened seedhead development, "blank" seed heads and the production of inviable seeds. However, overall plant control, as defined by plant death is low when applied to reproductive poa plants. Thus, based on the characteristics of how Velocity works, applications while *Poa annua* is still young and vegetatively growing result in better overall control. A recent label change has allowed Velocity applications at rates of 10 gmai/A to be applied to perennial ryegrass as soon as 30 days after seeding. Optimal control is achieved when applications are made on a 14 day interval. Once the perennial ryegrass has been established for at least 60 days, the Velocity application rate can be increased to a maximum of 30 gmai/A. A note of caution is needed when rates of 30gmai/A are used is in order. *Poa annua* death may occur rapidly and there may be a transitory yellowing of the ryegrass. Rapid death of *Poa* may leave empty spots or open holes in the turf. A lower rate, multiple application program, using 15 to 20 gmai/A on a 14 day application interval results in a slow P*oa annua* population reduction. In the case of creeping bentgrass, this program gives the bentgrass a chance to fill in as the *Poa* becomes less competitive. This also results in a more gradual change to the playing surface, which may be of more interest to golf turf managers who must maintain a playable surface while removing the *Poa*.

Lastly, there is much to learn about the interactions between turf plant growth regulators (PGR's) and Velocity. PGR's have been shown to reduce poa populations and keep seedheads from forming. Current research is being conducted to explore the effects of combining PGR and Velocity programs for both *Poa annua* management and quality of the desirable turf species.

What Weed Control Professionals Need to Know About Monsanto's New Roundup PROMAX™ Formulation

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Monsanto has recently received label approval from the California Department of Pesticide Regulation for its new Industrial, Turf and Ornamental herbicide formulation. The new product, Roundup PROMAX™, is formulated as a 4.5 lb per gallon glyphosate acid equivalent (a.e.) or 5.5 lbs of the potassium salt of glyphosate as the active ingredient (a.i.) per gallon. As such, this new formulation contains more glyphosate a.e. than any other Monsanto Industrial, Turf and Ornamental Roundup® herbicide yet developed. Monsanto's switch from the use of the isopropylamine (IPA) molecule to the much smaller potassium (K^+) ion, during formulation with the glyphosate acid, allows for the increased amount of glyphosate acid in the new formulation. Because of the product's increased glyphosate concentration, users will be able to achieve the same level of weed control with lower rates than previously experienced with Roundup® Pro herbicide. Users are advised to consult the new product's label for proper rates to control the various types of weeds encountered. The new formulation will offer easier handling for users because of its lower viscosity. Users may notice easier pumping and pouring in their day-to-day operations.

Roundup PROMAX™ contains a unique surfactant system that allows the solution to penetrate weed leaf surfaces faster, which means Roundup PROMAX™ is rainproof in half the time of Roundup® PRO. To better understand this effect, Monsanto conducted a number of laboratory and greenhouse studies[1] with Roundup PROMAX™. In these studies, plants treated with Roundup PROMAX™ showed significant and severe chlorophyll (photosystem II) disruption which is often the first manifestation of stress in a leaf[2], rapid cuticle penetration followed by rapid and extensive glyphosate translocation within the treated plants, and rapid phytotoxicity vs. two other surfactant-containing, glyphosate-based herbicides used as comparisons.

A number of efficacy studies were conducted at various but different environmental and climactic sites throughout the state of California with cooperating vegetation management customers. Roundup PROMAX™ controlled the treated annual and perennial weeds as effectively as Roundup® Pro and in some instances provided more rapid broadleaf weed phytotoxicity than Roundup® Pro.

<u>Citations</u>

[1] 2007 Monsanto Research Test

[2] "Chlorophyll fluorescence—a practical guide," by Kate Maxwell, Environmental and Molecular Plant Physiology Laboratory, Department of Agricultural and Environmental Science, The University, Newcastle upon Tyne NE1 7RU, UK and Giles N. Johnson, University of Manchester, School of Biological Sciences, 3.614 Stopford Building, Oxford Road, Manchester

M13 9PT, UK, *in* Journal of Experimental Botany, Vol. 51, No. 345, pp. 659-668, April 2000

What's New in Turf Weed Control?

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Turf managers are facing ever-increasing challenges with management of common and exotic weed species. Fewer herbicide active ingredients are available today due to escalating environmental concerns, regulatory requirements, and re-registration costs and processes. Development of new turf protectants including herbicides requires more than 120 separate tests over as much as 10 years at a cost to the manufacturer of approximately $200 million dollars. Considering that the patent process lasts for 17 years from time of discovery, companies have little time to gain a return on this investment. Characteristics of new and future herbicides include lower use rates, more targeted weed spectrum, and Reduced Risk as defined by the U.S. Environmental Protection Agency (EPA). Reliance on multiple applications of fewer active ingredients increases the likelihood of developing weed resistance. Moreover, many of the herbicide active ingredients available today have single, site-specific modes of action that contribute to the development of herbicide resistant weed biotypes. Resistance to herbicides that inhibit acetolactate synthase (ALS) has been increasing at a faster rate than in any other herbicide group. Most of the newer herbicides registered on turf are ALS inhibitors including the sulfonylureas, bispyribac-sodium, and penoxsulam. The sulfonylureas are a large class of herbicides that provide selective control of cool season grasses including annual bluegrass and perennial ryegrass used for overseeding, sedges, and broadleaf weeds. Bispyribac-sodium is used for selective control of annual bluegrass and rough bluegrass, and penoxsulam provides selective control of broadleaf weeds including white clover and English lawn daisy. A new class of triketone herbicides inhibits plant pigments. Although not yet registered in California, mesotrione is a triketone herbicide that provides selective control of bentgrass and broadleaf weeds in cool season turf. In addition to new active ingredients, manufacturers are developing new formulation technology that increases herbicide efficacy while decreasing solvent carriers. Alternative weed control measures are also being evaluated in light of increasing bans on chemical weed control products. Despite improved technology in chemical weed control, there is no substitute for carefully reading and following the pesticide label, maintaining properly calibrated application equipment, and employing appropriate turf management practices.

Aerial Application and Nozzle Selection

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Selection of spray nozzles is critical to achieve proper application of agricultural herbicides. Adequate coverage for efficacy is required but this must be combined with proper parameters to minimize off target movement of the product.

Before selecting nozzles, consideration needs to be given to regulatory requirements, label requirements, droplet sizes and their driftibility, and interaction with active ingredients and adjuvants. Also, boom type and placement on the aircraft is important and must be considered.

Booms should be 70% to 75% of the wing span. This minimizes wing tip vortices which lead to drift. Booms also should be placed at least 10 to 16 inches below the trailing edge of the wing. This keeps the nozzles in "clean" air and away from turbulence which can cause droplet break up and thus smaller droplets that are more prone to drift. On rotary winged aircraft, the percentage of boom length compared to the rotor is similar to fixed wing but the booms are almost always more than 16 inches below the rotors. Also, booms that are streamline or airfoil types are preferable over round booms because there is less air turbulence around the boom. On helicopters, round booms are perfectly acceptable because of their placement in relation to the rotor.

Most nozzles are flat fan, T Jet disc core types, or CP. All are good and perform adequately when properly placed on the boom.

Various tables and software spread sheets may be used when selecting nozzles. These give indications of droplet sizes, droplet ranges, driftibility, and other parameters. Once a nozzle type and orifice size has been selected using these tools, the selection needs to be confirmed. This is necessary to ensure proper droplet size for efficacy, label language, and regulatory requirements.

Confirmation is achieved by using water and spraying over water sensitive cards. These are then analyzed for VMD, Vd. 0.1, Vd. 0.9, and percent of spray volume less than 200 microns. If parameters are not met that reduce drift, minimize drift, or meet other required parameters, then adjustments may be made to deflection angle, pressure, airspeed, orifice size, or a combination of these. The aircraft is then retested.

The Latest in Biotechnology and Herbicide Tolerance

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Herbicide resistance technology has changed production agriculture. Various biotechnology methodologies have been used to identify and create potential herbicide resistance genes. A new method call gene shuffling uses multiple rounds of shuffling to amplify gene function. Each protein variant is tested to determine whether the desired function is improved. A new herbicide resistance gene called GAT (Glyphosate ALS Tolerance) has been created using gene shuffling. The GAT enzyme functions to detoxify and change glyphosate so it cannot bind with the EPSPS target for improved crop safety. This technology has allowed for herbicide design strategies that bring new weed control options to the market place. These include short and long-term residual plus burn-down combinations. GAT herbicide technology offers advanced options for weed management. U.S. approvals are expected in 2009 with commercial introduction in 2010 for corn. For soybean, U.S. approvals have been received.

Changing Landscape of Agronomic Crops in California

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The acreage planted to California field crops dramatically changed during the past ten years. Most of this change occurred in the cotton acreage. Cotton's acreage decreased 75 percent, from slightly over one million acres in 1997 to a little over two hundred fifty thousand in 2008. This change occurred at an almost constant rate over this 12 year period. The other major field crops alfalfa, wheat, rice and corn all had very steady planted acreages over this same period. The fraction of both wheat and corn harvested for silage increased by over one third. This increase forage production lines up with an over 50 percent increase milk production from 1997 to 2008. Although it wasn't always the same physical acreage, almost one half of cotton's loss shifted to almonds and pistachios. These statistics are from the USDA National Agricultural Statistics Service.

Managing Herbicide Resistance Using Alternative Rice Stand Establishment Techniques

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Five alternative stand establishment techniques were employed for four consecutive years since 2004: 1) conventional water-seed rice, 2) conventional drill-seeded rice, 3) water-seeded rice after spring tillage and a stale seedbed, 4) water-seeded rice after a stale seedbed without spring tillage, and 5) drill-seeded rice after a stale seedbed without spring tillage.

These systems highlighted the advantages of each in the shift of the weed seedbanks throughout the years. This season, the techniques were switched to take advantage of the impact the new system would have on weed recruitment and the established seedbank. Water seeded systems tend to favor aquatic weeds while dry or drill seeded systems tend to favor aerobic/dryland weeds. Added to the two basic techniques is the use of a stale seedbed where weeds are encouraged to germinate prior to seeding the crop then eliminated with a total herbicide like glyphosate ("stale seedbed" technique). This dramatically reduces the weed pressure on the crop as long as the soil surface is not disturbed after the stale seedbed glyphosate application.

This year, plots from this experiments received alternative treatments to validate the potential of shifting aerobic and anaerobic stand establishment, and the value of implementing a stale seedbed with glyphosate to deplete fields from all kinds of herbicide resistant weeds. Thus, plots where rice had been conventionally water seeded were heavily infested with aquatic weeds. Weeds almost disappeared from these plots when rice was drill seeded (no-till) following a stale seedbed with Roundup. Plots with heavy barnyardgrass and sprangletop infestations after 4 years of drill seeding rice were switched to water seeding after a stale seedbed with Roundup without any spring tillage and again, weeds were almost absent from these plots as a result of the change in rice establishment method. All this was achieved without any additional herbicide applied besides the Roundup. Herbicides can still be applied if 100% weed control is desired and to prevent seed set by late emerging weeds. Alternating rice establishment systems from aerobic (dry seeding) to anaerobic (water seeding) regimes (and vice versa) combined with the use prior to seeding of a total non-selective herbicide for which resistance does not yet exist in weeds of rice (such as Roundup or other) allows for a major reduction of herbicide resistant weed infestations in rice and of the overall herbicide use and associated costs. Yields were not different across treatments. Except for the rotation from conventional water seeding into a drill seeded no-till system, all other rotations had the same yields in areas with conventional weed control or where the only weed control treatment was glyphosate (stale seedbed). This clearly demonstrates the success of these strategies to 1) control herbicide-resistant weeds, and 2) lower herbicide use in rice. A spring-tilled water seeding after a stale-seedbed technique was implemented in a grower's field in Glenn County using glyphosate. This practice was successful in controlling a heavy infestation of mimic and obtaining good yields in a 10 acre field where mimic had been causing heavy yield and economic losses; the key for success with this technique is to allow for substantial weed emergence prior to applying glyphosate. This exercise confirmed what we had been observing in our experimental plots at the RES and demonstrates the feasibility of implementing one of the proposed alternative establishment under grower conditions.

New Opportunities Offer Control of Problem Weeds and Grasses in Alfalfa

Mick Canevari[1]

Abstract

Alfalfa is the largest crop produced in California exceeding one million acres. It is estimated that 75% of acreage is treated for weeds on an annual basis. The hay market financially rewards weed free high quality forage with high prices. In 2008, the price for number 1 weed free hay exceeded $220 per ton to the grower, as compared to weedy hay which sold for < $110 per ton. Managing weeds in a timely manner is necessary to provide maximum production of high quality alfalfa hay. Poor weed management can lead to premature stand loss, poor quality hay, unacceptable weed control, alfalfa injury and a loss of income. Therefore, maintaining an appropriate amount of weed control options, primarily safe and effective herbicides is critical to sustain an economic viable alfalfa industry.

Keywords: alfalfa, Prowl H20, pendimethalin, Chateau, flumioxazin,

Chateau *flumioxazin* was registered for use in alfalfa in 2008 for preemergent weed control in semi dormant alfalfa. It has some postemergence activity on small germinating annual weeds. The postemergence action may not be sufficient in most field situations containing emerged weeds much beyond the cotyledon stage. Larger weeds will require the addition of a postemergence herbicide. Tank mixing with paraquat, glyphosate, imazamox and hexazinone have demonstrated excellent results. Chateau by itself at the rate of 4 oz of product or 0.094 lb ai/A gives very good preemergence control of common chickweed and common groundsel with 80% control of annual bluegrass and annual sowthistle.
Chateau would be an excellent addition for alfalfa weed control especially in a preemergence winter application providing several months of soil residual activity. See Figure 1.

Prowl H20 *pendimethalin* was registered in 2007 for use in established alfalfa. Prowl having similar chemistry to Treflan is in the dinitroaniline herbicide family and especially effective in controlling grasses, many broadleaf weeds and dodder when applied pre-emergent to weed germination. Prowl H20 is formulated to be stable on the soil surface for several weeks with little volatility or loss before it is rain incorporated or irrigated. Another advantage is the liquid formulation can be tank mixed with other pre or post emergent herbicides (paraquat, Velpar, Chateau, 2,4DB, Prism, Post and Raptor) to compliment a broader spectrum and long term residual control. The rates of Prowl can be adjusted from 2 to 4 quarts per acre depending on weed species and expected population and weed pressure. The higher rates applied during January/February timeframe have provided excellent long season grass control into late summer cuttings (August). Prowl H20 has not shown any crop injury issues to date. Figure 2.

<u>Summary</u>

Both Chateau and Prowl H20 have shown excellent weed control in alfalfa. Generally, they will be most effective in tandem with other contact herbicides but add a safe effective method of long term weed control. The importance of developing and registering new herbicides for alfalfa continues to be a high priority to industry for weed control, crop rotation, managing for

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weed/herbicide resistance. The development of new herbicides is extremely important as new water and air regulations restrict the use of older chemistries.

Figure 1. Winter Dormant Applications

	Chick Weed	Annual Bluegrass	Sow-thistle	Groundsel	Henbit	Prickly Lettuce	Shepherd's Purse	Fiddle-neck	Burning Nettle	London Rocket
Chateau 3 oz	94	79	68	71	98	100	100	100	100	100
Chateau 4 oz	97	85	74	95	100	98	98	100	100	100
Chateau 6 oz	95	89	62	88	100	98	-	-	-	-
Chat+Vel 4 oz + .5 lb	100	100	100	100	100	100	-	-	-	-
Chat+Rp 4oz + 3oz	100	92	98	100	100	98	-	-	-	-
Chat+Gr 3oz + .5lb	99	100	-	87	100	-	89	-	-	-
Chat+Gr 4oz + .5lb	97	99	100	94	100	100	91	-	-	-
Gramoxo 0.5 lb	80	84	95	89	78	100	88	47	60	84
Velpar 0.5 lb	78	52	60	93	100	100	93	94	90	98
Raptor 6 oz	66	32	48	29	74	33	-	40	85	85
Chat 4oz Vel .5 lb Gram .5lb	100	100	100	100	100	100	100	-	100	100

Figure 2. Season Long Control of Yellow Foxtail in Alfalfa

Treatment/Timing[1]	Rate (lb ai/acre)	June 15[2]	August 16	September 13
Treflan 5G/Early	3.0	92	77	75
Treflan 5G/Early	4.0	96	82	79
Prowl 4EC/Early	3.0	97	90	90
Prowl 4EC/Early	4.0	97	90	89
Velpar 90WP/Early	1.0	75	46	26
Karmex 80WP/Early	1.0	63	39	20
Control		55	21	11
Treflan 5G/Late	1.0	63	57	53
Treflan 5G/Late	2.0	82	72	82
Prowl 4EC/Late	1.0	85	61	58
Prowl 4EC/Late	2.0	87	69	77

[1] Treatment/Timing = Early application 1/12/84; Late application 2/22/84
[2] Date = % Control for 4 rep averages; 0 = no weed control; 100 = complete weed control

Developing Science-Based Strategies to Manage Water Conveyance and Control Weeds and Sediment in Irrigation and Potable Water Supply Canals

By
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The intent of this paper is to discuss the type and severity of problems facing agencies responsible for providing water supply to municipal, industrial and agricultural water users. This paper describes on-going applied research, field monitoring, laboratory analyses and hydrologic investigations being conducted by Northwest Hydraulic Consultants (NHC) with the Solano County Water Agency (SCWA) and Solano Project Operators to identify the sources and magnitude of sediment, turbidity and aquatic vegetation entering and affecting the Putah South Canal (PSC), located in Solano County, California. The presence and highly variable concentrations of these constituents in the PSC cause increasing canal maintenance and operational costs, and water quality problems for water users that rely on PSC water for their primary source of irrigation, municipal or industrial water supply.

The Federal Solano Project

The PSC is part of the Federal Solano Project, which was constructed in the 1950’s by the U.S. Bureau of Reclamation (USBR) to meet water demands of agriculture, municipal, industrial, and military facilities within Solano County in California. The Solano County Water Agency (SCWA) is responsible for the operation and maintenance of the Solano Project on behalf of the USBR. The SCWA in turn has a long-term contract with the Solano Irrigation District (SID, referred to in this paper as the “Solano Project Operators”) to implement the operation and maintenance activities associated with the Project. The Project consists of four major facilities: Monticello Dam, Putah Diversion Dam, PSC, and the Terminal Reservoir. The PSC is a 33-mile long concrete-lined open canal extending south along the eastern toe of the English Hills through the Cities of Vacaville and Fairfield to the Terminal Reservoir in Green Valley (Figure 1). The PSC serves municipal, industrial, and agricultural customers and frequently transitions from rural to urban settings. The canal is divided into 12 reaches, or controlled checks. Along the canal, there are 5 operational spills (2 inactive), 11 plant intakes (1 inactive), and approximately 55 pumped or gravity turnouts/laterals consisting of combinations of open channels and/or pipe conveyance infrastructure.

The Solano Project was designed to irrigate approximately 100,000 acres of land. Principal crops are corn, wheat, sugar beets, tomatoes, fruits, nuts, wine grapes, and irrigated pasture. The project is also a major municipal and industrial water supply for over 411,000 people in the cities of Vallejo, Vacaville, Fairfield, Benicia, and Suisun City, supplying about 32,000 ac-ft annually.

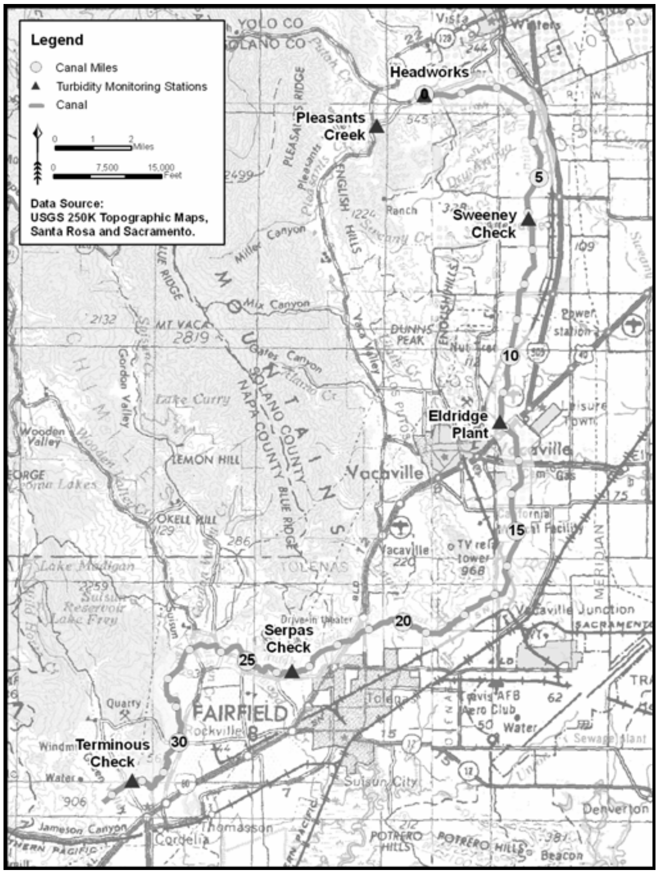

Figure 1. Map of Putah South Canal, Solano County, California.

Sediment and Aquatic Vegetation Problems

During the spring and summer months approximately 75% of the water deliveries provided through the PSC are for irrigation and agricultural uses. Municipal and industrial (MI) water users along the PSC withdraw raw water year round from the canal and treat it in order to meet current drinking water standards. Sudden and dramatic increases in turbidity in the canal water can occur during winter storm periods. Turbid water can enter the canal during storm events from lateral sources along the canal and through the Headworks located at the Lake Solano Diversion Dam at the head of the canal (Figure 1). These turbidity pulses create operational problems for the water treatment plants (WTPs) and increase costs for treating the water supply distributed to their customers. When possible, the plants will close their intakes and temporarily forego excessively turbid water or water that has just received chemical treatments to control algae. However, with increasing urban development and population growth throughout Solano County (as of 2007 its population was estimated at 411,680; with 4.34% growth since 2000) there is increasing demand for potable water supply as well as a continued need for irrigation water for agricultural use. Increasing demand places greater constrains on the WTPs abilities to by-pass turbid or algaecide (Copper Sulfate) laden canal waters. Some plants, such as the Waterman WTP in Fairfield only have the system storage capacity to by-pass PSC water for 24 hours until they need to accommodate less desirable quality water to meet user demands. This leads to increased operational and water treatment costs.

Sediment entering the PSC settles and deposits along the bottom of the canal. Sediment deposition promotes aquatic weed growth and algae blooms, which impact water quality in the canal and, in turn, promotes more sediment deposition due to the rapid growth of thick stands of aquatic weeds. For maintenance purposes, SCWA and the Solano Project Operators attempt to de-water and clean the entire canal of accumulated aquatic vegetation and sediment deposits each year. Essentially, the canal is drained and sediment, aquatic vegetation and biological detritus are mechanically removed reach by reach. Canal cleanout requires extensive labor, heavy equipment, and vast logistical planning and coordination. Canal cleanout operations interrupt water supply to treatment plants and affect water turbidity and water quality in sections of the canal located downstream from active vegetation and sediment cleanout activities. The efficiency of the cleaning process is limited by the inability to completely drain the canal, with the result that bottom deposits have a slurry-like nature which make them very difficult to remove mechanically (Figures 2 and 3). Formerly, Solano Project Operators utilized wasteways along the canal to completely drain and flush the canal, but increased environmental concerns have since discontinued their use.

Figure 2. Removal of aquatic weeds and sediment from Sweeney Check at MP 6.15. Photo of October 19, 2006.

Figure 3. Pushing sediment and vegetative detritus down Union Check at MP 14.80. Photo of November 3, 2006.

The major goals of this on-going study are to:

1. Assess geomorphic and hydrologic processes contributing to increases in sediment loading, turbidity, and growth of aquatic vegetation in the canal;
2. Identify and quantify the major sources of turbidity and sediment entering the canal, and identify causes and seasonal differences;
3. Determine sources and primary species of aquatic vegetation (algae and macrophytes) that colonize in sediment deposits along the canal bottom;
4. Determine composition and characteristics of the sediment and vegetation materials that are causing project operational difficulties, increasing annual maintenance costs, and frequent water quality and water treatment problems;
5. Develop recommendations and cost effective solutions for mitigating these problems in the canal;

Project tasks included: monitoring annual canal operations, canal cleanout activities, winter storm monitoring (turbidity and suspended sediment concentrations), identification of sources of sediment, hydraulic measurements in the canal and Lake Solano, assessment of annual sediment budgets, water user surveys, and aquatic vegetation assessments. Following is a summary of the major on-going monitoring, laboratory and field testing activities associated primarily with issues and problems related to the growth and decay of aquatic vegetation and annual removal of sediment and vegetation from the PSC.

Project Operation, Maintenance and Water Treatment Problems Associated with Aquatic Vegetation

There is an accumulation of the black anoxic floc-like organic material (Figures 4 and 5) deposited along the canal bottom each year as a direct result of the growth and decay of aquatic vegetation. There is also a close linkage between the sediment introduced into the canal, and the volume of aquatic biomass capable of being produced each year. Figure 6 illustrates the primary sources and relationships between sediment and vegetation in the canal. Deposited sediments provide nutrients and a location where colonization and growth of aquatic vegetation takes place, particularly aquatic macrophytes that rapidly colonize sediment deposits along the canal bottom, along the inside of canal bends, upstream of canal check structures, as well as in panel cracks and seams. Thick mature patches of aquatic macrophytes encourage further capture and settling of fine sediments from the water column, and provide a location where inorganic sediments combine with vegetation and other organic detrital materials. These thick mats of sediment and organic bottom materials become anaerobic during the summer and fall and generate hydrogen sulfide and other odor-causing and water quality treatment problems, especially during annual canal cleanout operations when these deposited materials are disturbed. Thick growths of aquatic vegetation can clog irrigation turnouts, plug drip emitters, reduce water treatment plant intake efficiency, and lead to increased operations and maintenance costs. This situation occurs frequently at the Waterman WTP's Intake that is located just upstream from the Serpas Check structure (Figure 4).

Controlling algae, especially filamentous algae, is essential because it grows very rapidly in the canal and can quickly clog water intake structures and dramatically affect their performance. Daily "raking" of algae and higher aquatic vegetation to clear intake trash racks is labor intensive, costly, and does not address the increasing problems associated with the growth of aquatic vegetation in the canal. Solano Project Operators used to use rapid acting herbicides that were more effective at controlling algae and other vegetation, but the application of broad-range herbicides, such as *acrolein*, is no longer allowed. Present vegetation management consists of applications of copper sulfate in the canal to treat algae and manual "raking" and removal of vegetation from intake screens. Chemical treatment scheduling and dosing rates are managed similarly to schedules and practices established several years ago and may not be meeting present day needs with respect to application rates, schedules, or locations. Therefore, present treatment methods are being re-evaluated and updated to determine what herbicides and application methods are most effective and affordable. Also potentially affecting present chemical treatment methods are State and Federal changes occurring to the quality criteria that water users and water treatment plant operators must adhere to which limit chemical treatment methods that can be used in the PSC.

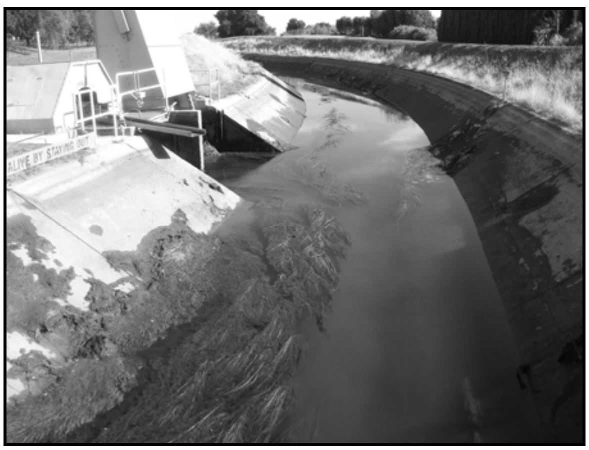

Figure 4. Thick growth of algae and macrophytes that plug the intake to the Waterman WTP located just upstream of Serpas Check. Photo of November 9, 2006.

Figure 5. Water samples from Putah South Canal collected during 2007 cleanout. The sample on the right was just collected; the sample on the left had settled for about 30 minutes. Both samples contain high concentrations of organic materials (decomposed vegetative materials) with a little sediment.

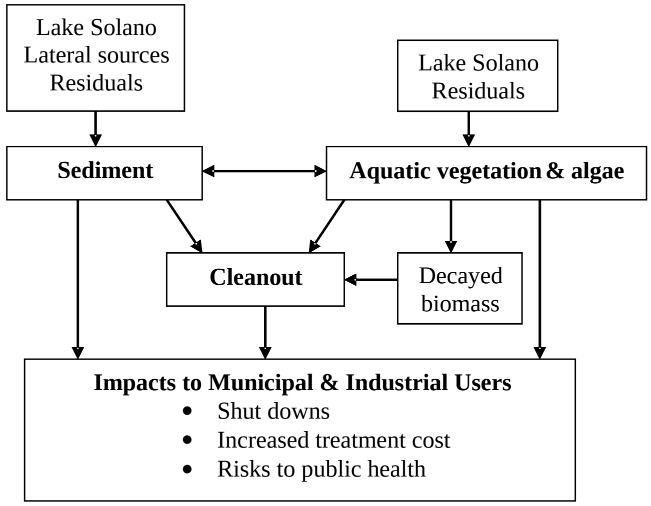

Figure 6. Sources and relationships between sediment and aquatic vegetation.

Field and Laboratory Activities

During the fall periods of 2006, 2007 and 2008, just prior to canal cleanout, NHC measured the approximate thickness of sediment deposits along the canal and estimated the percent coverage of aquatic vegetation in all checks along the canal (Figure 7). NHC observed a range of volumes of sediment deposits on the order of 1,000 to 12,000 cubic yards per year depending on rainfall and runoff conditions that occur during a given rainy season. During these three years the greatest sediment deposition, and thickest weed populations, were observed to occur upstream from checks, along the inside of canal bends and in areas where there is usually some sediment accumulated on the canal bottom. During the 2008 canal cleanout monitoring, NHC estimated the total weed volume within each check before and after canal cleanout. These results are shown in Figure 8. Total volume of weeds in the canal prior to and after the cleanout were approximately 2,000 and 100 cubic yards, respectively.

Field reconnaissance and vegetation survey campaigns were conducted to identify, list and photograph the location and types of aquatic vegetation found in the PSC. Technical assistance was provided from Dr Lars Anderson. In the fall of 2007, NHC staff assisted Dr Anderson to perform aquatic vegetation sampling and species identification logging along the entire length of the PSC from the Headworks to the Terminal Reservoir. According to the vegetation inventory, the primary species prevalent in the PSC include: (1) Eurasian watermilfoil, (2) Sago pondweed, (3) Horned pondweed, (4) Elodea, (5) *Nostoc* (algae), (6) *Cladophora* (algae), (7) *Rhizoclonium* (algae), and (8) *Tetraspora* (algae).

Beginning last fall 2008, NHC and Dr. Anderson have also been conducting monthly biomass monitoring and aquatic vegetation "netting" near the Headworks of the canal. Vegetation was "netted" during a given period of time using a 2-foot by 3-foot rectangular screen with 1/4-inch mesh. Netted vegetation was examined and the fragment counts per hour, species type, and fragment lengths by species of vegetation entering the canal from Lake Solano were documented. Figure 9 presents results from one of the vegetation netting campaigns. Vegetation netting results showed that a significant increase in the number of fragments entering the canal occurred during Headworks trash rack cleaning due to disturbance and shearing of weed materials captured on the screens. Aquatic vegetation biomass "netting" will continue monthly through June, 2009. Also, since September, 2008, NHC and the Solano Project Operators have documented the approximate volume of aquatic vegetation removed daily from the trash screens at the Headworks (Figure 10). Researchers at the USDA-ARS Exotic and Invasive Weeds Research Unit at UC Davis have also initiated a program to collect weed fragments from Lake Solano and to incubate them in the lab to determine the viability of the fragments and length of incubation time required to develop the sprouting of turions. Results from these on-going monitoring and laboratory activities will provide important information regarding the seasonal loading of aquatic weeds into the canal from Lake Solano and will also help to prepare viable alternatives for managing aquatic weed problems in the canal.

Potential Aquatic Weed Management Alternatives Being Considered

Following are several potential aquatic weed management alternatives being considered for this project:

1. Improve the vegetation screening efficiency and sediment extraction at the Headworks (first line of defense). Intercept, screen and keep aquatic vegetation and sediment form entering the canal;
2. Modify the upper checks (second line of defense) to trap, isolate and remove fugitive vegetation and sediment in the upper checks as much as possible. This will greatly reduce the extent of the problems and amount of annual cleaning required;
3. Design and implement an effective herbicide treatment program (third line of defense) to reduce growth and survival of algae and aquatic weeds in the canal;
4. Design and implement an aggressive Best Management Practice (BMP) program along the canal to reduce or eliminate lateral sediment loading into the canal (also a third line of defense). This will reduce sediment and nutrient loading and thus potential weed and algae colonization. Reducing the sediment loading will greatly reduce costs for annual cleanout and interruption to water supply during cleanout;
5. Provide supplemental backup water storage and supply for WTPs so they can survive for longer periods of time without canal flow during cleanout or during rare winter storm events that may require shutdowns;
6. Test and evaluate alternative methods for more efficient canal cleanout.

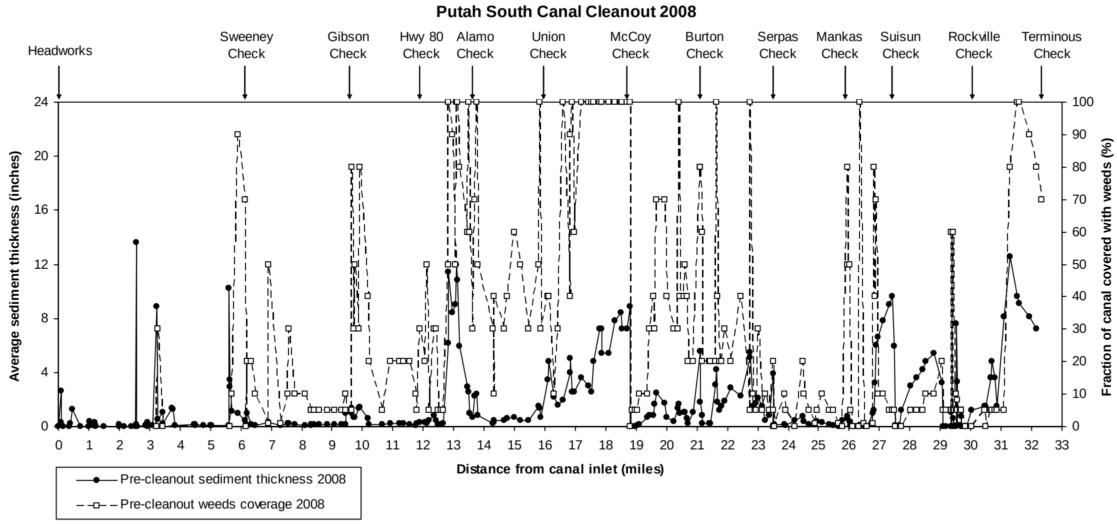

Figure 7. Longitudinal variations of average thickness of sediment deposits and weed growth prior to fall 2008 cleanout.

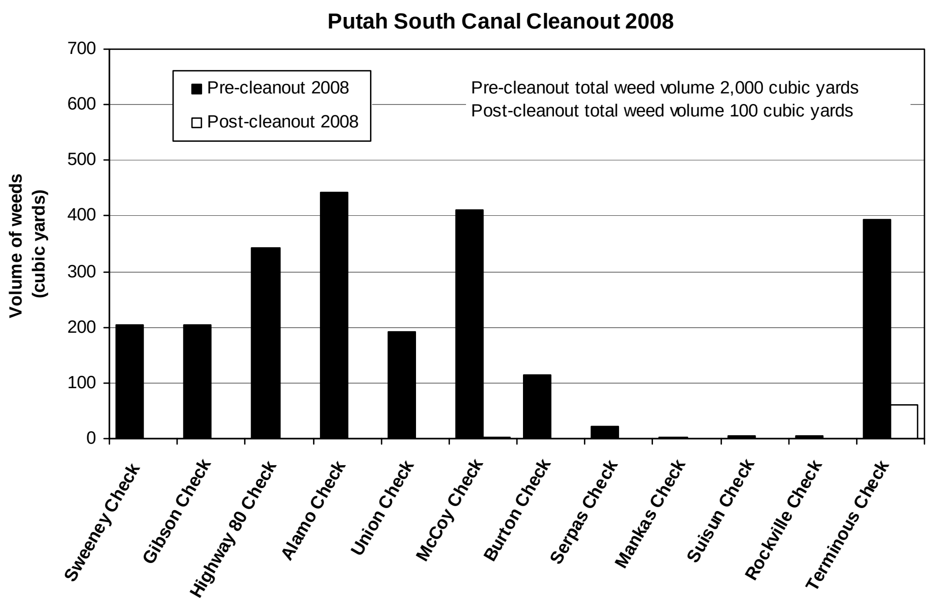

Figure 8. Estimated volumes of aquatic weed mass in each check before and after fall 2008 canal cleanout.

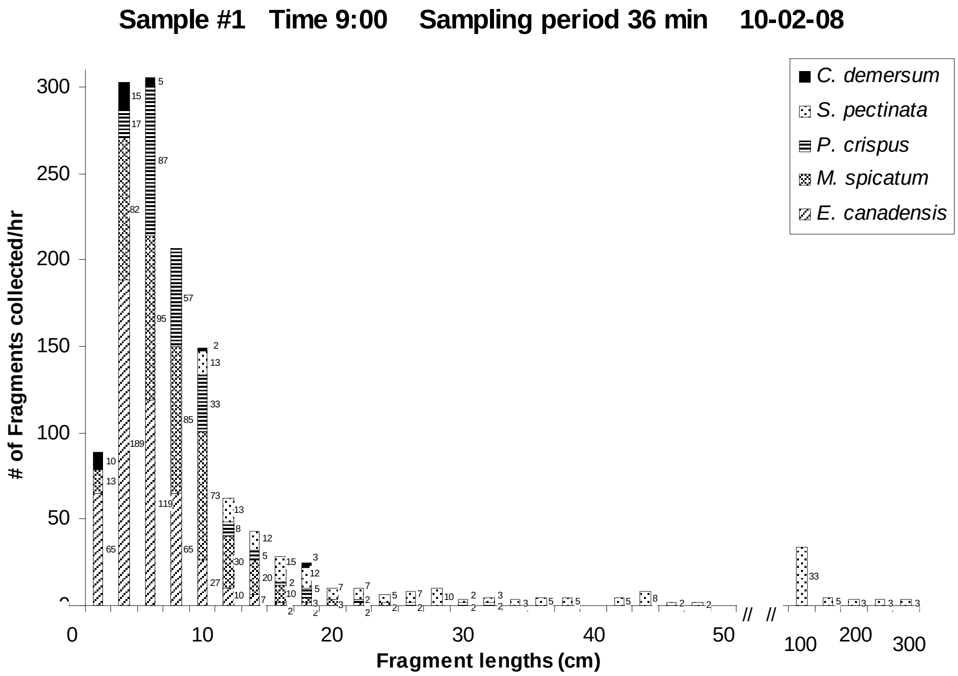

Figure 9. Typical results from aquatic vegetation "netting" just downstream from Headworks (10-02-08)

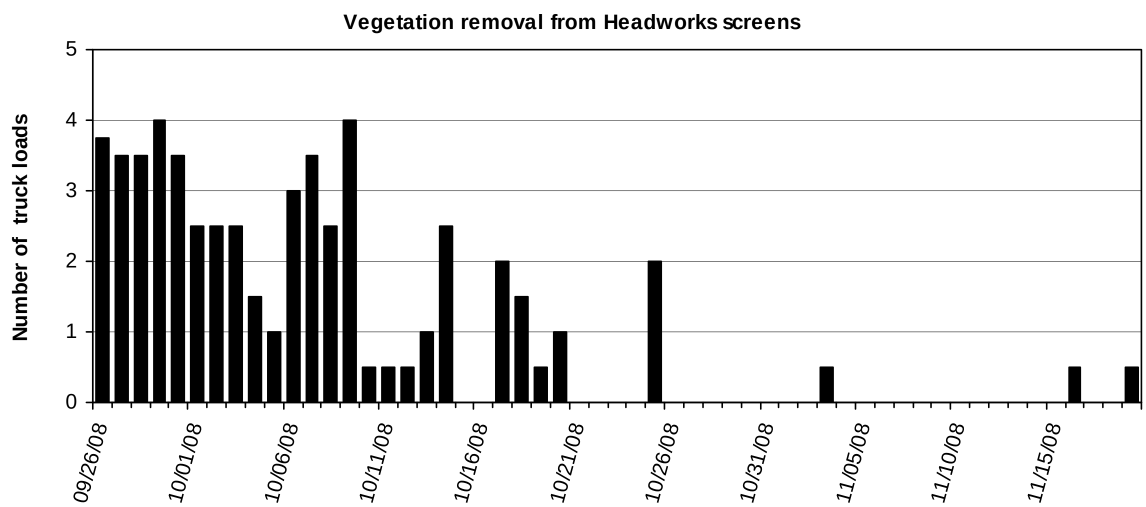

Figure 10. Daily log of the number of truck loads of aquatic vegetation removed from trash racks at Headworks (entrance to PSC)

Applying the Fundamentals of Weed Science in Vegetable Crops

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Weed management is based on the integrated use of all the tools available to weed managers – prevention, eradication, and control. Vegetable crops which tend to be more sensitive to weed competition than agronomic crops, have little or no tolerance for produce imperfections, and require a high level of weed control necessary for economical control. Unfortunately, vegetables tend to have few herbicides, and those few herbicides do not control all weeds. Therefore vegetable crops tend to have complex multifaceted weed management programs. How do the basic tools of weed management apply to vegetable crops?

Prevention involves stopping weeds from contaminating an area. The objective of prevention is to keep as few weeds as possible from replenishing the weed seedbank in the soil. Examples of prevention include:

- Not allowing weeds go to seed in or around the field
- Using clean crop seed
- Cleaning equipment before moving between fields

Eradication is the complete elimination of weeds from the field. It is very difficult to eradicate all weeds from a field, but it is necessary to eradicate certain species from a field such as field bindweed or yellow nutsedge. For example, it is not possible to produce strawberry in a field infested with field bindweed. If strawberry is to be grown in a field, then any field bindweed must be eradicated before time of planting. As with prevention, weed eradication requires careful planning and often times years of careful weed management to achieve.

Weed control utilizes cultural, physical and chemical tools to limit weed infestations and minimize weed competition. Cultural weed control tools include the use of preplant irrigation and shallow tillage to prepare a weed free "stale seedbed" for crops. Another cultural weed control tool is crop rotation. Crop rotation allows the use of different weed control tools in the various rotational crops which prevents one weed from becoming dominant as occurs with monocultures. Physical weed control involves tillage to uproot weeds, hand hoeing and hand pulling of weeds. Another example of physical weed control is the use of mulches to block light and prevent weed growth. Chemical weed control includes use of fumigants and herbicides.

Integrated weed management varies by crop, but involves the use of the most economically viable and efficacious combination of weed control tools necessary for profitable crop production.

References

Zimdahl, R.L. 2007. Fundamentals of Weed Science, 3rd Edition. Academic Press: 666 pages.
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Registering Herbicides in Specialty Crops - An Industry Perspective

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The level of past industry participation in herbicide minor crop uses has been a function of discovery output and the combination of incentives and barriers that drive minor use registration decisions. Over the past ten to fifteen years there have been several external factors that have negatively impacted the rate of new herbicide production from industry. These include industry consolidation, a decrease in the global value of the conventional herbicide market, adoption of HTC technology, a substantial increase in regulatory activity primarily through re-registration programs in the U.S. and EU, and increased costs of discovery research and product development. This increased cost of doing business in an increasingly competitive market has undoubtedly forced industry players to adopt different discovery strategies. For instance companies may focus future efforts only on crops where HTC technology has not, or is not anticipated, to reduce market value.

Business economics dictate that companies will focus only on crops and discovery effort that will create a significant positive return on investment. And in most cases development of new herbicides for minor crops is not economically viable due to low or negative return on investment and disproportionate liability risk. Also, most multinational companies focus primary on conventional chemistry rather than organic approaches, where regulatory processes are complex and success is rarely achieved. However it is very possible in the future to produce active ingredients derived from natural products, a discovery approach currently taken by several multinational companies. However, to motivate increased participation companies need incentives and mechanisms to mitigate risk.

The IR-4 program and increased data protection are current government programs in place that defray cost and provide incentives. Other incentives should be explored to make minor crops more attractive targets. Examples of this are reduced registration timelines and fees, and possibly extended patent protection. However liability risk and/or dedicating the necessary resources to adequately research crop selectivity are still major economic barriers. Creative solutions to ensure that companies are not unreasonably exposed to yield loss claims would remove one primary reason why companies are reluctant to register their herbicides for minor crops.

Additional Index Words: Minor crops; specialty crops; weed control; industry.
Abbreviations: IR-4, Interregional Project 4; HTC, herbicide tolerant crop

Nutsedge Control in Onions

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INTRODUCTION

There were 49,000 acres of onions produced in California in 2007 which is 30% of US production (NASS, 2008). 2,255 of the California acres are located in Monterey and Ventura Counties. The coastal districts provide a specific niche for the onion market by supplying onions late summer to fall when other districts have finished harvest operations. Onions are particularly susceptible to weed pressure because they have slow seedling development and they do not form a competitive canopy later in the growth cycle. In conventional systems growers rely upon a preemergence herbicide to reduce weed pressure during the seedling stage and upon postemergence applications to kill escaped weeds and to apply a preemergence material to inhibit weed emergence later in the growth cycle. In 2007 and 2008 several new registrations of herbicides or modified labeled uses were granted:

- Goal Tender for use at the 1st true leaf stage (prior label use stated 2nd true leaf stage)
- Prowl H2O for use at the loop stage (prior label use stated 2nd to 9th true leaf stage)
- Nortron for preemergence and postemergence use (growth stage not specified)
- Outlook for use against yellow nutsedge at the 2nd true leaf stage
- Dual Magnum for use against yellow nutsedge at the 4th true leaf stage

These registrations have greatly improved weed control programs in onions by giving growers increased herbicide choices and increased flexibility regarding when during the crop cycle they can be used.

Outlook was registered in 2007 prior to the onion growing season and growers used this material during both the 2007 and 2008 growing seasons. Dual Magnum was registered at the end of the growing season in 2008 and growers have not yet been able to use it along the coast. Outlook is registered for use at the 2nd true leaf stage and Dual Magnum at the 4th true leaf stage. Yellow nutsedge (*Cyperus esculentus*) is a warm season weed that emerges when soil temperatures warm in the late spring. In 2006 the weather was wet and cool. In a trial conducted in 2006, both Outlook and Dual Magnum were applied at the 2nd true leaf stage (May 8) and there was little emergence of yellow nutsedge at that time. Both materials had reduced nutsedge emergence at the weed evaluation conducted 76 days after planting. A small number of nutsedge plants broke through at the 120 days after planting weed evaluation, but in general both materials provided excellent control of yellow nutsedge and good safety to the onions. However, in the 2007 trial the spring weather was dry and warm and by the 2nd true leaf stage on April 11 there was significant emergence of well developed nutsedge plants. Outlook is not effective against established nutsedge plants. As a result, this research project was initiated to evaluate burning nutsedge back with an acid fertilizer (7-7-0-7) and then applying Outlook. This research report discusses the results of trials conducted in 2007 and 2008.

METHODS

Two field trials were conducted in Monterey County: ***Trial No. 1***: This trial was established with a cooperating grower south of King City. The soil at the site was Metz complex loamy sand. Each plot was one 40 inch bed wide by 25 feet long; the plots were arranged in a randomized complete block design with four replications. The field variety was 'Tamara' and was planted on March 4, 2007. Prior to the establishment of the trial, the field had been treated with Dacthal post plant preemergence and Goal Tender at the first true leaf stage; both of these materials had no impact on the nutsedge population. First true leaf applications were made on April 4 and second true leaf on April 11. The acid based fertilizer 7-7-0-7 and Outlook was applied at the first and second true leaf stages (see Tables for application rates and timing). Irrigation was applied on the first or second day following the Outlook applications to incorporate the material into the soil. Evaluations of the number of nutlets in the soil of each treatment were conducted by collecting roughly 8,000 – 10,000 cm^3 of soil on September 27. The soil was sieved to remove all nutlets in the soil which were then counted and weighed. The number of nutlets in each sample was converted to nutlets per 1,000 cm^3. Yield evaluations were conducted on September 27 by harvesting all bulbs in an eight foot long strip in the middle of each plot and counting and weighing bulbs. ***Trial No. 2:*** This trial was conducted with a cooperating grower west of San Ardo. The soil type at the site was Pico fine sandy loam. Each plot was one 40-inch bed wide by 30 feet long and replicated four times in a randomized complete block design. The field variety was planted to a proprietary dehydration variety from ConAgra on March 10. Prior to the establishment of the trial, the field had been treated with Dacthal post plant preemergence and Goal Tender at the first true leaf stage; both of these materials had no impact on the nutsedge population. The first true leaf applications were made on April 10 and the second true leaf on April 21. The acid based fertilizer 7-7-0-7 and Outlook were applied at the first and second true leaf stages (see Tables for application rates and timing). Irrigation was applied on the first or second day following the Outlook applications to incorporate the material into the soil. Evaluations of the number of nutlets in the soil of each treatment were conducted by collecting roughly 8,000 – 10,000 cm^3 of soil on September 19. The soil was sieved to remove all nutlets in the soil which were then counted and weighed. The number of nutlets in each sample was converted to nutlets per 1,000 cm^3. Yield evaluations were conducted on September 19 by harvesting all bulbs in an eight foot long strip in the middle of each plot and counting and weighing bulbs. ***Trial No. 3.*** In a herbicide trail at Oxnard, CA, May – September 2007, Outlook and Dual Magnum were evaluated for yellow nutsedge control in a sandy loam soil. Dual Magnum was applied at 4 leaf stage of onion at 0.63 lb a.i. /acre (May) and repeatedly at 0.95 lb a.i./acre at 5-6 leaf stage (June) and at bulb formation in July, while Outlook was applied at the same three timings but always at 0.33 lb a. i. /acre rate.

Details for all trials: All materials were applied with a CO_2 backpack sprayer with two passes of a one nozzle wand with an 8008E tip at 30 psi applying the equivalent of 72 gallons per acre.

RESULTS

Trial No. 1: The trial site was heavily infested with yellow nutsedge. The nutsedge was emerged by the time the onions were at the first and second true leaf stage. Given that Outlook is a post emergence material, it was thought that if the nutsedge was burned back with an acid based fertilizer (e.g. 7-7-0-7) then Outlook could inhibit the emergence of new leaves of nutsedge. Weed pressure was so extreme in the trial that weed control ratings were used to evaluate treatments rather than weed counts. First true leaf applications of Outlook gave better weed control than second true leaf applications on the April 23 and May 4 evaluation dates, but by June 1 all Outlook treatments had similar weed control ratings (Table 1). All Outlook treatments had greatly improved weed control than the untreated control. However, on the August 9 evaluation date the nutsedge began to resprout and weed control began to breakdown. There was no significant phytotoxicity in any of the treatments. There were significantly fewer nutsedge and lower weight of nutsedge nutlets in the soil in the Outlook treated plots (Table 2). There is a trend that indicates that the 14 oz/A application had fewer nutsedge in the soil than the two sequential applications of 7.0 oz/A. Yields of all Outlook treatments were improved over the untreated (Table 2). However, yields were less than observed in an adjacent trial in a part of the field with little nutsedge pressure (data not shown), which may indicate that there was a yield reduction which may have been due to the following factors: 1) nutsedge pressure; 2) phytotoxicity from 7-7-0-7 applications; or 3) a combination of these factors.

Trial No. 2: This trial was conducted in a field with an extremely high nutsedge population. Nutsedge was emerged and well established by the first and second true leaf stages. Early applications of the acid fertilizer 7-7-0-7 in combination with 7.0 or 14.0 oz/A of Outlook provided the better nutsedge control for two months after application than applications made at the 2nd true leaf stage (Table 3). By July 29 the level of control provided by Outlook was breaking down and the nutsedge was resprouting and all treatments declined in efficacy. One treatment included Goal Tender at the first true leaf stage and this treatment also provided excellent weed control but was the most phytotoxic treatment on most evaluation dates (Table 3). The stand of onions in this trial was impacted by the high nutsedge population early in the growth cycle and the yield evaluations are a bit difficult to interpret due to variability in the data. In general it appears that the 1st true leaf applications of Outlook at 14.0 oz/A had lower yield than the 7.0 followed by 7.0 oz/A treatment. The untreated plots had no marketable yield. The variety used in this trial was less vigorous than varieties used for fresh market and the regrowth of nutsedge was higher in the part of the field with this variety than in an adjacent planting of a more vigorous fresh market type of onion.

Trial No. 3. Dual Magnum completely prevented nutsedge shoot emergence from 21 May to 26 June, while Outlook reduced it more than 70% during the same period compared to untreated control, in which 77 shoots per 45ft^2 plot emerged. In July nutsedge emergences continued at accelerated rate due to warmer soil temperatures and changed from 77 shoots/plot to 278 shoots/plot from 11 July to 7 August. Repeated applications of increased rate of Dual Magnum were effective in preventing shoot germination and the nutsedge shoot density changed from 10 to 18 shoots/plot for the same time period, and was significantly lower than untreated. Nutsedge emergence in plots treated with Outlook changed from 20 to 61 shoots/plot but was not statistically different from untreated control, likely due to large variability in nutsedge density among all plots. No significant crop injuru or associated yield reduction was observed following these in-seaosn applications of Dual Magnum and Outlook.

CONCLUSIONS

Yellow nutsedge is a serious weed in onion production. It cannot be effectively removed by hand or cultivation and has the potential to devastate the yield of onions. Both Outlook and Dual Magnum are registered for use on onions to control yellow nutsedge. Neither of these materials have postemergence activity on onions and in most years the nutsedge will be emerged prior to the allowed timing for use of these materials. These trials showed that burning nutsedge back with an acid based fertilizer such as 7-7-0-7 allowed the subsequent application of Outlook to effectively inhibit nutsedge regrowth for about two months. The control provided by Outlook and Dual Mangum helped to safeguard the yield of onions which otherwise was greatly reduced by competition by nutsedge. Outlook reduced the number and size of nutsedge tubers in treated plots and may help reduce nutsedge pressure in subsequent crops. Dual was safe in onions when applied in-season and provided good nutsedge control in southern California, where yellow nutsedge emerges continuously throughout late spring and summer.

LITERATURE CITED

NASS. 2008. Vegetable 2007 Summary. Agricultural Statistics Board, NASS USDA. Washington, D.C. 86 pp.

Pereira, W., G. Crabtree and R.D. Williams. 1987. Herbicide action on purple and yellow nutsedge (*Cyperus rotundus and C. esculentus*). Weed Technology 1:92-98.

ACKNOWLEDGEMENTS

We would like to thank the cooperating growers: Rio Farms, Jim Gill and Christensen and Giannini Farms for their cooperation in conducting the field trials and staff research associates Miriam Silva Ruiz and Salvador Montes.

Table 1. Trial No. 1. Weed ratings[1] and phytotoxicity ratings on April 23, May 4, June 1 and August 9, 2007

No.	Treatment	Material/A	a.i./A lbs	Application Timing	Nutsedge				Phytotoxicity			
					4/23	5/4	6/1	8/9	4/23	5/4	6/1	8/9
1	7-7-0-7 Fb Outlook 6.0 Fb Outlook 6.0	35 gallons 7.0 oz 7.0 oz	 0.33 0.33	Post 1 t. leaf Post 1 t. leaf 14 days later	5.8	7.8	8.3	3.5	0.2	0.0	0.0	0.0
2	7-7-0-7 Fb Outlook 6.0	35 gallons 14.0 oz	 0.66	Post 1 t. leaf Post 1 t. leaf	6.7	8.0	8.6	3.5	0.3	0.0	0.0	0.0
3	7-7-0-7 Fb Outlook 6.0 Fb Outlook 6.0	35 gallons 7.0 oz 7.0 oz	 0.33 0.33	Post 2 t. leaf Post 2 t. leaf 14 days later	2.3	4.2	8.1	3.1	0.0	0.0	0.0	0.0
4	7-7-0-7 Fb Outlook 6.0	35 gallons 14.0 oz	 0.66	Post 2 t. leaf Post 2 t. leaf	2.8	5.3	8.0	3.3	0.0	0.0	0.0	0.0
5	Untreated	----	----	----	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LSD (0.05)	----	----	----	0.9	1.1	0.6	0.6	n.s.	n.s.	n.s.	n.s.

1 – Scale: 0 = no weed control to 10 complete weed control.

Table 2. Trial No. 1. Yellow nutsedge nutlet counts in soil and onion yield evaluations on September 27, 2007

No.	Treatment	Material/A	a.i./A lbs	Application Timing	Nutlets/ 1000 cm^3 soil	Nutlets Wt (gr)/ 1000 cm^3 soil	Nutlets Mean wt (gr)	Onion Yield Tons/A	Onion Yield Bulbs/A	Onion Mean wt/head
1	7-7-0-7 Fb Outlook 6.0 Fb Outlook 6.0	35 gallons 7.0 oz 7.0 oz	 0.33 0.33	Post 1 t. leaf Post 1 t. leaf 14 days later	103.6 a	7.52 a	0.072	46.5	97,206	0.78
2	7-7-0-7 Fb Outlook 6.0	35 gallons 14.0 oz	 0.66	Post 1 t. leaf Post 1 t. leaf	61.8 a	5.28 a	0.079	47.2	89,854	0.86
3	7-7-0-7 Fb Outlook 6.0 Fb Outlook 6.0	35 gallons 7.0 oz 7.0 oz	 0.33 0.33	Post 2 t. leaf Post 2 t. leaf 14 days later	116.8 a	7.51 a	0.076	45.7	88,220	0.84
4	7-7-0-7 Fb Outlook 6.0	35 gallons 14.0 oz	 0.66	Post 2 t. leaf Post 2 t. leaf	98.2 a	6.21 a	0.070	46.3	90,181	0.84
5	Untreated	----	----	----	290.6 b	25.45 b	0.093	34.7	97,533	0.58
	LSD (0.05)	----	----	----	123.8	8.90	n.s.	9.9	n.s.	0.14

1 – Scale: 0 = no weed control to 10 complete weed control.

Table 3. Trial No. 2: Nutsedge weed rating[1] (upper number in each cell) and Phytotoxicity ratings[2] (lower number in each cell – shaded grey) on six dates.

.Treatment	Material /A	Timing	April 25	April 29	May 8	May 14	June 5	July 29
7-7-0-7 Outlook 7-7-0-7 Outlook	60 gal 7 oz 30 gal 7 oz	1st true leaf 1st true leaf 2nd true leaf 2nd true leaf	7.0 3.2	7.5 2.7	7.0 1.2	6.6 2.0	7.8 1.5	4.5 3.0
7-7-0-7 Outlook 7-7-0-7	60 gal 14 oz 30 gal	1st true leaf 1st true leaf 2nd true leaf	8.0 3.7	8.5 3.7	8.5 3.0	8.3 3.5	9.1 4.2	5.0 2.8
7-7-0-7 Outlook	60 gal 7 oz	2nd true leaf 2nd true leaf	3.7 2.5	6.2 2.0	4.7 1.0	5.0 1.5	4.2 2.0	3.8 2.3
7-7-0-7 Outlook	60 gal 14 oz	2nd true leaf 2nd true leaf	5.0 3.2	6.5 2.0	5.5 0.7	5.0 1.7	6.5 1.7	3.5 2.5
7-7-0-7 Outlook Goal Tender	60 gal 14 oz 8 oz	1st true leaf 1st true leaf 1st true leaf	7.8 4.2	8.2 4.2	8.7 3.0	8.0 4.2	8.3 3.5	5.8 4.0
Untreated	----	----	0.0	0.0	0.0	0.0	0.0	0.0
Pr>F Weed Rating			<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
LSD 0.05 Weed Rating			1.5	0.7	1.3	1.3	1.6	1.6
Pr>F Phytoxicity			<0.0001	<0.0001	<0.0001	<0.0001	0.0004	0.0009
LSD Phytoxicity			0.6	1.1	0.6	1.2	1.5	1.4

1 – Rating: 0 = no weed control to 10 = total weed control; 2 – Scale: 0 = no crop damage to 10 = crop dead

Table 4. Trial No. 2: Yield evaluation on September 19.

Treatment	Material/A	Timing	Marketable			Culls			Total		
			1000's/A	T/A	Mean lbs	1000's/A	T/A	Mean lbs	1000's/A	T/A	Mean lbs
7-7-0-7 Outlook 7-7-0-7 Outlook	60 gal 7 oz 30 gal 7 oz	1st true leaf 1st true leaf 2nd true leaf 2nd true leaf	128.7	14.4	0.22	10.8	0.1	0.04	139.5	14.6	0.21
7-7-0-7 Outlook 7-7-0-7	60 gal 14 oz 30 gal	1st true leaf 1st true leaf 2nd true leaf	84.9	11.2	0.28	9.1	0.3	0.05	94.0	11.6	0.26
7-7-0-7 Outlook	60 gal 7 oz	2nd true leaf 2nd true leaf	110.1	9.4	0.17	36.8	0.8	0.05	147.0	10.3	0.15
7-7-0-7 Outlook	60 gal 14 oz	2nd true leaf 2nd true leaf	143.1	16.2	0.23	18.6	0.5	0.05	161.8	16.7	0.21
7-7-0-7 Outlook Goal Tender	60 gal 14 oz 8 oz	1st true leaf 1st true leaf 1st true leaf	102.5	11.8	0.23	14.1	0.4	0.05	116.6	12.1	0.21
Untreated	----	----	0.0	0.0	0.0	1.0	0.1	0.01	1.0	0.1	0.01
Pr>F			<0.0001	<0.0001	<0.0001	0.0870	0.0488	0.0228	<0.0001	<0.0001	<0.0001
LSD 0.05			33.0	3.5	0.06	23.7	0.5	0.03	48.7	3.5	0.06

Is There a Bigger Role for Precision Agriculture in Vegetable Crops?

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Integrated weed management in vegetable crops requires the use of hand weeding and cultivation for the economical control of weeds. Precision cultivation, the use of robotics/machine vision technology, can improve the efficiency of cultivation and reduce the use of expensive hand weeding. In 2007 and 2008, four trials were conducted on romaine lettuce and two trials were conducted on celery to test if RoboCrop©, a computerized vision-guided precision cultivation machine, could reduce hand weeding times and increase herbicide application efficiency.

In the four lettuce trials conducted, three different cultivation tools and two directed post-emergent herbicides were tested with the RoboCrop©, both with and without pronamide applied pre-emergent at 1.2 lb ai/A. The trials were arranged in a split plot design, with pronamide as the main plot and cultivator tool or directed herbicide application as the subplot. The cultivator tools included in the comparison were: sweep knives, bezzerides (torsion weeders), and coulters with sweep knives. The post-emergent directed herbicides included pelargonic acid (Scythe) 4.2EC at 3, 6 and 9% v/v and carfentrazone (Shark) 2E applied at 0.032 lb ai/A in the 2007 trials and 0.01 lb ai/A in the 2008 trials. Data gathered were the number of marketable heads, total weed densities and hand-weeding times. Yields were not affected by any treatments; with the exception that significantly lower yields occurred in the carfentrazone treatments in 2007 due to crop injury. Pelargonic acid applied at 9% v/v consistently provided the best weed control; up to 98%. The treatments that resulted in significantly lower hand-weeding times all included pronamide.

The two celery trials (one each in 2007 and 2008) compared mechanical cultivation with sweep knives to a directed application of pelargonic acid at 3% v/v (2007) and 6 & 9% v/v (2008). Data gathered were the number of marketable bunches, total weed densities and hand-weeding times. None of the celery treatments in either trial were found to be significantly different from each other in terms of weed control, hand weeding times, or yield. This means that mechanical cultivation and directed herbicide applications have the same success rates when used with the RoboCrop© in celery.

Mulches and their Impact on Weeds

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Opaque plastic mulches are commonly used to prevent weed germination in the production of strawberries, fresh market peppers, tomatoes and other horticultural crops, especially on organic farms. Previous work by Steve Fennimore et al. showed that polyethylene (PE) mulches that were black, red, yellow, green or white on the top side and black on the under side provided 78-98% broadleaf weed control while weed control under clear or blue mulches was poor (44-50%). However, the sharp shoots of yellow nutsedge (*Cyperus esculentus*) penetrate through any commonly used PE mulch and the weed can establish within 1-2 weeks. Yellow nutsedge is difficult to control even with non-methyl bromide fumigants and there are currently no effective strategies to manage this weed in non-fumigated strawberries or in any organic production systems. Hand weeding can cost $5,000/acre per year or even more and has little effect on nutsedge tubers. Additionally, hand weeding of nutsedge requires labor allocation from other operations, such as harvest, and therefore is often not completed. When uncontrolled, nutsedge starts to produce tubers at 4-5 leaf stage; the tubers are spread in the field with tillage and are viable for up to 3 years.

In a series of experiments we have been evaluating mulches or mulch combinations for reliable, long-lasting nutsedge control. In 2006-07 an RCB experiment with five replications was conducted at Oxnard, California to compare emergence of yellow nutsedge and strawberry performance in beds covered with black PE mulch alone and beds where Novovita paper (recycled newspaper, gypsum) was laid under mulch. In 2007-2008 this experiment was repeated but Novovita paper was installed between the two layers of PE mulch, and, as additional treatments, weed barrier mat and water resistant Tyvek (DuPont) home wrap paper were tested under black PE mulch. All plots were 4 by 25 ft. In 2008-2009 all above mentioned mulch combinations were tested again, and one additional treatment included a single layer of Dura Skrim (0.167 mm thick) plastic.

In fall and winter 2006-2007 the combination of paper under plastic completely eliminated yellow nutsedge germination that otherwise germinated through plastic at a density of 0.5 plants /ft^2 per week. However, in spring when the paper disintegrated due to contact with wet soil and when soil temperature increased above 60ºF, the nutsedge resumed germination at a rate of 0.3 to 1.6 plants/ft^2 per week in all treatments. This indicated that paper with greater water resistance or that could be protected from contact with wet soil was needed for season-long control.

In 2007-2008 the plastic-paper-plastic treatment (paper between two PE mulch layers), weed barrier mat, and Tyvek all provided complete control of nutsedge shoots for nine months, which otherwise germinated through PE mulch alone at a density of 0.1 plants /ft² per week. In the first 3 months of the 2008-2009 season all treatments, including Dura-Skrim, controlled nutsedge germination 100% and the evaluation will be completed in summer 2009.

In 2006-2007 and 2007-2008 seasons none of the mulches or mulch combinations affected strawberry plant growth and fruit yield or soil temperature in the root zone. However, in 2008-2009 planting holes in weed barrier mat and in Dura Skrim plastic were small and made transplanting difficult, resulting in poor plant establishment. Since these two materials do not stretch and the planting hole can not be enlarged by hand during planting, we suggest cutting larger planting holes if these mulches are used. This is especially important for plants such as strawberry that require space within planting holes for crown division and expansion but this may be less of an issue for crops with a single stem such as pepper or tomato.

Our results so far show that all of the mulch combinations tested in 2007-2008 provided near 100% nutsedge control. Additionally, the mulch combinations significantly reduced the number of wind-dispersed weeds in planting holes, likely by minimizing weed seed-to-soil contact. The weeds in planting holes directly compete with crop and can only be selectively controlled through hand-weeding. Economic analyses of physical barriers showed that plastic-paper-plastic combination was least expensive, followed by weed barrier mat, Tyvek and Dura Skrim. Costs for all mulch treatments were less than or similar to hand weeding estimated at $6,500/acre /9 month season.

Since no deterioration was observed after nine months for Tyvek, weed barrier mat and Dura Skrim we will collect them the end of current season, store and install them at a nutsedge-infested site at the beginning of the following season. Even though additional labor may be involved, the reuse of these mulches will cut the expenses in half while reducing the need for disposal. Biodegradable mulches are also being considered as treatments for the next experiment.

Table. Evaluation of mulches and mulch combinations for weed control near Oxnard, CA.

Treatment	Years tested	Yellow nutsedge control, %[a]	Wind-dispersed weed control in planting holes, % [b]	Treatment cost, $/acre
Regular black PE mulch (control)	2006-2007	0	0	500
Paper under PE mulch	2006-2007	100 for 3 months, 0 afterwards	---	870
Paper between two PE mulch layers	2007-2008 2008-2009 [c]	100 100	67	1,370
Weed barrier matt under PE mulch	2007-2008 2008-2009	100 100	62	4,856
Tyvek home wrap under PE mulch	2007-2008 2008-2009	100 100	89	5,209
Dura Skrim plastic	2008-2009	100 100	---	6,500

[a] Yellow nutsedge control excludes nutsedge germinated in planting holes.
[b] Wind dispersed weeds were: annual sowthistle, horseweed and common groundsel.
[c] 2008-2009 evaluations are in progress and results for the first 3 month only are reported.

Pre-Commercial Screening of the Leading Biofuel Crop Miscanthus x giganteus for Invasive Plant Traits

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Miscanthus (*Miscanthus X giganteus*), a perennial grass native to central Japan, is a leading candidate as a dedicated biofuel feedstock due to its broad environmental tolerance, rapid growth rate, ability to grow in low production soils, and sterility. Aside from sterility, however, these characteristics also increase the probability of miscanthus escaping cultivation and becoming an invasive weed. Giant reed *(Arundo donax)*, a perennial grass native to the Mediterranean region, is an economically important invasive plant occurring in waterways and riparian zones throughout California and the southwestern US. Both species are potential biofuel crops and share life history characteristics and habitat preferences. To quantify the invasive potential of miscanthus in California environments, we assessed vegetative propugule shoot and root regeneration, establishment, and performance, under various types of abiotic stress. Miscanthus rhizome fragment weighing 1, 2, 5 and 10 g all generated shoots buried to a depth of 0, 5 and 10 cm. All treatment groups generated shoots and roots resulting in robust plants, except 1 g at 10 cm. Miscanthus and giant reed stem fragments weighing 1, 2, 3, and 5 g containing one node were placed and 5 and 10 cm and failed to produce any shoots that emerged, but generated shoots and roots in standing water, submerged under water with soil contact, and on the soil surface. Miscanthus and giant reed plants grown in pots for 8 weeks at soil moisture tensions ranging from flooded, control (approximately 0.0 Mpa), -0.27 Mpa, and -4.0 Mpa. Plants under drought treatments suffered reduced growth. All the plants experiencing -0.27 Mpa soil tension maintained photosynthetically active foliage for 8 week. The shoots of plants that experienced -4.0 Mpa soil tension were necrotic at the time of harvest. Rhizome fragments taken from -0.27 Mpa and -4.0 Mpa were placed in control conditions and, for both species, 75% of the fragments produced shoots. The ability of miscanthus to produce shoots and persist in both droughty and flooded conditions increases the probability of escaping field boundaries and establishing without human intervention in waterways or riparian areas.

CalTrans District 10 Weed Management Strategies: Got Russian Thistle, Marestail and Fleabane?

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Today I hope to clear up some misconceptions about how and why Caltrans performs vegetation management in general and how District 10 does it more specifically. I know there are misconceptions because I often hear what Caltrans is doing wrong and what we should be doing. Caltrans is a large, highly visible entity and it is natural that passing motorists will see what you are or aren't doing and have a better idea. Of course, most of these people don't have the slightest grasp of the restrictions, restraints, or goals that Caltrans has. Today, I hope to shed some light on these challenges and goals and give you a better appreciation of why things look the way they do as you are driving down a state highway.

District 10 is located in central California and consists of 20 highways and interstates in 8 counties. It is diverse in climate, elevation, and weed species. We have near desert conditions in the southwest and avalanche potential in the east. It's not a one size fits all district and we don't have one size fits all solutions to our vegetation management challenges.

First I'll cover the challenges and goals and later I'll contrast vegetation control methods in 2 very different parts of the district. Hopefully you'll understand why I cringe when well-meaning citizens make suggestions to me, usually around the theme of eliminating herbicide use and instead do things like mow, use biological control, solarization, replace annual grasses with perennial grasses, and my all time favorite…..just mulch everything!

Bureaucracy

How many people in this room work for a bureaucracy? My guess is that most of you do so I will not belabor the challenges and futilities of working in this environment. Of course, working for a bureaucracy in California is another story. Working for a large bureaucracy is not all bad. When you encounter a problem you can bring many resources to bear to overcome some otherwise insurmountable issues…..slowly of course. For example, you can purchase large toys and very specialized equipment that may otherwise be out of reach to a smaller organization. And to put things into context, I live in a house with four teenagers, three of them girls. Do you think I sweat coming to work on Monday mornings?

Caltrans = Safety First

Caltrans is regulated by volumes of safety regulations which have been established over the years mostly as a result of many deaths and injuries to both employees and the public. I can't overemphasize how dangerous it is both on the highway and adjacent to it. Any maintenance operation must follow strict guidelines therefore any vegetation operation will be first and foremost influenced by safety considerations. Any method, no matter how appealing or popular, will not happen if it compromises safety. We prefer methods that keep maintenance personnel out of harms way as much as possible. That means methods that are proven, proactive, and that can be performed from the relative safety of a large piece of equipment.

Environmental

In district 10 there is a large staff of people whose job it is to identify and protect environmentally sensitive areas, or "ESA"s. ESA's may include endangered species' habitats, sensitive watershed sites, wetland areas, fossil locations and any number of other reasons one might want to protect a location. Environmental concerns can and do dictate what, if any, maintenance can be performed in these locations. There are 84 pages and several areas per page that we are not allowed to spray in. Some of these locations restrict even mechanical weed control. Identified bus stops are also listed and they restrict spraying within 100 feet.

The Environmental Impact Report of 1992

In 1992, Caltrans agreed to abide by the suggestions of an Environmental Impact Report which was done to address concerns that Caltrans was using too many herbicides and destroying the Earth. The EIR suggested we reduce herbicide usage by 50% by 2000 and 80% by 2012. The EIR also suggested we take a more sophisticated approach and institute Integrated Vegetation Management practices such as cultural, biological, mechanical, and other methods instead of relying on herbicide usage. In addition, we are required to submit a mitigation checklist and an annual vegetation control plan which lays out the vegetation management method we plan to use for every mile of every highway.

The 2000 goal of a 50% reduction has been accomplished and was done by reducing fire strips, reducing width of applications and using more sophisticated products with much lower use rates. It can be argued that the EIR was a success but I'd have to argue that it is only a partial success due to the fact that we have more and larger fires and an increased incidence of noxious weeds taking root on our shoulders and spreading to adjacent property.

Stormwater

Over the last 10 to 15 years, the importance of storm water runoff control has greatly increased. The result of this influence is manifested in the increased use of shoulder grasses as a biofilter to help control soil erosion and control toxic laden highway runoff. This has reduced the number and width of fire strips in District 10 and is considered effective if the mowing can be timed correctly. This is also political. Current management would like to see more fire strips. District 10 used to chemically mow its shoulders and medians but management decided to go in another direction.

Approved Chemical List

Another restriction we have is the Caltrans approved chemical list. If we choose to spray chemicals we can only use products that have gone through a detailed review process. This list includes surfactants and adjuvants. Almost all the products on the list are category 3. Most of the adjuvants and surfactants are counted in the active ingredient totals so unfortunately this is a disincentive to use them. The review process also includes field trials of the various submitted products in roadside locations which are documented for efficacy.

Goals

I've mentioned many though not all of the restrictions and considerations we have to contend with before we can get to the business of controlling vegetation on our roadsides. As far as goals go I'd like to mention the following statement from headquarters concerning vegetation control. "The Department's goal is to maintain a safe, effective and economical vegetation control program which responds to public concerns in an open, flexible and professional manner." In addition to that, Caltrans' greater goal is to improve mobility across California. Caltrans specifically manages vegetation for the following reasons. Sight distance and fire-risk management, prevent pavement degradation, control noxious weeds, clear drainage facilities, and improve aesthetics. Keep in mind that the actual roadway receives most of the resources and the roadsides get what's left over.

State Highway 88

Highway 88 has its humble beginnings in Stockton at Highway 99 and ends more majestically in the High Sierra at the Nevada state line. It is considered an all weather highway which is in the foundation for our vegetation management challenges there. The route is used by gamblers going to Tahoe or Jackson, skiers going to and from Kirkwood, logging trucks, off road recreation lovers, and unfortunately out of state hay hauling trucks.

Because of this, we have the greatest concentration of "A" rated weeds in our district along this highway. To complicate matters, we also have some of the most sensitive areas in the district located here. The weed palate consists of the exotic Skeleton Weed, various Knapweeds, Oblong Spurge, Klamath Weed, and various Thistle species. In addition to those we have the usual suspects in abundance including Blackberry, Ailanthus, Poison Oak, Marestail, and Yellow starthistle. Currently we are very concerned about the spread of some of the broom species. At the lower elevations we have many orchards and vineyards adjacent to our right of way that we must be concerned with when making chemical choices. In the foothills we pass through large expanses of pastureland which requires being sensitive to fire concerns and containment of the Yellow star thistle. Where the highway enters the Mother Lode we start to see pressure from Ailanthus and blackberry. Just above Jackson the woody species and "A" rated weeds really become an issue especially due to the increased presence of sensitive areas such as State and National Forests, watersheds and State Parks. This is where an Integrated Vegetation Management approach becomes valuable. We employ techniques such as using an articulated arm brush mower to control blackberry and other woody species in sensitive areas. We also use California Conservation Corps labor for woody species control and we are exploring the use of weed mats under guardrail in sensitive watershed locations. We also try to be diligent with mowing the roadside grasses and try to cooperate with landowners with fire strips.

From a chemical standpoint, we use products labeled in orchards and vineyards such as Goaltender™ for use anywhere near these locations. In the pasture locations we use Telar™ for pre emergent broadleaf weed control and Transline™ or Milestone VM™ for Yellowstar touchup post emergent. At the higher elevations we're starting to use MilestoneVM™ and Roundup and are excited with the results. This is a very strong tank mix for control of the Knapweeds, thistles, and broom. We are anticipating the approval of Milestone VM Plus™ which I have tested extensively. I anticipate we will be able to substantially reduce our labor efforts for woody species control in locations where we can use it and that means fewer man hours in harms way.

Merced County, Interstate 5, and State Highway 152

At the opposite end of the district we have conditions in stark contrast to what I just covered. This area gets little rainfall, is usually windy, is hotter and the water is at a ph of 8 or more. The roadways are broad and the rights of way broader still. Both I-5 and 152 have wide center medians and often equally wide rights of way on the shoulder. This is the land of Russian Thistle and other tumbleweeds. We are also blessed with an abundance of Prickly Lettuce, Marestail, Fleabane, Mustard, Filaree and Datura. These weeds give this area a survivor personality and traits like stubborn and difficult come to mind.

Due to the lack of rainfall, the grasses don't compete well and spot fires often clear out patches of what grass does grow exposing the soil to opportunities for Russian Thsitle to take hold. We try to mow the accessible locations but usually we only have the resources to mow once and that is not enough. Chemically we are challenged by the fact that Roundup requires a buffering agent in the highest ph range we find in this area and we currently don't have one on the Caltrans list. For pre emergent control, we use Telar or Goaltender but can go only 25 feet from either side on a 100 foot median. The limited number of pre emergents available makes me concerned for resistance potential. In addition, weed carcasses make it difficult for good application of herbicides. On Highway 152 many of the medians are low lying and are often wet much of the year.

Due to the fact that most of our equipment is large, we are limited on where we can apply herbicides to flat, dry locations. We are currently looking at acquiring some smaller spray equipment which will allow us more flexibility. Also, our equipment is designed for the road and we could use the capability to do more off-road work. We have a tumbleweed mower available, but due to the scale of the problem it hasn't been proved effective. From an herbicide standpoint, we were not satisfied with the control we were getting from various tank mixes for broadleaf control on our off/onramps in this area. After some testing, we hit on a tank mix with Telar XP™ and Milestone VM™ we are excited about. We had season long control of Russian thistle from a December application. In addition to that we started adding Milestone VM™ to our post emergent Roundup™ applications and it looks like it is having suppressive results on the Russian thistle. I believe this will also help with resistance issues.

In conclusion, I hope that you can better appreciate the challenges and restrictions Caltrans faces as well as our goals. Physical resources are only part of the solution in the environment that exists in California. There are a large number of concerned and knowledgeable people willing to assist in just about any vegetation management issue you may encounter. I count as resources the various County Agriculture Commissioners, UC extension agents, Weed Management Association members, chemical company reps., utility managers and many more. I thank CWSS for this opportunity to add my perspective to the California weed management challenge.

Santa Clara Valley Water District Weed Management Strategies: Got Regulations?

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Introduction

In 1989, the Santa Clara Valley Water District (District) began the process of preparing an Environmental Impact Report (EIR) for its herbicide activities. At the time, the intended outcome of the EIR was to reinstate the use of herbicides as a maintenance tool in southern Santa Clara County. Herbicide use had been discontinued on District properties south of Cochran Road in Morgan Hill fifteen years earlier.

While work progressed on the initial outcome, changes in other areas of the maintenance program mandated that a more comprehensive EIR be prepared to address all stream maintenance activities. And hence the Stream Maintenance EIR for the Santa Clara Valley Water District was born.

The content of this paper is limited to the vegetation management activities of the District's flood control work.

From a vegetation management perspective, maintenance staff was tasked with identifying the maintenance activities and their associated impacts. Once quantifying the programmatic impacts, staff began negotiating mitigation packages with regulatory staff and community groups. A key component of the success of the program approval was the involvement of these stakeholder groups from the early planning stages, into the program implementation, and routinely as the program evolves.

Twelve years later, the District kicked off its first work season under the Stream Maintenance Program EIR in 2002. The programmatic document defined an ongoing program with an initial permitting life of ten years. You may have noticed by now that it took twelve years to get a ten year permit – and yes, we are working on our next one!

The Vegetation Management Program Components

The vegetation management program is an integrated program which combines a variety of mechanical, cultural, hand removal and herbicide activities to address vegetation management needs on District streams. There are two major components of the program, with each one providing a separate outcome.

1. In stream vegetation control for storm water conveyance
Aquatic herbicides, hand clearing and channel mowing are all combined to manage the District's 500 plus miles of streams throughout the county. The entire program impacts 223 acres of in stream riparian and wetland vegetation. Mitigation for these impacts includes control of invasive species (Arundo donax and Spartina alternaflora), land preservation in the upper watershed areas and wetland creation. Since the program mitigates for impacts one time, an acre of wetland or riparian vegetation can be managed in multiple years, while only mitigated for one time. This is one of the many benefits of a comprehensive program design.

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To balance flood control and environmental concerns, selective removal of both riparian and wetland vegetation is performed throughout most of the channel cross section, while maintenance guidelines require the removal of all vegetation within 100' of the upstream and downstream side of bridges. Vegetative buffers are established along low flow channels of streams to minimize impacts to aquatic species

2. Right of way maintenance for access and fire prevention
Short term residual pre emergence herbicides (Pendulum and Gallery) are tank mixed with Roundup Pro Concentrate to control weeds on top of bank areas such as fire breaks and maintenance access roads. Channel slopes are mowed and large open areas are mechanically disked each spring to meet local fire codes and provide maintenance access.

Best Management Practices and work calendar

As a safeguard to the public and the environment, herbicide applications may only be performed by staff or contractors possessing a Qualified Applicator Certificate or Qualified Applicator License in the appropriate categories (Aquatics and Right of Way). Having this safeguard was a key component in getting regulatory agency approval of the herbicide program. The District pays for the licensing and provides a five percent differential to employees who apply herbicides in the regular course of their daily duties as an incentive. The District is tasked with performing over 500 acres of in stream work between July 1st and October 15th of each year. This is the general period between the end of bird nesting season and the beginning of anadromous fish migration. Since birds and fish do not use calendars, these dates may fluctuate depending on the species and the area of the county. This gives the herbicide crews less than a few weeks in some cases to get the areas done within the environmental window.

Summary and Conclusion

In summary, the District is continually striving to meet its mission:

“***The mission*** *of the Santa Clara Valley Water District is a healthy, safe and enhanced quality of living in Santa Clara County through* ***watershed stewardship*** *and* ***comprehensive management of water resources*** *in a* ***practical, cost-effective*** *and* ***environmentally sensitive manner.”***

In order to achieve this mission, it is necessary to balance flood control, water supply, fire protection and environmental stewardship. To add to this balancing act, work projects need to be performed within budget in these trying fiscal times. There will always be a challenge of doing more work with fewer resources. A comprehensive maintenance EIR will have significant initial costs, but if properly prepared will pay for itself in the first few years of implementation.

This has been a brief description of a very comprehensive program. For additional information, please contact the author.

Enhancing the Transmission Corridors for all Stake Holders: A Cooperative Effort

Bob Brenton, Brenton VMS, Folsom, CA

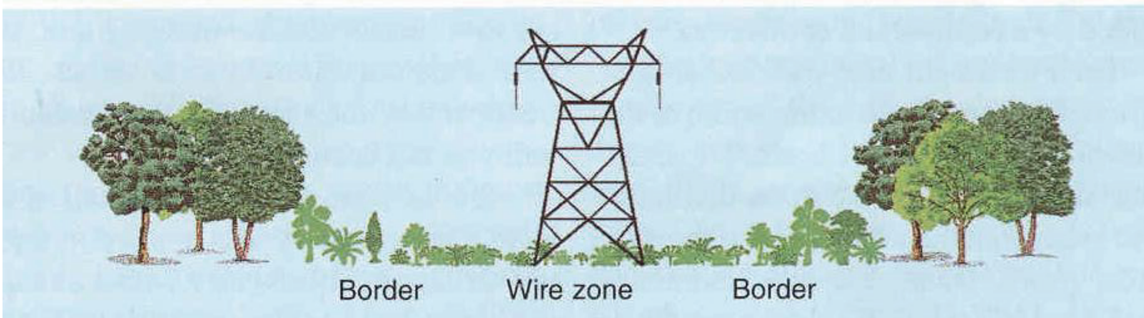
Enhancement is the implementation of an Integrated Vegetation Management (IVM) plan to manage incompatible vegetation associated with transmission rights-of-way. Properly maintained rights-of-way are essential for the safety of the public and workers, to minimize vegetation-related outages, to provide access for inspection and maintenance of facilities and for the timely restoration of service during emergency conditions.

Interestingly enough rights-of-way that are managed for the above goals have some additional benefits for wildlife. Drs. Bramble and Byrnes who first began studying rights-of-way management techniques and their effect on wildlife in 1953 developed the concept of the wire zone/border zone method in 1982. The Wire Zone, which includes the ROW area lying under the transmission wire plus 10 feet on both sides is managed for low-growing shrub-forb-grass plant community (early successional) while the Border Zone, which is the portion of the ROW that extends from 10' outside of the wire to the edge of the ROW, is managed for taller shrubs, and brush plant community (transition zone). This is depicted in the figure below. Managing the wire zone/border zone utilizing an IVM approach results in greater plant and animal diversity.

IVM is a system of managing pest vegetation in which action thresholds are considered, then all possible control options are evaluated and finally the management tactics are selected and implemented. Vegetation management on electric transmission rights-of-way and roads includes a combination of mechanical, cultural, biological, and chemical methods that manipulate existing vegetation into relatively stable communities of low growing grasses and broad-leaf species. Control options are used to prevent or remedy unacceptable pest activity or damage. The choice of control options is based on worker/public health and safety, environmental impact, effectiveness, site characteristics, and economics. The Edison Electric Institute, the Utility Arborist Association and the Environmental Protection Agency Pesticide Stewardship Program support IVM programs key to the enhancing of the ROW.

The first step is to clear the right-of-way by removing incompatible vegetation. This is typically accomplished either mechanically or manually. Cutting or mowing vegetation perpetuates the growth of incompatible vegetation because of the biological response of resprouting. The right-of-way is then monitored for resprouting and reinvasion by incompatible vegetation. Once this occurs, the right-of-way is then managed, or enhanced, to provide the desired outcome. A number of factors are considered before the enhancement method or methods are chosen and implemented, and enhancement frequently includes the use of herbicide applications to selectively control the incompatible vegetation.

The long-term goal of a vegetation management program is to provide for public safety, worker safety, and environmental safety while providing for reliable service by converting right-of-way plant communities from predominately tall growing plant species to communities dominated by low growing plant species. This can be accomplished by selectively controlling incompatible plants while preserving low growing grasses, herbs and woody shrubs over a period of many years. With proper management, the low growing vegetation can eventually dominate the right-of-way and retard the growth of the tall growing vegetation, providing control of incompatible vegetation and reducing the need for future treatments.



Potential Expansion of CDFA's Noxious Weeds Based on a Climate Matching Model

Joseph M. DiTomaso, Dept. of Plant Sciences, University of California, Davis, jmditomaso@ucdavis.edu, Elizabeth D. Brusati and Doug Johnson, California Invasive Plant Council

Risk assessment is the evaluation of current and potential future impacts. It is a critical component of invasive plant management and policy, and is essential to implementation of state and federal plans. With budget reductions, private and public land managers must focus their effort on high priority species and areas to produce the most effective ecosystem restoration. Predictive models have been used to assist in early detection of invasive species by forecasting where invasive plants may spread and predicting the effects of global climate change. Although there are 200 invasive species of wildlands in California (California Invasive Plant Council Inventory, 2006), we limited of initial work to evaluating the current and predicted range of 36 of these plant species. We surveyed Weed Management Areas for data on current extent and population status (stable, increasing, decreasing due to control). To predict future spread, we used information on the native and introduced ranges of these plants globally and applied this information through the climate-based modeling software CLIMEX. We then applied a climate-change scenario to the predictions to determine the potential suitable habitats within the state. Results show that some of these species have the potential to greatly expand their ranges with or without climate change. Individual species showed wide variation in their response to climate change, with some species showing a doubled in the amount of suitable habitat while others showed over 75% reduction in their potential range. Results may help land managers set priorities for vegetation management and design early detection programs.

Efficacy of a Natural Product on Some Common Vineyard and Orchard Weeds

Anil Shrestha, Dept. of Plant Science, California State University,Fresno

John Roncoroni, University of California Cooperative Extension, Napa

Black walnut (*Juglans nigra*) is known to have allelopathic effects on other plants. If extracts from black walnut could be commercially formulated as a bioherbicide, they may become an important weed management tool. NatureCur ® is a commercial extract of black walnut currently being sold as a root health promoter in turfgrass. Toxicity of this product was noticed on some weed species in 2006. Therefore, field studies were conducted in 2007 and 2008 to test the toxicity of several concentrations of a NatureCur ® on seeds and seedlings of several weed species in the laboratory, greenhouse, and in an orchard and vineyard. Petri dish experiments showed that the LD_{50} of the NatureCur ® solution for horseweed (*Conyza canadensis*) and hairy fleabane (*Conyza bonariensis*) seeds was 16.8 and 14.4 ml/L water (v/v), respectively. However, the LD_{50} for common purslane (*Portulaca oleraceae*) and tall annual morningglory (*Ipomoea purpurea*) seeds was 25.8 and 25.4 ml/L water (v/v), respectively. Weed seedlings grown in pots in the greenhouse were inhibited when 15 ml of the solution with a concentration of 50 ml/L water (v/v) was applied as a soil-drench. Micro-plot experiments in the orchard showed that application of 1 L of the solution with a concentration of 75 ml/L water (v/v) killed 100% of the natural population of horseweed seedlings when applied as a soil-drench. Similarly, the same concentration of NatureCur ® applied as a soil drench provided season-long control of horseweed and hairy fleabane but was less effective against grasses. This formulation of NatureCur ® has potential as a pre- and post-emergent broadleaf herbicide. The product, however, has not yet been registered as a pesticide and efficient methods of applying the material in the field need to be developed for commercial acceptance of this product as an herbicide.

Evaluation of Reduced Methyl Bromide Rates and Alternative Fumigants in a Stonefruit Nursery

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California currently has over 1.2 million acres of bearing fruit and nut crops and, in any given year, significant portions are replanted due to declining productivity or changing market preferences. Establishment of productive orchards begins with vigorous, high-quality nursery stock. The perennial crop nursery industry, a $165 million annual contributor to California's economy, usually produces nursery stock in a 3-5 year cropping cycle that may include one or two years of cover crops between nursery crops. The nursery cycle usually begins with preplant soil fumigation in the summer prior to planting the nursery rootstock. Seed or cuttings of the desired rootstock are planted in the fall or winter after fumigation, and the trees are budded or grafted to a preferred scion variety in the spring or summer of the next year. Stonefruit tree stock usually reaches marketable size after only one growing season and is harvested as a bare-root plant the winter after the rootstock is planted. Plants are sized, graded, bundled, and held in cold storage until brought to production fields for dormant transplanting.

One of the keys to production of vigorous open-field nursery stock is the control of soil borne pests including parasitic nematodes, disease pathogens, and weeds. For more than 50 years, methyl bromide (MB) was widely used for soil fumigation in high value vegetable, fruit, and nursery crops but was phased out in 2005 due to concerns over stratospheric ozone depletion except for Critical Use Exemptions (CUE) and Quarentine/Preshipment (QPS) uses. The continued use of MB is under intense international scrutiny and the Methyl Bromide Technical Options Committee (MBTOC) recommends that reduced rates of MB can effectively control pests where no other feasible options exist. However, little research on the MBTOC-recommended rates has been conducted under California nursery conditions. A tree nursery field trial was conducted in 2006-2007 to determine the effects of low rates of MB with or without chloropicrin applied under standard tarps and virtually impermeable film (VIF).

Materials and Methods:
A trial was conducted at L.E. Cooke Nursery near Visalia, CA in a new nursery field. The field site had a silage corn crop in 2006 following removal of a 40 year old walnut orchard the previous fall. Corn was harvested in late summer 2007 and the field was prepared for fumigation by the nursery. Twelve fumigation treatments (Table) were shank-applied on October 16, 2007 by a commercial fumigant applicator (TriCal Inc., Hollister, CA). Specific reduced MB rates included in the experiment were intended to test MBTOC suggestions for use of MB with or without chloropicrin and with standard or low permeability film. Where chloropicrin (Pic) is not registered, MBTOC suggests that MB applications of 35 g/m^2 in warm, coarse soils, or 45 g/m^2 in cold (310 and 400 lb/A, respectively), fine soils can provide sufficient pest control. Where chloropicrin is registered, a combination of MB/Pic is used at 26 or 20 g/m^2 under standard tarps and at 17.5 or 15 g/m^2 under low permeability films for nutsedge and other weeds and pathogens, respectively. Two alternative fumigants, 1,3-dichloropropene (1,3-D) or 1,3-D plus chloropicrin, were also included in the trial. The nursery planted 100 ft rows of two rootstocks ('Nemaguard'

peach seed and 'Marianna 2624' plum cuttings) in each plot in November 2006. Crop emergence and vigor and weed control were monitored throughout the 2007 growing season. The nursery harvested and graded each row of trees in November 2007. Data collected in the trial included nematode control (citrus nematode bioassay), weed seed survival (bagged weed seed bioassay), resident weed establishment, initial handweeding time, and tree diameter and quality at harvest.

Table. Fumigation treatments in a field nursery trial near Visalia, CA in 2006-07.

	Treatment (%)	rate	MB equivalent (g/m^2)	Tarp
1	Untreated	--	--	None
2	MB (98:2)	350 lb/A	39	HDPE
3	MB:Pic (67:33)	350 lb/A	26	HDPE
4	MB (98:2)	237 lb/A	26	HDPE
5	MB (98:2)	237 lb/A	26	VIF
6	MB:Pic (67:33)	266 lb/A	20	VIF
7	MB:Pic (67:33)	233 lb/A	17.5	VIF
8	MB:Pic (67:33)	200 lb/A	15	VIF
9	MB:Pic (67:33)	166 lb/A	12.5	VIF
10	MB:Pic (67:33)	133 lb/A	10	VIF
11	Telone II	33.7 gal/A	--	HDPE
12	Telone C35	48.5 gal/A	--	HDPE

Results and Discussion

All fumigation treatments effectively controlled citrus nematode buried at 12, 24, and 36 inch depths. Unfortunately, there was not a sufficient natural nematode population to provide a better evaluation of nematode control. Viability of weed seed buried three inches deep in each plot was assessed using either germination tests or tetrazolium staining techniques. Yellow nutsedge tubers, annual ryegrass seed, common chickweed seed, and redroot pigweed seed viability was lower in all treated plots compared to the control. No treatment reduced the viability of common mallow. Evaluation of resident weeds on March 21, 2007 indicated that all treatments had fewer winter annual grass and broadleaf weeds compared to the unfumigated control (Figure 1). There were no statistical differences between fumigation treatments due to fairly large plot-to-plot variability; however the lowest MB rate and both 1,3-D treatments tended to have slightly higher (numerically and visually) weed populations. A timed handweeding operation was conducted on each plot on March 22, 2007. Similar to the weed population counts, there were no differences among treated plots and all treatments required less time to weed compared to the unfumigated plots (Figure 2). Once again, the 1,3-D treatments tended to take slightly more time to hand weed although the time was not statistically different. In November 2007, the cooperating nursery harvested each row of trees using a single-row tree digger. Nursery personnel sized and graded each tree according to commercial standards. No statistical differences due to fumigation treatment were noted in cull trees or in percent of saleable trees (Figure 3).

Under the conditions of this trial, pest control and tree productivity did not differ among reduced rate MB treatments and the industry standard treatment. VIF tarps are not currently allowed for use with MB in California but, if these regulations change, these treatments should be considered for use in perennial crop nurseries. Although the results of this trial were favorable, it is important to note that the experiment was conducted in a first-year nursery site with low nematode and weed populations. In particular, the citrus nematode bioassay is a better indication of treatment failure than success due to the artificial conditions imposed with burying and recovering the sample bags. The issue of nematode control is of critical importance in the nursery industry because of certification requirements of "non-detectable" levels of parasitic nematodes. It is possible, if not probable, that long-term repeated use of low rates of MB or alternative fumigants could reveal weaknesses in pest control not evident in single-cycle field trials.

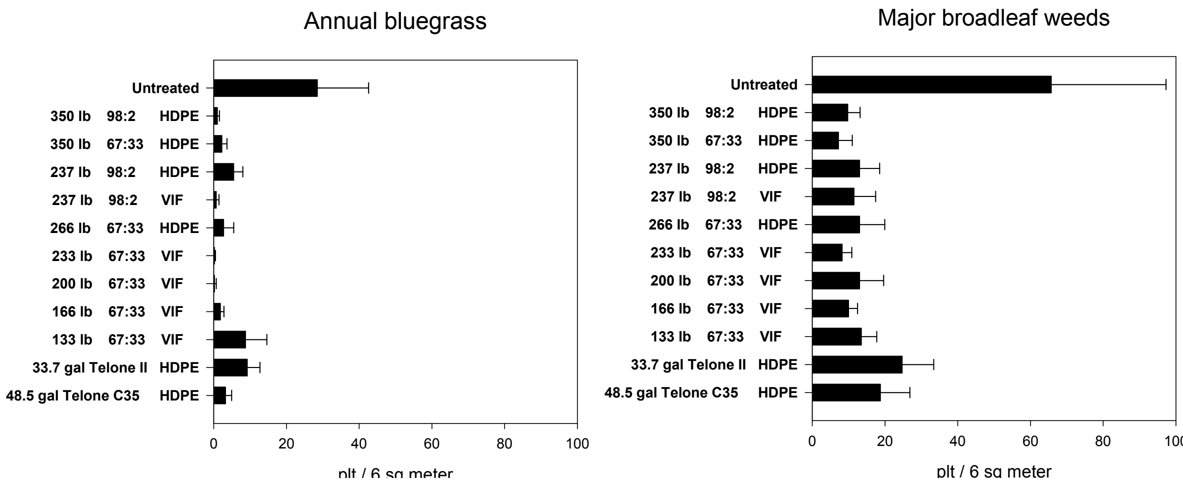

Figure 1. Annual bluegrass and broadleaf weed populations on March 21, 2007 in a stonefruit field nursery trial fumigated in October 2006. Weeds were counted in a 6 m^2 area between two rows of Prunus rootstock. Broadleaf weeds were primarily clover, horseweed, fiddleneck, filaree, and redmaids.

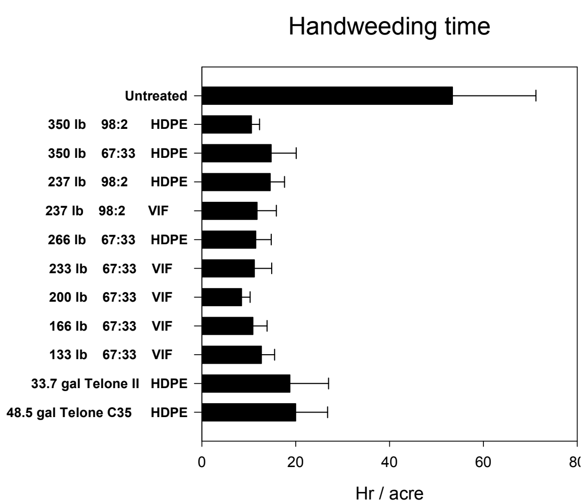

Figure 2. Initial handweeding time (hr/A) in a stonefruit nursery trial near Visalia, CA on March 22, 2007.

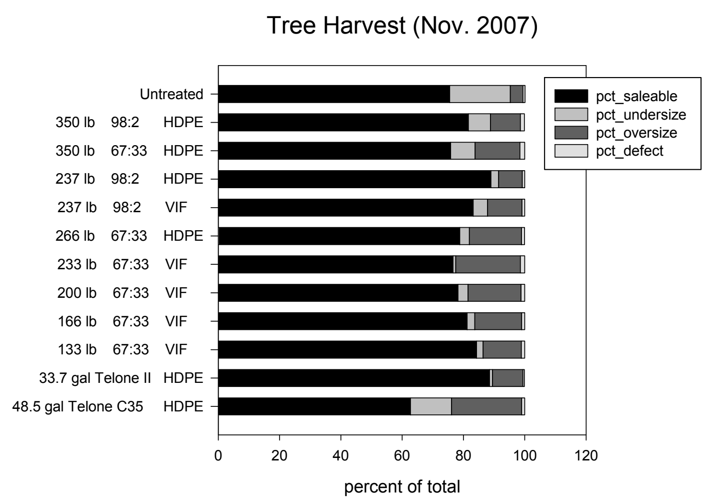

Figure 3. Nursery tree (peach and plum rootstock) grade at harvest in November 2007. Trees were commercially sorted into saleable, under-size, over-size, and cull classes.

Developments in Organic Herbicides in Specialty Crops

Shosha Capps and W. Thomas Lanini, University of California, Davis

Options for weed control in both organic and conventional specialty crops are restricted by the limited number of herbicides registered for use in these production systems. The purpose of this research is to increase options available to growers by investigating the efficacy of various natural product herbicides, including vinegar, C-Cide, Green Match, Green Match EX, Matran, Raps, Racer, and Weed Zap. These products have been evaluated in greenhouse and field trials to assess weed control as effected by product, concentration, spray volume, adjuvant, weed type (grass or broadleaf) and weed species. Trials were conducted in 2007 and 2008, with greenhouse trials continuing into 2009. The three field trials associated with this project were conducted in grapes, tomatoes, and lettuce, and took place in Davis, CA and Napa, CA.

Although full data analysis has not yet been conducted, basic analysis of variance shows that broadleaf weeds are more effectively controlled than grasses, and that higher concentrations and spray volumes increase control across all herbicides, with a larger effect shown from increasing spray volume. The most effective herbicides were Racer (pelargonic acid) and vinegar (acetic acid), followed by Greenmatch EX, Matran and Weed Zap. C-cide was the least effective product tested, although improved performance was observed in warm weather (tomato and lettuce) trials. (sacapps@ucdavis.edu)

Matrix Tree and Vine Herbicide - Performance and Crop Safety Update

Ron Vargas Consulting, LLC, UCCE Emeritus
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Matrix, (*Rimsulfuron*), from DuPont Crop Protection is not a new herbicide, however it is newly registered (November 2007) for citrus fruit, stone fruit, pome fruit, tree nuts, and grapes. Matrix is a sulfonylurea herbicide with an ALS (acetolactate synthase) inhibitor mode of action. As the only sulfonylurea herbicide now registered on tree and vines it will provide growers with a mode of action chemistry for weed resistance management.

Major attributes of Matrix include:

- Provides broad spectrum pre and post-emergence control of many broadleaf weeds and grasses
- It is extremely effective on flaxleaf fleabane and horseweed
- Provides improved burn down of emerged weeds in combination with Roundup and other contacts
- Applied at a low use rate of 4 oz. product per treated acre
- Can be tank mixed with other residual and contact herbicides
- Has excellent crop safety
- It is non-volatile with no application cutoff date
- There are no groundwater limitations
- Controls Roundup resistant ryegrass and horseweed
- Provides partial control of yellow nutsedge

For best control Matrix should be applied in combination with another pre-emergence herbicide, such as Prowl or Surflan, and include a contact herbicide if emerged weeds are present. When applied winter to early spring (November - February) in a band application at a rate of 4 oz. product per acre and receives ½ inch of rainfall or irrigation within 2 to 3 weeks after application, weeds are controlled 120 to 150 days. The crop should be established at least one full growing season prior to application.

Matrix Performance

Research studies, as well as grower experience, has shown Matrix to provide excellent control of many broadleaf weeds such as flaxleaf fleabane, horseweed, filaree, clovers, common groundsel, henbit, pigweed, mustard, purselane, puncture vine, panicle willowherb, and grasses such as barnyardgrass, crabgrass, green and yellow foxtail, foxtail barley, and ryegrass.

A study conducted in 2008 on nectarines (Table 1) indicated Matrix applied in combination with either Surflan, Prowl, or Chateau with Roundup provided 150 days control of flaxleaf fleabane, horseweed and barnyardgrass. Dandelion, a perennial, was also being controlled up to 85 percent. In the same study field bindweed was being suppressed up to 150 DAT (days after application).

A study in 2006 in wine grapes (Table 2) indicated the importance of early winter applications. Matrix applied on January 4 was providing 100 percent control of both horseweed and redstem filaree on May 11, (120 DAT) and 78 percent control of yellow nutsedge. But, when applied on April 6, in combination with Goal Tender control of horseweed was only 68 percent, redstem filaree, 57 percent and yellow nutsedge 47 percent.

An additional study on wine grapes in 2006 (Table 3) exhibited Matrix in combination with Rely at 180 days after treatment providing 95 to 100 percent control of panicle willowherb, fluvelin, and sowthistle when applied on December 12. When applied on February 10 control was somewhat reduced (90 to 95 percent), but still providing extremely effective control.

Matrix Crop Tolerance and Safety

One of the biggest advantages of Matrix is its crop safety. Matrix has been extensively tested for crop tolerance. There is excellent crop safety in almonds, pistachios, walnuts, grapes, apples, pears, cherries, peaches, nectarines, plums, and citrus.

Matrix simulated drift and fruit marking studies in 2007 and 2008 indicated crop tolerance and safety (Table 4 & 5). Matrix applied to foliage of fruit trees with young developing fruit from the 4 oz. use rate to rates as low as 0.25 oz., to simulate drift, exhibited slight yellowing of foliage with no visual symptoms to fruit at 21 DAT. Symptoms were slight to negligible with the low simulated drift rates. Plums appeared to be more sensitive than peaches or nectarines with apples being the least affected. At 67 DAT there were no injury symptoms on foliage or fruit of peaches, nectarines, or apples with plums still exhibiting a slight yellowing of foliage with no symptoms or marking on the fruit.

A plant sucker study in 2008 (Table 6) showed slight yellowing of grape and apple suckers at 21 DAT when Matrix was applied at 4 and 8 oz. product. At 43 DAT no symptoms were evident on grape suckers. There were no injury symptoms in the upper canopy of either grapes or apples at both 21 and 43 DAT. When Matrix was applied in combination with Rely, plant suckers were completely burned off.

The only concern in crop safety is with replanting of trees and vines into treated soil. The label states, "Trees or other desirable plants whose roots extend into treated crop use areas may be injured." A study conducted in 2008 (Table 7) indicated the importance of not putting Matrix treated soil into the planting hole. When Matrix treated soil was put into planting holes of almonds, plums, and grapes at 100 days after planting crop growth and development was being reduced 90 to 95 percent. At 120 to 150 days after planting all crops evaluated in this study were dead.

With little to no concern for crop safety issues, Matrix will provide growers with an additional herbicide with the flexibility of being used as a pre-emergence or post-emergence treatment for the control of many broadleaf weeds and grasses, especially flaxleaf fleabane and horseweed. And as an alternative mode of action chemistry growers will have an additional tool to be used in the development of a weed resistance management program.

Table 1 Matrix, Nectarine Study, 2008

Treatments	Rate	Percent Control - 150 DAT				
		Horseweed	Flaxleaf Fleabane	Wild Celery	Dandelion	BYG
Matrix + RU	4 oz + 2 qt	100	100	100	85	97
Matrix + RU + Surflan	4oz + 2qt + 4qt	100	95	100	80	100
Matrix + RU + Prowl	4oz + 2qt + 4qt	97	100	100	75	100
Matrix + RU + Chateau	4oz + 2qt + 12oz	100	95	100	85	95
Matrix + RU + Surflan	2oz + 2qt + 4qt	45	50	50	70	90
Control		0	0	0	0	0

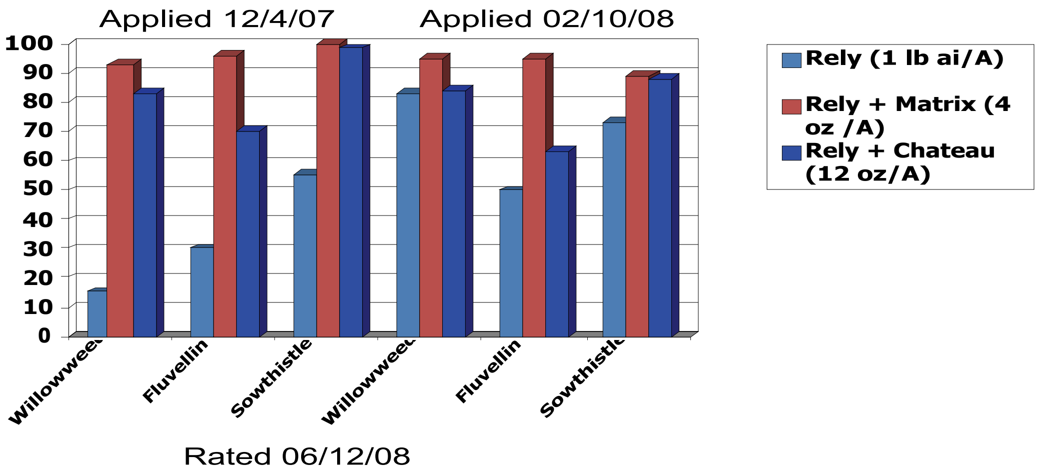
Ron Vargas Consulting LLC, and Terri Oswald & Dave Kelly, DuPont Protection

Table 2 Matrix Timing for Weed Control in Wine Grapes, Lodi, UCCE 2006

Treatments	Marestail				Redstem Filaree			Yellow Nutsedge
	Feb 16	Mar 8	Mar 30	May 11	Mar 8	Mar 30	May 11	May 11
Matrix 4 oz Jan 4 (pre)	100	100	100	100	100	100	100	78
Matrix 4 oz + Goaltender Feb 10 (early post)	3	93	100	99	87	93	100	78
Matrix 4 oz + Goaltender Apr 6 (late post)	0	0	0	68	0	0	57	47

Steve Colbert, DuPont Research Development

Table 3 Matrix on Wine Grapes, 2008



John Roncoroni, UCCE Napa Co.

Table 4 Matrix, Drift/Fruit Marking, 2008

Treatments	Percent Injury, Foliage, 21 DAT				
	Rate Oz	Peach	Nectarine	Plum	Apple
Matrix	4.0	22	27	25	5
Matrix	2.0	20	15	30	10
Matrix	1.0	12	5	25	7
Matrix	0.50	5	10	25	5
Matrix	0.25	2	0	25	5
MSO	1%	0	0	0	0
NIS	0.25%	0	0	0	0
Untreated		0	0	0	0

No injury to fruit of any species

Ron Vargas Consulting, LLC and Terri Oswald & Dave Kelley, DuPont Crop Protection

Table 5 Matrix, Drift/Fruit Marking, 2008

Treatments	Percent Injury, Foliage, 67 DAT				
	Rate Oz	Peach	Nectarine	Plum	Apple
Matrix	4.0	2	2	12	0
Matrix	2.0	0	0	8	0
Matrix	1.0	0	0	10	0
Matrix	0.50	0	0	5	0
Matrix	0.25	0	0	7	0
MSO	1%	0	0	0	0
NIS	0.25%	0	0	0	0
Untreated		0	0	0	0

No injury to fruit of any species

Ron Vargas Consulting, LLC and Terri Oswald & Dave Kelley, DuPont Crop Protection

Table 6 Matrix, Plant Suckers, 2008

Treatments	Rate	Percent Control		
		21 DAT Grapes	43 DAT Grapes	21 DAT Apples
Matrix	4 oz	30	0	23
Matrix	8 oz	33	0	30
Matrix + Rely	4 oz + 2 qt	80	100	87
Matrix + Rely	8 oz + 2 qt	100	100	83
Control		0	0	0

No injury in upper canopy

Ron Vargas Consulting, LLC and Terri Oswald & Dave Kelley, DuPont Crop Protection

Table 7 Matrix Plant Back, 2008 - Percent Growth Reduction – 110 DAT/100 DAP

Treatments	Rate Oz	Almonds	Plums	Grapes
Matrix	4	95	92	90
Matrix	8	85	90	92

All treatments; MSO @ 1%

Ron Vargas Consulting, LLC and Terri Oswald & Dave Kelly, DuPont Crop Protection

Rangeland Pasture Cost-Share WMA Cost Share Program for Invasive Thistle Control

*James L. Sullins** [1], *Steven D. Wright*[2], *Elizabeth Palmer*[3]

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Few noxious weeds have caught the general public's attention as has yellow starthistle in California. Yellow starthistle (YST) (*Centaurea solstitialis* L.), was introduced into California in the mid-1800. YST proliferation is a serious threat to the biodiversity and the productive potential of California's rangelands. In 1985, over 8 million acres were infested, and by 1995 an estimated 12 million acres were infested. YST has continued to rapidly colonize susceptible habitats including an estimated 20,000 acres of Tulare County foothill range. UC Cooperative Extension and Agricultural Commissioner, Tulare County; RCD; and USDA NRCS formed the Tulare County Noxious Weed Task Force. YST proliferation raised public awareness of noxious weed issues and the need for control and brought many stakeholders to the task force. This early organization lead to official designation as a Weed Management Area (WMA), bringing together landowners and managers (private, city, county, state, and federal) in a county, multi-county, or other geographical area to coordinate efforts and expertise against common invasive weed species. The WMA status enabled the task force to coordinate research, education, and outreach efforts across many jurisdictional boundaries and to broaden the focus to address several invasive noxious weeds. Results included securing a $70,000 three year state grant to develop educational brochures; conduct seminars and weed tours; collaborate in research on control strategies and field demonstrations; population inventory, monitoring and mapping; equipment acquisition and labor for implementing a control program. The WMA provides a structure to coordinate and collaborate in a local successful weed management effort, with key areas of research, education, outreach, inventory, control program, and monitoring.

Research trials have been conducted from 1997 to 2008 to determine best strategies for YST control in Tulare foothill range. Based on research trials, from 2002 thru 2005 Transline® was used in the control program. However due to research trial results, from 2006 to the present that demonstrated a broader spectrum of control and longer pre-emergent activity, the control program has used Milestone® .

Education and Outreach programs have been conducted at county and community levels, with field days, newsletters, news releases, and community events. Inventory and monitoring data has been collected utilizing GPS and GIS since 1998.

In 2002, a rangeland YST cost-share control program was initiated with the initial three-year grant for $70,000. Grant funding has varied annually from a high of $46,000 in 2009 to zero funding in 2007. From 2002 to 2008, six out of seven years, the TCWMA has conducted a cost share program for YST control. During this same period, 209 sites/properties have been treated for a total of 1,219.5 acres. Eighty one percent of sites were treated once during this period, with 16% and 10% treated 2 and 3 times, respectively in the seven year period. Sixty-six percent of the acreage was treated once, and 15% and 13% treated twice and three times respectively in the seven year period.

Share cost has varied based on the amount of grant funds to offset In-Kind cost. From 2002 thru 2004 the property owner cost share was $20 per acre, with an average annual treatment of 34 sites and 160 acres. With reduced grant funding in 2005, cost-share was increased to $45, with a resulting decrease in cost-share participation to only 15 sites/properties for a total of 86 acres. Due to no funding in 2006 and based on reduced participation in 2005 at the higher cost-share rate, there was no control program in 2006. In 2007 and 2008, funding was re-established and a share-cost was set at $15/acre, with an average of 47 sites/properties and 325 acres treated.

Conclusions

- There are several variables that affect the success of the WMA Invasive Thistle Control program:
- Weather and resulting thistle growth rate must determine program start time. Temperature and rainfall will affect the noxious weed complex as well as the potential for competition from desirable species.
- Cost-share amount will affect the number of participants at and above $45/acre, and grant funds to offset participant costs are essential to the success of the program.
- The use of Milestone® has enhanced the control program with a broader spectrum of control and longer pre-emergent activity.
- Grazing factors are important to control success, late and deferred grazing increases competition by desirable species and enhances the program success.
- In most cases, a single treatment is not as effective as multiple year treatments.
- A competent technician that can relate to the clientele and can work independently is essential.

Biology and management of horseweed (*Conyza canadensis*) and hairy fleabane (*Conyza bonariensis*) in California

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In recent years, increasing populations of horseweed or mare's tail (*Conyza canadensis*) and hairy or flax-leaved fleabane (*Conyza bonariensis*) have been observed in vineyards, orchards, canal banks, and roadsides in California, especially in the Central Valley. Numerous growers, pest control consultants, and managers have complained that the recommended rates of some postemergent herbicides, such as glyphosate, are no longer effective on these weeds. Since glyphosate-resistant biotypes of these species have now been confirmed, alternate integrated techniques need to be employed to effectively manage resistant and non-resistant biotype populations and to prevent the further development of herbicide resistance. A basic understanding of the biology of these weeds is essential to develop an integrated management approach. A full-length article authored by us was recently published by the University of California, Division of Agriculture and Natural Resources Publications. The article contains illustrations, information on the biology and ecology, and lists chemical and non-chemical options for control and management of the two species in cropped and non-crop systems in California. The article can be obtained online for free at: http://ucanr.org/freepubs/docs/8314.pdf.

Fertility Injury Symptoms
or
Nutrient Deficiency/Toxicity Symptoms in Plants

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Diagnosing a nutrient deficiency, toxicity or fertilizer injury symptom in plants requires keen visual examination as well as an open mind in searching out possible causes. The first consideration should be the size of the area affected, is it a large area of several acres, a small area of an acre or less having several trees or hundreds of plants or is it a very small area of several square feet having a single tree or perhaps 2-3 alfalfa or other crop plants? The next step is to view individual trees or plants, beginning with an observation of the whole plant and then selected parts—the leaves, stems and branches that are affected. Are the leaves in the top of the tree affected more than those on the lower branches? Likewise, in field crops or smaller plants, are the younger leaves or older leaves most affected and show the more severe symptoms. The next level of observation involves the part of the leaf that is most affected. Is the whole leaf generally yellow or chlorotic, or are the margins or center beginning at the tip of the leaf most affected? Is there some type of interveinal chlorosis or yellowing of the leaf that is showing most prominently? Is there a change in color of the leaf part or even death of affected leaf area occurring as the leaves mature? The presentation will involve a discussion of some of these aspects of the development of different nutrient deficiencies, toxicity of several elements or nutrients and some fertilizer responses as they affect a number of plants. There are a number of references including the Western Fertilizer Handbook, 9th Ed., 2002. Interstate Publishers, Inc., Danville, IL. which can be utilized to identify some of the plant symptoms found in the field. Perhaps the most important step in the process of proper diagnosing of plant symptoms is the sampling and chemical analysis of affected and non-affected plant tissue for all the possible nutrients or elements that might be present in deficient or toxic concentrations.

Diagnosing Abiotic Disorders of Landscape Plants

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Landscape plants can be injured by biotic and abiotic agents. Abiotic or nonliving agents include environmental and physiological factors, such as water deficit, aeration deficit, and nutritional deficiency. Biotic agents are living organisms such as insects, pathogens, nematodes, and viruses. Whether the cause is biotic or abiotic (or both), an accurate diagnosis is virtually always needed to remedy the ailment. This paper addresses a key element of the diagnostic process and then describes symptoms associated with selected abiotic disorders. For a detailed discussion of both topics, see Costello et al (2003).

Although there are many steps involved in the diagnostic process, a vital first step is the accurate identification of the plant. It is critical to know the genus and species to determine whether the existing condition is normal or abnormal. In some cases, what may look abnormal may be a natural trait for the species. For instance, bald cypress (*Taxodium distichum*) is a deciduous conifer that turns orange brown before losing its needles in the fall. Not knowing that this is normal for bald cypress may lead to the misguided determination that a problem exists. With an accurate identification, however, this condition would be recognized as normal and no further action need be taken. Similarly, the shedding of leaves in cork oak (*Quercus suber*) in spring and the defoliation of California buckeye (*Aesculus californica*) in early summer both may be thought to be problematic if it was not known that these traits are normal for the species. Certainly, there are a number of other steps in the diagnostic process (e.g., symptom identification, site inspection, management history, etc.), but an accurate identification of the plant is a necessary first step.

Symptoms are the external and internal reaction, response, or alteration of a plant as a result of disease or injury. Some symptoms are diagnostic, meaning that they are characteristic of a problem and lead directly to a diagnosis. Other symptoms are nonspecific, or not indicative of a particular problem. Here, symptoms associated with 5 abiotic disorders are described briefly, some diagnostic and others nonspecific.

Water Deficit

Symptoms range from slow growth to death of the whole plant. The level of injury depends on the severity and duration of the deficit and the sensitivity of the plant. Common symptoms include growth reduction or cessation, leaf necrosis, leaf drop, shoot dieback, and whole plant decline. For deficits that are relatively mild, but last for extended periods, slow growth may be the only symptom expressed. When deficits are severe, however, leaf necrosis and branch dieback are more likely (depending on the species). Plants located in hot, windy, nonirrigated sites are prone to water deficit. In addition, plants in limited soil volumes (containers or small planting pits) frequently experience water deficits. Although many landscapes are irrigated, water deficits can occur if irrigation schedules are inadequate or if irrigation systems are not properly designed and/or installed.

Aeration Deficit

Similar to water deficit, aeration deficit can produce a range of symptoms from slow growth to death of the whole plant. When oxygen supply or availability is below a critical level for a short period of time, an acute deficit occurs. Symptoms include wilting, extensive leaf drop, and dieback. Roots may appear discolored and water-soaked. Relatively mild aeration deficits that persist over an extended period of time may cause chlorosis, slow growth, and leaf drop. Plants that incur chronic deficits are prone to root disease and stem cankers. Commonly, aeration deficits are caused by excess water in the root zone, typically due to excessive irrigation and/or poor drainage. In such cases, water displaces air in soil macropores and oxygen diffusion is impaired. Grade changes (fills) have been thought to cause aeration deficits, but this has not been supported by research.

Mineral Deficiency

For woody plants that are well established in landscapes, deficiencies of nitrogen, phosphorus, and potassium are relatively uncommon. They can occur, but are not frequently found in California landscapes. Microelement deficiencies (iron, zinc, and manganese) are relatively common, however. In particular, iron deficiency can be found in many landscapes and on a number of species. Symptoms are distinctive: interveinal chlorosis of the youngest leaves. In some cases, the tips of leaves and shoots are blackened. Typically, this deficiency results from an elevated soil pH level, above 7.5 for many species. Species vary in susceptibility to iron deficiency, however, with sweetgum being an example of a sensitive species. Treating with chelated iron is an effective way to diagnose and treat (short term) this deficiency. Manganese deficiency causes symptoms similar to iron deficiency, while zinc deficiency causes leaves to be stunted and clustered at the end of shoots.

Specific Ion Toxicity

Although a number of ions can be phytotoxic, those that cause injury most commonly are boron, chloride, and sodium. Boron injury is distinctive: marginal chlorosis, necrosis, and pitting occur on leaves, typically in mid to late summer. Necrosis may appear black. Species vary substantially in sensitivity to boron, with some species showing no injury in the same location as severely injured species. For evaluations of species tolerance or sensitivity to boron, see Costello et al (2003). Sodium injury appears as a foliar mottling and interveinal chlorosis that progresses to necrosis of leaf tips, margins, and between veins. Chloride toxicity causes stunted growth, chlorosis, necrosis of leaf tips and margins, bronzing (in some species), and premature abscission of leaves. Both sodium and chloride can accumulate in soil from applications of deicing salts, fertilizers (containing sodium or chloride), and irrigation water. Recycled water can contain concentrations sodium and chloride that are phytotoxic for certain species (e.g., *Sequoia sempervirens*).

Salinity

Soils contain a mixture of water-soluble salts that are necessary for plant growth and function. When present in high concentrations, however, salts can injure sensitive plants. When absorbed by roots, salt toxicity is first expressed as stunting of growth and yellowing of foliage. In broadleaf species, leaf necrosis and defoliation usually follows. Typically, the symptoms are most severe on the edges and tips older leaves where salt accumulation usually occurs. For conifers, needles turn yellow, then brown from the tip downward and defoliate. In severe cases, plants are killed. Injury can result from the foliar application of salts, typically from salt spray (in coastal areas), deicing salts, and irrigation spray. Symptoms include marginal chlorosis of leaves, defoliation, premature fall coloration, and delayed spring leafout. The degree of injury depends on the sensitivity of the plant to salts and the concentration of accumulated salts in the soil. For evaluations of the sensitivity of landscape species to salt levels, see Costello et al (2003). Irrigation water and fertilizers are key sources of salt in landscapes. Irrigation water should be analyzed for salt content, regardless of source (municipal, well, river, etc). Recycled water can have high salt levels and should be analyzed frequently (at least monthly). Select and apply fertilizers to minimize salt accumulation, particularly in poorly drained soils.

In addition to the abiotic disorders described above, a number of others occur in landscapes, including sunburn, cold and high temperature injury, wind damage, gas injury, air pollution, herbicide toxicity, and mechanical injury. Each of these disorders have relatively distinct symptoms that can be used to link the problem with the cause. It is important to be aware of the array of disorders and their respective symptoms to develop accurate diagnoses and effective treatment recommendations.

Reference

Costello, L.R., E.J. Perry, N.P. Matheny, J.M. Henry, and P.M. Geisel. 2003. *Abiotic Disorders of Landscape Plants: A Diagnostic Guide*. University of California Agriculture and Natural Resources Publication 3420. Oakland, CA. 242 p.

Evaluation and Classification of Inert Ingredients in Pesticide Products

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The U.S. EPA is authorized by the Federal Insecticide, Fungicide and Rodenticide Act FIFRA) to register pesticide products. Pesticide products consist of one or more active ingredients, and may contain one or more inert ingredients (inerts). An inert ingredient is any substance, other than an active ingredient, which is intentionally included in a pesticide product. Inerts may be added to improve plant uptake, extend shelf-life, enhance water solubility/dispersion, make application easier, etc. Just as with pesticide active ingredients, inerts are evaluated by the Environmental Protection Agency (EPA) to ensure that there will be reasonable certainty of no harm to human health or the environment if used according to the label. For its evaluation of inerts EPA requires the same minimal data set that it requires for active ingredients. Data requirements (at 40 CFR 158) include residue chemistry, product chemistry, toxicology for human health risk assessment, ecotoxicology, and environmental fate.

Under the List Category Policy of 1987, EPA categorized inerts into four groups, or lists, based on toxicity. List 1 included inerts of toxicological concern; List 2 included potentially toxic inerts with high priority for futher testing; List 3 included inerts of unknown toxicity; List 4 was split into two parts: 4a included minimal risk inerts, and 4b included compounds that were generally regarded as safe for current use patterns, but that would need further evaluation for proposed new use patterns.

Due to the toxicological concern, EPA issued a Pesticide Registration notice in 1987 requiring registrants to identify List 1 inerts on pesticide labels. The notice was updated in 1990 to include additional List 1 inerts. Prior to 1987, no inert ingredients were required to be identified on pesticide labels, as registrants consider the identity and composition of inerts to be trade secrets, which are protected under FIFRA.

With passage of the Food Quality Protection Act (FQPA) in 1996 EPA was charged with reassessing all food tolerances and tolerance exemptions for inert ingredients. Based on the reassessments (completed in 2006), EPA now classifies inert ingredients as either food use, non-food use, or minimial risk. Food-use inerts are approved for use in pesticide products applied to food and are those that have tolerances or tolerance exemptions at 40 CFR part 180. Non-food use inerts are permitted for use in products applied to non-food use sites, such as ornamental plants, highway rights-or-way, or rodent control areas. Minimal risk inerts are approved for use under FIFRA Section 25(b), and are often called “4a inerts” in reference to the lists established by the 1987 policy. The current list of minimal risk inerts is available on the EPA website (www.epa.gov/opprd001/inerts).

In 1997 EPA issued another Pesticide Registration notice regarding inert ingredients. Recognizing that many chemicals that are not the stated active ingredients in pesticide products are not chemically inert (i.e., inactive), and concerned that the term "inert" is often interpreted by consumers to mean "harmless," EPA encouraged registrants to use the term "other ingredients" rather than "inert ingredients" on pesticide labels.

Two inert ingredients that were reassessed in 2005 are the preservatives butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT). Both of these chemicals are used extensively in food, drugs and cosmetics. EPA had placed them on List 3 (unknown toxicity) based on the 1987 List Category Policy. EPA did a human health hazard assessment based on a suite of toxicological studies that included acute, subchronic and chronic tests, oral and dermal exposures, mutagenicity, carcinogenicity, and reproductive/developmental toxicity. Potential exposure to humans and the environment were evaluated using environmental fate data. Aggregate exposure to humans from all sources was also evaluated. Given the expected BHA and BHT use rates, EPA found reasonable certainty of no harm in its human health risk characterization, and unlikely significant hazard to aquatic or terrestrial organisms in its ecological risk characterization. Both chemicals were exempted from tolerances and so were classified as food use inerts.

References

Electronic Code of Federal Regulations Parts 158 and 180. Accessed 2008. http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=%2Findex.tpl

U.S. EPA. 1987. Pesticide Registration (PR) Notice 87-6: Inert Ingrdients in Pesticide Products; Policy Statement. http://www.epa.gov/PR_Notices/pr87-6.html.

U.S. EPA. 1990. Pesticide Registration (PR) Notice 90-1: Inert Ingredients in Pesticide Products; Revised Policy Statement. http://www.epa.gov/PR_Notices/pr90-1.html.

U.S. EPA. 1997. Pesticide Registration (PR) Notice 97-6: Use of Term "Inert" in the Label Ingredients Statement. http://www.epa.gov/PR_Notices/pr97-6.html.

U.S. EPA. Accessed 2008. Inert Ingredients in Pesticide Products - Reassessment Status List , http://www.epa.gov/opprd001/inerts/decisiondoc_a2k.html

Traversing the Maze of Pesticide Enforcement

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The maze of pesticide enforcement may at times baffle or confuse those responsible for pesticide use programs but I assure you that enforcement decisions are not arbitrary and do follow a predictable pattern. This is thanks, in part, to the Enforcement Response and Civil Penalty Action Regulations found in Title 3 California Code of Regulations (CCR) Sections 6128 and 6130.

Section 6130, related to Civil Penalty Actions, was enacted in November 1986 and has been amended several times over the years. Section 6128 entitled Enforcement Response, was just enacted in November 2006 and came about as a response to the industry's and activists' complaints that pesticide enforcement varied widely from county to county in California. The California Department of Pesticide Regulation responded with a regulation that defined what enforcement or compliance action would be taken in response to the severity of the violation and compliance history of the violator.

California Agricultural Commissioners throughout the state follow the Enforcement Response Regulation and thus give some consistency to what response violators can expect.

Classification

The first step in determining the enforcement response is to determine the classification of the violation. Section 6130 defines the classes of violations. There are three classes of agricultural pesticide use violations ranging from Class A for the most serious violations, to Class C for minor infractions.

> **Class A** violations are the most serious because they create "an actual" health or environmental hazard or they are violations of a lawful order of the commissioner. Violations are also classified as Class A if they are a repeat of a Class B. Any incident that causes an illness would be a Class A violation.
> **Class B** violations have a reasonable possibility of creating a health or environmental effect. Violations may also be classified as Class B if they are a repeat of a Class C violation. An example of a Class B violation would be failure to wear required personal protective equipment.
> **Class C** violations are minor infractions that don't fall into either Class A or Class B. They are most often less serious paperwork or procedural violations.

To complete the classification of the violation, the Commissioner must look at the compliance history of the company or agency. Section 6130 states: "A violation shall be classified as a repeat violation, if it occurs within two years of a violation for which a civil penalty was levied against that person/company in the same county and of the same class." This does not mean that any violations over two years old will not be considered at all. It means that they will not be considered when determining the class of violation. They may however, be considered when deciding where in the fine range a specific fine should be set if a fine is the correct action or they may be considered when deciding between a compliance action or an enforcement action when either is an option.

Enforcement Response

Once the violation classification has been determined using Section 6130, the next step is to determine the correct enforcement response using Section 6128. Before going any further, we must define the various terminologies:

- **Compliance actions** document that certain behavior or an act is in violation of the law or regulations. They do not directly impose a monetary penalty. Compliance actions include notices of violation, warning letters, documented compliance interviews, and non-compliances noted on the inspection forms. Compliance actions also include public protection actions such as cease & desist orders; seize or hold product or produce orders; and prohibit harvest orders.
- **Enforcement actions** have the potential to impose a monetary penalty or loss of a right or privilege and are initiated by a Notice of Proposed Action. Enforcement actions include administrative civil penalties known as ACP's (Agricultural Civil Penalties) and SCP's (Structural Civil Penalties); refusal, revocation, or suspension of a license, certificate, or permit; civil court action; or criminal court action.
- **Decision reports** are written explanations and records of commissioners' decisions not to take enforcement actions.

Class A or serious violations require a serious enforcement response. Section 6128 allows for the following responses to a Class A violation:

- A formal referral to the District Attorney, City Attorney, or Circuit Prosecutor, or;
- A formal referral to the Director or Structural Pest Control Board Registrar for a statewide licensing action or Attorney General action, or;
- An enforcement action (if this is an ACP or SCP, the fine level is $700 - $5000 per violation)

Class B or moderate violations allow for a little more discretion in the enforcement response. Section 6128 allows for the following responses to a Class B violation:

- A formal referral to the District Attorney, City Attorney, or Circuit Prosecutor, or;
- A formal referral to the Director or Structural Pest Control Board Registrar for a statewide licensing action or Attorney General action, or;
- An enforcement action (if this is an ACP or SCP, the fine level is $250 - $1000 per violation), or;
- A compliance action with a decision report, provided there has not been a compliance action for a violation in the same class within two years of the current alleged violation.

Class C or minor violations allow for the most discretion in the enforcement response. Section 6128 allows for the follwoign responses to a Class C violation:

- An enforcement action (if this is an ACP or SCP, the fine level is $50 – 400 per violation), or;
- A compliance action with a decision report when there has been a compliance action for a violation in the same class within two years of the current alleged violation, or;
- A compliance action without a decision report, provided there has not been a compliance action for a violation in the same class within two years of the current alleged violation.

It should be noted that Section 6128 further requires that in the case of a priority investigation as defined in the 2005 Cooperative Agreement, between the California Department of Pesticide Regulation, the California Agricultural Commissioners and Sealers Association, and the U.S. Environmental Protection Agency, Region IX, the commissioner shall provide an opportunity to the District Attorney, City Attorney, or Circuit Prosecutor to participate in the investigation and/or pursue a civil or criminal action when a violation may have occurred.

Employer/Employee Responsibility

The issue is often brought up by employers: "I do everything I can to make my employees compliant. Can't you just fine them instead of the company when they are responsible for the violations?" In certain situations, the agricultural commissioner <u>may</u> bring an action against an employee. Those conditions are spelled out in CCR Title 3. Section 6130.

The agricultural commissioner may fine an employee if:

- The violation is for failing to use personal protective equipment or other safety equipment, <u>and;</u>
- The employee is licensed such as a QAL (Qualified Applicator License), QAC (Qualified Applicator Certificate), OPR (Structural Operator), FR (Structural Field Rep), or RA (Structural Applicator).

<u>AND</u>
All of the following conditions are met:

- The employer provided the required safety equipment and it was at the use site in a useable condition, and;
- The employer has a written workplace disciplinary program that requires the use of the equipment, and follows that disciplinary procedure, and;
- The employer has complied with all of the training requirements, and;
- The employer supervised the licensee to assure that the equipment was properly used by the employee, and;
- At the time that the employee failed to use the safety equipment, he or she had knowledge of what discipline could be imposed under the written workplace disciplinary program.

What can I do?

Here are a few suggestions for help you avoid the Pesticide Enforcement Maze or get you out more quickly and easily if you do stumble in:

- Train your employees emphasizing the use of safety equipment
- Have a written workplace disciplinary program and review it in your training.
- Make sure that someone goes over a checklist with each of your employees as they leave to see that they have their safety equipment with them when they leave the shop each morning and that it is in good condition.
- Periodically, make unannounced visits to the application sites to make sure that employees are following the laws and regulations.
- Some companies offer incentive programs for employees that get good inspections from the agricultural commissioner's office.
- Be a good role model for your employees and don't badmouth the agricultural inspectors in front of your employees – it's not professional and does not encourage compliance on their part.
- If by some chance, one of your employees gets inspected and there is a non-compliance, contact the agricultural commissioner's office immediately and let them know what steps you have taken to get back in compliance.
- This is also a great time to talk to the deputy or agricultural commissioner about what action is planned and who will be held responsible.
- If your company should receive a notice of proposed action for a fine, contact the Deputy Agricultural Commissioner and ask for an informal meeting. Most counties are happy to meet with you and discuss the issues. You can then make a better decision as to whether or not to request a hearing.

Hopefully this has given you a better understanding of the pesticide use enforcement response actions and how to avoid them. If you have further questions on this subject, please contact me at the Sacramento County Agricultural Commissioner's Office at (916)875-6603 or Jensenj@saccounty.net.

Pesticide Toxicology

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The California Poison Control System has answering sites in Sacramento, San Francisco, Fresno, and San Diego. The System is overseen by the University of California, San Francisco, School of Pharmacy. There are two phone numbers for Poison Control: 1-800-876-4766 (1-800-8POISON) which is good anywhere in California, and 1-800-222-1222 which is a nationwide number.

Nationally, in 2004, there were 2,776,925 exposures reported to Poison Control Centers. Of these, 1,096,356 were non-drug exposures, and 9% (or 102,754) of the non-drug exposures were to pesticides. The majority of pesticide exposures resulted in no effect or minor effect, but 2853 of the exposures caused moderate effects, 219 cause major effects, and there were 8 deaths. 74% of all human exposure calls are managed at home.

The most common class of insecticide involved in these exposures was pyrethrin/pyrethroids, followed by the Organophosphates, Carbamates, and Chlorinated Hydrocarbons. Glyphosate, (Roundup) accounted for 46% of the herbicide calls.

Pesticides can be toxic by ingestion, dermal exposure, inhalation, or ocular exposure. They also can have a high risk for secondary exposure to rescuers and health care providers.

The mechanism of action, symptoms of toxicity, and medical management of a poisoning with various classes of insecticides were discussed. These classes included: Organophosphates and Carbamates (Cholinesterase inhibitors); Pyrethrins and Pyrethroids; Chloinated Hydrocarbons; Methoprene; Hydramethylnon, and N-Ethyl Perfluoroctane Sulfonamide.

The toxicity profiles of several classes of herbicides was also discussed. These herbicide included: the Chlorphenoxy Compounds, Paraquat and Diquat, Pentachlorophenols and Nitrophenols, Carbamate herbicides, Glyphosate, and Urea Substituted hebicides.

Simazine Degradation Rates in Central Valley Soils with Annual or No Simazine Use Histories

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Microbial degradation is the most important mechanism of herbicide dissipation in the soil environment. In some cases, microbial communities can become dominated by species with the ability to rapidly metabolize the molecule following repeated applications of the herbicide (or related herbicides). This enhanced biodegradation can greatly decrease the half-life of the herbicide and result in reduced residual weed control efficacy. Studies have shown that simazine may be subject to enhanced biodegradation in some areas of the world. Simazine is a commonly used preemergent herbicide in Central Valley vineyards and orchards, valued for its relatively low cost and long residual activity. It is important for growers to know if simazine is subject to enhanced biodegradation in the Central Valley as it may impact their weed control strategies. This study compares the simazine degradation rate and relative weed control in two vineyard soils, one treated annually with simazine (adapted) and one with no recent simazine use (non-adapted). In greenhouse and field experiments, simazine was applied to each soil and soil samples were taken at regular intervals for 49 and 224 days respectively to assess the simazine concentration. In both the greenhouse and field, the simazine degradation rate was faster in the adapted soil. In the greenhouse experiment, the adapted soil had significantly lower simazine concentrations than the non-adapted soil in samples taken 14 to 49 days after treatment (DAT). In the field experiment, simazine concentration was significantly lower in the adapted field only at 112 DAT. In addition, biomass for wheat planted in the greenhouse experiment and weed counts in the field experiments were used to assess the efficacy of the simazine treatments. In the greenhouse, there was no significant difference in wheat biomass between the two soils; however, plants grown in both soils were significantly smaller than their respective controls which suggested that an efficacious concentration remained at 49 DAT. In the field, the non-adapted site had better weed control than the adapted site at 56, 112, 168 and 224 DAT although this was only statistically significant at 112 DAT. Preliminary data from these experiments indicates that enhanced biodegradation of simazine does occur in Central Valley vineyards and may impact efficacy. Additional research is ongoing to verify the microbial contribution to enhanced biodegradation and to compare the simazine degradation rates from additional fields with varying simazine use history.

Effects of Glyphosate to Control Exotic Annuals for Coastal Sage Scrub Restoration.

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Barnett Ranch is a new San Diego County Park with a history of grazing and is dominated in part by dense stands of *Erodium botrys*, an exotic forb, and invasive annual grasses. Plots were established to determine whether broadcast application of glyphosate herbicide could be used to restore native Coastal Sage Scrub vegetation. There were two treatments -- an early season broadcast application of glyphosate, and an early season broadcast application followed by a late season spot treatment of glyphosate -- and a control. Two sites were treated; one a hillside dominated by *E. botrys* and the second a swale site dominated by exotic grasses. At the *E. botrys* dominated site, both treatments had significantly increased native forb cover and decreased exotic forb and exotic grass cover in relation to the control, but the two treatments did not differ significantly from each other. At the grassland site, native forbs increased and exotic grasses decreased significantly in both treatments compared to the control, however, exotic forbs also increased significantly with the removal of exotic grass. Species richness increased in both treatments at both sites relative to the control. However, the two treatments did not vary significantly from each other in species richness. These results suggest one application of glyphosate is sufficient. Seeding did not increase percent cover of natives or species richness. Seeding was performed in 2007, one of the driest years on record, so the lack of significant differences in seeding treatment is likely due to lack of sufficient precipitation.

Evaluations of Herbicides for Dodder Control in Tomatoes

Matthew Linder, Tom Lanini

SUMMARY: One greenhouse and two field studies were conducted to evaluate the potential of ALS type herbicides to control dodder without significant injury to tomatoes. Most of the herbicides tested suppressed dodder growth. Crop safety varied considerably, with Reflex, imazosulfuron, and Maverick, having good crop safety in field trials and Osprey, Upbeet, Harmony GT, and Regiment also having good crop safety in the greenhouse trial. Imazosulfuron (high rate) and Maverick also provided good suppression of dodder in the field studies. Further evaluations of dodder control and tomato safety with imazosulfuron will be conducted.

Weeds and Crops as Sources of Inoculum for Tomato Spotted Wilt Virus in California

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Tomato Spotted Wilt Virus (TSWV) is worldwide in distribution and has been in California since the mid 1980s, but has never been an economic threat in tomatoes until 2003 in Merced County. In 2004-05 TSWV incidence ballooned and caused serious loss in processing tomatoes grown on the Westside of Fresno County. Incidence of this virus continues to spread throughout the San Joaquin Valley and levels of incidence in 2008 processing tomatoes were variable from 1 to 25%. Tomatoes, peppers, and lettuce are major crops affected by TSWV in California, but tobacco and peanut crops are being severely affected in other parts of the country.

TSWV Symptoms: Tomato plant symptoms are characterized by initial chlorosis of leaves and terminal shoots, bronzing and necrosis. Fruit symptoms show faint to obvious concentric rings on green and/or red fruit. Oftentimes fruit is severely blotched, deformed, and unmarketable.

TSWV Vectors: The only means of field spread is via the virus vector. A number of thrips species are vectors of TSWV and responsible for the spread of the virus from plant to plant. TSWV is a plant:animal virus and also infects the thrips vector. In our studies the Western Flower Thrips (*Frankliniella occidentalis*) is the only thrips species collected from the tomato flowers and sticky cards in monitored fields. Only the first or second instar thrips larvae can acquire TSWV and then become able to transmit the virus to more plants. If an adult thrips feeds on a TSWV-infected plant, it will not be able to transmit TSWV to new plants. The virus is not passed from the adult thrips to a new egg.

TSWV Host range: TSWV has a very wide host range among plants, infecting more than 900 plant species including mostly dicots, but also some monocots. It is NOT seedborne. Many weeds and ornamental plants from many plant families are host to the virus. TSWV alternate host plants must meet specific criteria to be epidemiologically important. For a plant to be a significant source of TSWV inoculum:

1. The plant must be a host of TSWV;
2. The plant must support reproduction of the thrips;
3. The thrips must be able to acquire TSWV from the infected plant; and
4. The plant must be present within a time that would complement disease cycles and virus spread.

Most studies suggest that primary spread (spread into the crop from outside inoculum sources) is the most common type of spread seen for TSWV. Secondary spread (spread from plant to plant within the crop) would require active thrips populations multiplying within the crop, and doing so in a timeline compatible with crop development. (Thrips generation time takes approximately 20-30 days).

Thus, only plants that sustain virus infections and serve as suitable reproductive hosts for the vector can be considered important sources for spread of TSWV. Many plants susceptible to TSWV do not support thrips reproduction and are considered a "dead end" for virus spread. Two potential strategies to assist in managing TSWV is to 1) control the thrips vectors within the susceptible crop; and 2) identify and/or control the alternate host plants that support both TSWV and the thrips vector.

Transplant Monitoring in Commercial Greenhouses

Thrips and TSWV weekly monitoring was initiated in mid-February 2008 in transplant houses. In general, populations were relatively low (0-200 thrips/card), and highest numbers were identified in May. It is important to note here that thrips numbers in the field were also very high in May.

Much higher thrips populations were detected outside of the greenhouses through mid-May (~300-5800 thrips/card), with numbers decreasing by early July (data not shown). Thrips captured from all these greenhouses were identified as western flower thrips, and the numbers of females were three-fold higher than males.

In general, thrips populations associated with transplants were similar in 2007 and 2008. No obvious thrips damage was observed on transplants, nor were symptoms of TSWV observed on transplants. Consistent with this, no TSWV symptoms were observed on the fava bean indicators in greenhouses. Together, these results indicate that transplants are not an important inoculum source for thrips or TSWV in the field.

Survey of potential hosts for TSWV and thrips

To search for potential hosts for TSWV and thrips before, during and after the season, we monitored representative almond orchards; spring-planted lettuce in Fresno and spring- and fall-planted radicchio in Merced; and numerous weeds collected in the winter and spring. The radicchio planted in fall of 2007, especially direct seeded fields in Merced, had highest thrips populations and TSWV incidences (up to 95% infection), but thrips populations declined considerably into the winter. In spring-planted lettuce and radicchio very low incidences of TSWV were observed, although thrips populations were increasing in these fields. Collected thrips samples were also identified as western flower thrips.

Interestingly, an early planted pepper field in Merced, which was in close proximity to the heavily infected fall-planted radicchio field (already harvested) had extremely high thrips populations, especially in early April (30-70 thrips/flower) and an unusually high incidence of TSWV (>70%). However, as the spring-planted radicchio field in this same location had very low level of TSWV (<0.1%), it is not clear where the major source of TSWV inoculum for the pepper field came from.

Almond flowers were collected and thrips from these flowers were counted and tested for TSWV with RT-PCR. Thrips population densities were low both on yellow sticky cards and in flowers, and indicator plants placed in these orchards remained free of TSW-symptoms. To date, no TSWV has been detected in thrips from almond orchards or in almond trees. Thus, almonds do not seem to play a major role in TSWV in tomato.

In areas with recent outbreaks of TSWV, plants other than tomato were collected and tested for the virus. Plants tested include lettuce, spinach, London rocket, barnyardgrass, bindweed, bur clover, nettle, black nightshade, common sunflower, dodder, fiddleneck, lambsquarters, little mallow, pepper, pigweed, prickly lettuce, purslane, groundsel, mustard, almond, fig, Russian thistle, sowthistle, jimsonweed, cardone and tree tobacco. Most samples tested were negative for TSWV (Table 1), only lettuce, pepper, spinach, London rocket, cardone, little mallow, prickly lettuce, groundsel and sowthistle tested positive for the virus, but incidence was very low (<0.1%).

Table 1: Weed Survey Results for TSWV Incidence in Fresno and Merced Counties, 2008

Weed	Tested (+)	Weed	Tested (+)
Barnyardgrass	25 (0)	Lambsquarters	63 (0)
Black nightshade	25 (0)	Little mallow	110 (1)
Bindweed	25 (0)	Mustard (common)	60 (0)
Bur clover	25 (0)	Nettle	25 (0)
Common sunflower	25 (0)	Pigweed	25 (0)
Dodder	25 (0)	Prickly lettuce	90 (2)
Fiddleneck	25 (0)	Purslane	25 (0)
Groundcherry	25 (0)	Russian thistle	25 (0)
Groundsel (common)	40 (1)	Sowthistle	60 (1)
Jimsonweed	25 (0)	Tree tobacco	25 (0)

(+) number of plants tested positive for TSWV by immunostrips and/or PCR

Initial Research Summary (Research continues in 2009)

1. **Pepper & tomato crops** can amplify the virus and serve as an inoculum reservoir.
2. **Lettuce** is grown for a fall market and a spring market and overlaps with the summer crops of tomato and pepper. Lettuce could serve as a bridge crop for the TSWV. While some fall incidence of TSWV has been observed for several years only in 2008 was TSWV observed in the spring crop. Still incidence is low and patchy. Lettuce is not perceived to be a big threat as an inoculum reservoir or bridge crop, because most conventional lettuce is on an aggressive insecticide program for other key pests.
3. **Radicchio** is a small acreage crop that poses a big threat as a potential TSWV inoculum reservoir and bridge crop. It is capable of supporting large populations of thrips and is very susceptible to TSWV. In 2007 in Fresno County it was observed as a primary source of TSWV infected thrips that moved to nearby tomato fields spreading the virus. Growers came to recognize this and changed cultural practices. It appears that the TSWV threat can be managed with aggressive thrips management and crop sanitation as the monitored radicchio field in Fresno was TSWV free in 2008. However some radicchio fields in Merced County still had some virus incidence.
4. **Almond trees** & flowers do not appear to be an inoculum reservoir threat.
5. **Weeds** do not seem to be an important inoculum reservoir at this time although they could potentially develop into one.

References

Gilbertson, R. L., Batuman, O., Le Strange, M., Turini, T. A. , Stoddard, C. S., Ullman, D. E. 2008. Western Flower Thrips Abundance and Incidence of Tomato Spotted Wilt in Processing Tomato Fields in the Central Valley of California. CA Tomato Research Institute 2008 Annual Project Report, p. 75-84.

Groves, R. L., Walgenbach, J. F., Moyer, J. W., and Kennedy, G. G. 2002. The role of Weed Hosts and Tobacco Thrips, *Frankliniella fusca*, in the Epidemiology of Tomato Spotted Wilt Virus. Plant Dis. 86: 573-582.

Groves, R. L., Walgenbach, J. F., Moyer, J. W., and Kennedy, G. G. 2001. Overwintering of *Frankliniella fusca*, on Winter annual Weeds Infected with Tomato Spotted Wilt Virus and Patterns of Virus Movement Between Susceptible Weed Hosts. Phytopathology 91: 891-899.

Allen, W.R. 1991. Petunia as an Indicator Plant for Use by Growers to Monitor for Thrips Carrying the Tomato Spotted Wilt Virus in Greenhouses. Plant Dis. 75:78-82.

Time and Temperature Requirements for Thermal Death of Seeds of Yellow Starthistle (*Centaurea Solstistealis* L.) and Black Mustard (*Brassica Nigra* L.)

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Solarization is a method of soil disinfestation that relies upon high temperatures to reduce populations of pest organisms in the soil (Stapleton and De Vay 1986). Soil temperatures above 45 C have been found to reduce emergence of seeds of annual weed species (Horowitz et al. 1983, Peachey et al. 2001). While solarization has promise as a potential alternative to soil fumigation, specific guidelines for treatment are lacking (Stapleton et al. 2000). Time and temperature requirements for thermal death have already been determined for seeds of six weed species (annual sowthistle, barnyardgrass, black nightshade, common purslane, London rocket, and tumble pigweed) at temperatures reached during solarization (Dahlquist et al. 2007).

We determined the time required for thermal death for seeds of two additional weed species, yellow starthistle (*Centaurea solstitialis* L.) and black mustard (*Brassica nigra* L.), at 50 C. Seeds were placed in organdy bags and allowed to imbibe water at room temperature for 2 hours before heat treatment. Seed bags were placed in 0.47-L mason-type canning jars filled with 30-grit silica sand wetted to field capacity (10.4% moisture) with deionized water and maintained at 50 C in a water bath. Six jars per species were maintained at 50 C, and three jars were kept at room temperature as controls. In each experiment, three to four bags of seeds were placed in each jar. Seed bags were removed at intervals from 2 to 19 hours. After removal from the jars, seeds were taken out of the packets and placed in 100 by 15-mm petri dishes on 7-cm-diam Whatman #1 filter paper moistened with 1.4 ml of deionized water. Petri dishes were incubated in a growth chamber on a cycle of 8 h at 20 C in darkness and 16 h at 30 C. Germination percentages were determined for each dish after 14 days. The percentage germination from each bag of seeds was divided by the average percentage germination of the three controls to correct for any variables besides temperature. A tetrazolium test was performed on black mustard seeds with intact seed coats that had not germinated to determine viability. Seeds were incubated for 24 hours in 1% (wt/vol) triphenyl tetrazolium chloride and then examined for staining patterns.

Seeds of both weed species were dead within 16 hours at 50 C. This combination of time and temperature falls within the range of values for the weed species previously studied. Annual sowthistle required 4 hours at 50 C for complete mortality, while more heat-tolerant species such as black nightshade and tumble pigweed required 71 and 113 hours, respectively. This indicates that yellow starthistle and black mustard seeds are relatively susceptible to high temperatures. In tetrazolium tests, 96% of black mustard seeds were determined to be non-germinable, indicating that the lack of germination was due to mortality at high temperatures rather than heat-induced dormancy.

References:

Dahlquist, R.M., T. S. Prather, and J.J. Stapleton. 2007. Time and temperature requirements for weed seed thermal death. *Weed Science* 55:619–625.

Stapleton, J. J. 2000. Soil solarization in various agricultural production systems. *Crop Protection* 19:837–841.

Stapleton, J. J. and J. E. DeVay. 1986. Soil solarization: A non-chemical approach for management of plant pathogens and pests. *Crop Protection* 5:190–198.

Evaluation of a New Natural Product Herbicide for Rice Weed Control

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To date, no selective herbicides are available to control weeds in organic rice. Means to control both broadleaf and grass weeds in organically grown rice are limited to water management and hence, yield loss in organic rice due to weeds can exceed 50%. Thaxtomins (4-nitroindol-3-yl-containing 2,5-dioxopiperazines) are a group of natural product phytotoxins produced by microbes of the genus *Streptomyces.* In preliminary tests*,* thaxtomin A, a metabolite produced by *Streptomyces acidiscabies*, an actinomycete isolated from a marine environment, has shown high levels of crop selectivity and potential utility in weed control on rice. In a greenhouse study where thaxtomin A at 0 - 0.4 mg/mL was applied to four common rice weeds: *Ammania sp*. (redstem), *Alisma plantago-aquatica* (common waterplantain), *Cyperus difformis* (smallflower umbrella sedge), and *Leptochloa fascicularis* (sprangletop), thaxtomin A at 0.2 mg/mL provided good control (70%) of redstem and excellent control of common waterplantain (100%) and sedge (90%). No phytotoxic effects were observed in rice plants treated with the same concentrations of thaxtomin A, which suggests that thaxtomin A could be used alone and in combination with other rice herbicides to control weeds in both organic and conventional rice.

Using Passive Solar Heating Tents for Eradication of Weed Seed-Bearing Plant Material in Remote Areas

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A discovered infestation of live and skeleton plants of the Class 'A' weed pest, Iberian starthistle (*Centaurea iberica*), in Mariposa County prompted initiation of a field and laboratory project to adapt solar heating techniques for seed eradication. To facilitate off-site methods testing, seeds of invasive, but non-quarantined, tocolote (*C. melitensis*), collected from the Santa Monica Mountains Recreation Area in Ventura County, also were used. Field testing showed that an adaptation of the "double tent" solarization technique (www.solar.uckac.edu), designed for soil disinfestation, could provide inside air temperatures of more than 70 C (158 F) during warm summer days. Field and laboratory testing pointed out the critical need for moisture in the seed bags in order to obtain desired efficacy. Thermal inactivation studies were conducted on seeds exposed at 42, 46, 50, 60, and 70 C. The studies indicated that, at the higher temperatures of 60 and 70 C, seeds of both *Centaurea* species tested could be inactivated over the course of a single day of treatment, under conditions similar to those encountered in Mariposa County. Initial field validation in the San Joaquin Valley confirmed model guidelines, allowing no survival of hydrated *C. melitensis* seeds after one day of exposure. On the other hand, survival of non-hydrated seeds under similar conditions was documented. This technique may be of value for on-site eradication of seeds from localized infestations of invasive weed pests. It could be adaptable for use on infestations discovered in remote areas, where attempted removal of viable seeds or seed-bearing material might result in unwanted seed dispersal.