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MANAGEMENT OF SCLEROTINIA CROWN AND STEM ROT OF ALFALFA.

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Abstract
Sclerotinia crown and stem rot of alfalfa occurs in temperate climates throughout the world. In California's San Joaquin Valley it can be widespread in wet winters with extended foggy periods. Both established and seedling plants can be infected, but seedlings are more likely to be killed because there is little or no crown development at the time of infection. Trials were conducted to evaluate fungicides and canopy removal, either with a small plot harvester or with the contact herbicide Gramoxone Max (paraquat) for *Sclerotinia* control in seedling alfalfa. The fungicides Pristine (boscalid + pyraclostrobin) and Endura (boscalid) reduced disease and increased yields in the first cutting compared to untreated controls, early mowing, and Gramoxone Max application.

Key Words: Alfalfa, *Sclerotinia*, Endura, Pristine, Gramoxone Max, boscalid, pyraclostrobin, paraquat, canopy management

Introduction

Stem and crown rot of alfalfa caused by *Sclerotinia* fungi occurs worldwide in temperate growing regions. Two species, *S. sclerotiorum* (Lib.) de Bary and *S. trifoliorum* Eriksson, can cause this disease (1). One method to differentiate these species is by microscopic

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examination of ascospores within the ascus. *S. trifoliorum* has 4 spores larger than the other 4 while *S. sclerotiorum* has 8 ascospores of similar size. In 2005and 2006, a limited number of apothecia collected from a Tulare County alfalfa field with a very high level of *Sclerotinia* were identified as *S. trifoliorum.* In early 2008, *S. sclerotiorum* was isolated from a diseased alfalfa plant collected in Kings County and identified using a DNA-based PCR procedure. Symptoms, life cycle and epidemiology are similar for the two species. One difference, however, is that *S. trifoliorum* has a narrower host range, tending to favor hosts in the legume family while *S. sclerotiorum* infects a broader range of host families. If *S. trifoliorum* is the primary pathogen, crop rotation may be a useful strategy to incorporate into a set of management practices to reduce the impact or spread of this disease.

No varietal tolerance or resistance has been recognized in the non-dormant varieties that are grown in the southern San Joaquin Valley. Both seedlings and established alfalfa plants can be infected. The most obvious symptom is wilting or flagging of stems (Fig. 1). Infection may occur

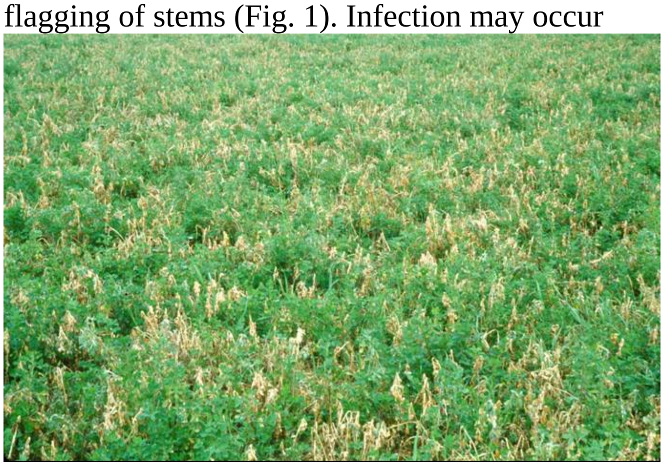

Fig. 1. Dead stems caused by Sclerotinia stem and crown rot.

anywhere between the base of the stem and the stem tip. The infected portion of the stem is light tan to bleached in color. The infected area is usually soft and at times “mushy.” Any plant tissue above the infection site will wilt and die. Leaves remain attached to the stem. When conditions are favorable (cool and moist), white strands (mycelium) of the fungus are visible on stems and around the base of infected plants (Fig. 2). When the host food source has been consumed or the weather turns warm and dry, sclerotia form within, or at the base of, infected stems. Sclerotia

Fig. 2. White mycelium visible under favorable conditions.

are small, hard, resistant vegetative structures formed by mycelium that enable the pathogen to survive unfavorable summer conditions (Fig. 3).

Fig. 3. Sclerotium in an alfalfa stem.

In late autumn, when soil is moist and temperatures are cool, sclerotia can germinate directly as mycelium and infect plants, or can produce fruiting bodies (apothecia, Fig. 4) which will eject hundreds of thousands of spores (ascospores) into the air. During years with widespread disease, infections within a field can

Fig. 4a (top) Close up view of an apothecium. Fig. 4b (bottom) Apothecia in a field in which infection was severe the previous year.

be very scattered. In addition, initial infection sites are often found on stems above ground level, indicating that ascospores are probably the primary inoculum of most concern.

High humidity is required for disease development. The tule fog that develops in the San Joaquin Valley during winter inversions and, which can persist for weeks, provides ideal conditions. Even on days with afternoon clearing, the crop canopy holds enough moisture to keep conditions favorable for disease.

When established plants are infected, only stems are usually killed and the crowns survive. However, if conditions for disease remain favorable for a long time, or if plants are already weakened prior to infection, established plants may die. In addition, most established stands are harvested late in the fall, leaving a relatively short canopy during the winter months. This lack of a tall, dense canopy, together with well developed crowns, usually results in little loss in established stands even during a high *Sclerotinia* year.

Seedlings are more likely to be killed by *Sclerotinia* as crowns have not yet formed or, if formed, are much smaller than in established plants. Alfalfa planted in September and October, the optimum time to plant alfalfa in the Southern San Joaquin Valley, will have a canopy height of 6 to10 inches or more by the time weather conditions occur that favor *Sclerotinia* infection. Growers claim that stand loss in seedling fields can be significant and some have abandoned planting at this optimum time because of the risk of stand loss associated with this disease, for which no fungicides are currently registered. One strategy that has been utilized is to spray alfalfa with Gramoxone Max (paraquat), a contact herbicide that burns back alfalfa foliage, in order to reduce the canopy in seedling fields, thereby reducing moisture and humidity.

Trials were conducted in 2004-2005 and 2005-2006 to determine crop loss due to this disease. The effectiveness of fungicide applications or an herbicide spray to burn back the canopy were evaluated for protecting early fall planted alfalfa seedlings from loss due to Sclerotinia crown and stem rot.

Methods and Materials

In both trials, chemical applications were made with a 4-nozzle CO_2 backpack sprayer in plots 6 ft wide x 30 ft (2004-05) or 25 ft (2005-06) long. Nozzles were either 8002 or 8003, pressure at the boom was between 25 and 30 psi, and the volume per acre ranged from 22 to 30 gal/A. A non-ionic surfactant (Latron B) was added to all fungicide applications at 0.25% v/v. All application rates are presented as formulated materials.

A self-propelled Carter harvester cut the center 3 ft of each 6 ft plot for yield data. Alfalfa was weighed in the field and samples were taken to determine moisture. All yields are presented on a 100% dry matter basis.

The statistical software package MSTAT-C was used for analysis (3). Design 13 under "Factor" was used for analysis of the split-split trial. LSD's for split-split plots were calculated using the program Least Significant Difference (2). A 2-way analysis of variance was used for the randomized complete block trial.

2004-2005 Trial The trial was conducted in a commercial alfalfa field in Tulare County planted in mid-September. Conditions were favorable for Sclerotinia stem and crown rot during the winter of 2004/2005. Significant rains in November followed by continued wet or foggy conditions through January and into February provided ideal environmental conditions for this disease to thrive.

The trial consisted of three replicated randomized complete blocks with split-split plots. Main blocks were either left unmowed or were mowed to remove the crop canopy on 3 December 2004. At this time, some foci of disease were already visible and the alfalfa was 8 to 10 inches tall. Six split-plot treatments were applied on 10 December 2004. These included an untreated control, Gramoxone Max (paraquat) @ 21.3 fl oz/A, a mix of two foliar fertilizers (Formula 1 and Protect Ag from Custom Agricultural Formulators, Fresno, CA) @ 1 qt/A each, Gramoxone Max @ 21.3 fl oz/A plus the two foliar fertilizers @ 1 qt/A each, Endura (boscalid) at 11 oz/A, and Pristine (pyraclostrobin + boscalid) @ 18.5 oz/A. The 11 oz rate of Endura contained 7.7 oz/A of the active ingredient boscalid and the 18.5 oz/A rate of Pristine contained 4.7 oz a.i. boscalid/A and 2.4 oz a.i. pyraclostrobin/A. Because conditions were so favorable for disease through January, an unplanned split-split plot application of Endura @ 11 oz/A was applied to half of all plots on 18 January 2005.

Disease ratings were recorded on 5 February 2005, about one month after the first treatments were applied, and on 25 February, five weeks after application of the last treatment. A scale of 0 –10 was used with 0 = no disease and 10 = the entire plot infected. At the first cutting, in addition to yield data, one 2 ft^2 area was cut from each plot and weeds were separated from alfalfa to determine the dry weight composition of alfalfa and weeds. After the second harvest, skips in the drill rows, which were attributed to stand loss due to *Sclerotinia*, were measured in three randomly chosen areas, totaling 9 ft^2 per plot, to estimate the impact of disease on stand. Data presented were converted to percent stand remaining.

2005-2006 Trial This trial was conducted in a commercial alfalfa field in Tulare County planted in late October of 2005. In addition to the untreated control, there were 7 treatments: Gramoxone Max @ 5.4 fl oz/A applied 10 January; Gramoxone Max @ 10.8 fl oz/A applied 6 February; Gramoxone Max @ 10.8 fl oz/A plus two foliar fertilizers (Formula 1 and Protect Ag) each at 1 qt/A applied 6 February; Pristine @ 10.5 oz/A applied 10 Jan and 24 February; Pristine applied on those same dates @ 18.5 oz/A; Pristine at 10.5 oz/A applied 6 February; and Pristine @ 18.5 oz/A applied on 6 February. Extent of infection was evaluated on 31 January by counting the number of infection sites per 12 ft^2. Stand was evaluated on a subjective 0-10 scale with 10 being a perfect stand and 0 indicating no plants remaining in the plot.

Results and Discussion

2004-2005 Trial On 5 January there was less disease in mowed plots than in unmowed plots (Table 1). Of the split plots, the Pristine and Endura treatments had similarly low levels of disease incidence. The Endura treatment was also

Table 1. Disease Ratings for 2004-2005 Sclerotinia Crown and Stem Rot Trial, Tulare County, CA[1.]

Treatments	Rate/A	Date applied	5 Jan Disease rating[2]		25 Feb Disease rating[2]	
Main plots (Factor A):						
Unmowed			5.3	b	2.3	
Mowed		3 Dec	4.1	a	1.7	
	F		*69.14*		*4.47*	
	Degrees of freedom		*1*		*1*	
	P (Factor A)		*0.02*		*0.17*	
	LSD (.05)		*0.63*		*NS*	
Split plots (Factor B)						
Untreated			6.3	d	2.2	b
Gramoxone Extra	21.3 fl oz	10 Dec	4.8	bc	2.2	b
Phosphyte + Protect Ag	1 qt + 1 qt	10 Dec	5.8	cd	2.3	b
Gramoxone Extra + Physphyte + Protect Ag	21.3 fl oz + 1qt + 1qt	10 Dec	4.3	b	2.6	b
Endura + Latron 0.25% v/v	11 oz	10 Dec	3.8	ab	0.8	a
Pristine + Latron 0.25% v/v	18.5 oz	10 Dec	2.8	a	1.8	ab
	F		*19.15*		*3.88*	
	Degrees of freedom		*5*		*5*	
	P (Factor V)		*0.000*		*0.01*	
	LSD (.01)		*1.19*		*1.34*	
	P (AxB)		*0.04*		*NS*	
	LSD (0.05) splits within the same main treatment		*1.23*			
	LSD (0.05) splits in different main treatments		*1.25*			
Split-split plots (Factor C)						
Not oversprayed					2.6	b
Oversprayed with Endura	11 oz	18 Jan			1.3	a
	F				*26.5*	
	Degrees of freedom				*1*	
	P (Factor C)				*0*	
	LSD (0.01)				*0.69*	
	P (AxC)				*NS*	
	P (BxC)				*NS*	
	P (AxBxC)				*NS*	

[1] Values are the means of 3 replications. Alfalfa was planted in September 2004.
[2] Disease rating: 0=no disease; 10=all plants infected.

similar to the Gramoxone treatments, with or without foliar nutrients, and presented an intermediate level of disease. Untreated control plots and plots treated with foliar nutrients alone had the highest disease ratings. There was a significant interaction (P=0.04) between mowing and spray applications (Figure 5) in which most treatments had less disease when mowed but the Gramoxone treatment had slightly more disease when mowed. This might be because it was easier to see disease symptoms when plots were mowed compared to unmowed plots with burnt foliage. Overall disease levels were lower on 25 February than in early January (see Table 1). The effect of mowing on disease levels was no longer significant. The Endura and Pristine split-plot treatments had the lowest disease ratings and were not significantly different from each other. The

Table 2. Yield Results and Stand Ratings from 2004-2005 Alfalfa Sclerotinia Crown and Stem Rot Trial, Tulare County, CA.[1]

Treatments	Rate/A	Date applied	19 April: Total yield alfalfa + weeds Tons/acre	19 April: % Weeds by weight	20 May Tons/acre	26 May % Stand
<u>Main plots (Factor A)</u>						
Unmowed			2.56	9.3	2.42	56.9
Mowed		3 Dec	2.42	8.9	2.30	50.2
	F		*12.81*	*0.012*	*1.77*	*7.02*
	Degrees of freedom		*1*	*1*	*1*	*1*
	P (Factor A)		*0.07*	*>0.50*	*0.31*	*0.11*
	LSD (.01)		*NS*		*NS*	*NS*
<u>Split plots (Factor B)</u>						
Untreated			2.43 bc	14.8 ab	2.35	47.5 bc
Gramoxone Extra	21.3 fl oz		2.22 c	2.8 a	2.33	55.9 ab
Phosphyte + Protect Ag	1 qt + 1 qt	10 Dec	2.55 b	23.0 b	2.34	41.2 c
Gramoxone Extra + Phosphyte + Protect Ag	21.3 fl oz + 1qt + 1qt	10 Dec	2.24 c	2.6 a	2.29	56.6 ab
Endura + Latron .25% v/v	11 oz	10 Dec	2.72 a	5.9 a	2.40	58.5 ab
Pristine + Latron .25% v/v	18.5 oz	10 Dec	2.78 a	4.9 a	2.46	61.7 a
	F		*21.92*	*4.46*	*1.71*	*5.53*
	Degrees of freedom		*5*	*5*	*5*	*5*
	P (Factor B)		*0.000*	*0.007*	*0.18*	*0.002*
	LSD (.01)		*0.201*	*15.6*	*NS*	*13.1*
	P (AxB)		*0.00*	*>0.50*	*>0.50*	*0.44*
	LSD (0.01) splits within the same main treatment		*0.285*	*NS*	*NS*	*NS*
	LSD (0.01) splits in different main treatments		*0.39*	*NS*	*NS*	*NS*
<u>Split plots (Factor C)</u>						
Not oversprayed			2.40 a	13.90 a	2.28 a	49.11 a
Oversprayed with Endura	11 oz		2.57 b	4.10 b	2.44 b	58.02 b
	F		*11.23*	*7.53*	*12.74*	*15.04*
	Degrees of freedom		*1*	*1*	*1*	*1*
	P (Factor C)		*0.003*	*0.01*	*0.002*	*0.007*
	LSD (.01)		*0.201*	*15.6*	*NS*	*13.1*
	P (AxC)		*0.12*	*>0.50*	*>0.50*	*>0.50*
	P (BxC)		*>0.50*	*0.42*	*>0.50*	*>0.50*
	P (AxBxC)		*0.37*	*>0.50*	*>0.50*	*0.12*

[1] Values are the means of 3 replications. Alfalfa was planted in September 2004.

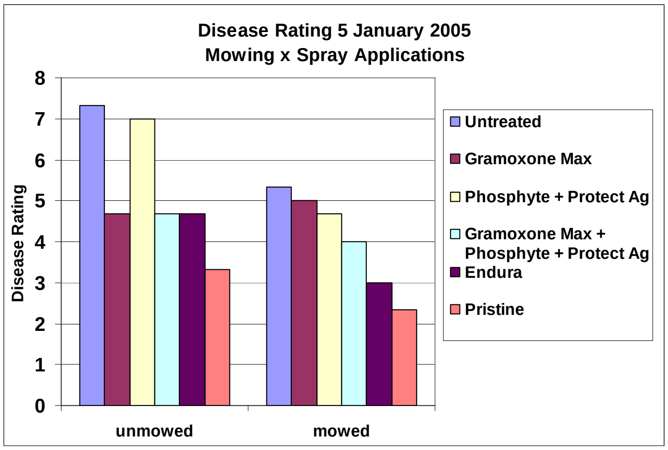

Fig. 5. Sclerotinia crown and stem rot disease ratings for split plot treatments by main plot treatments, demonstrating the relative performance of treatments under the two mowing treatments.

Endura treatment was significantly lower than all other treatments except for the Pristine. The split-split overspray of Endura on 18 January on half of each plot reduced disease significantly (p=0.001) compared to plots not over-sprayed. Even though mowed plots had less disease than unmowed plots at the January rating, there was no difference in yield between these treatments at the first cutting in April (Table 2). Split plots treated in December with Pristine or Endura yielded more than all other treatments. There was a significant interaction between mowing and split plots (P=0.00) indicating that not all treatments responded in the same way to mowing (Figure 6).

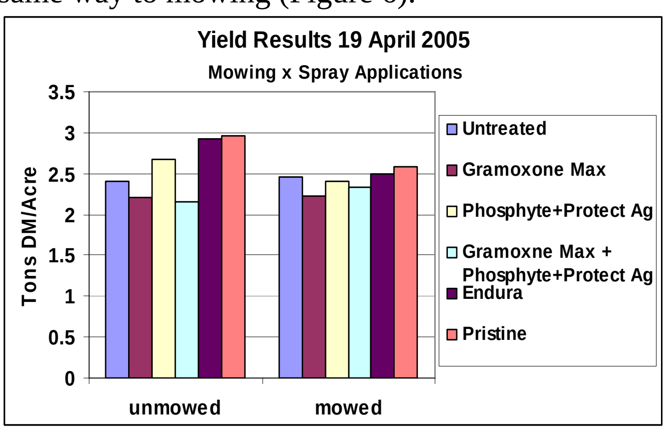

Fig. 6. Alfalfa yield results showing the increases for the Endura, Pristine, and foliar nutrient treatments when unmowed compared to mowed. Yields of the other treatments either remained similar or declined when left unmowed.

Yields for plots treated with Pristine, Endura or the fertilizers by themselves were reduced by mowing while the untreated control and both treatments with Gramoxone were either about the same or slightly increased in mowed plots compared to unmowed plots. Observations indicated that the high levels of disease in untreated control plots in the unmowed areas reduced yields so that they did not have a yield advantage over plots that had been mowed. For Gramoxone treated plots, burning back the foliage by the chemical was similar to mowing. On the contrary, in the Pristine and Endura treatments, disease was low in unmowed plots and with healthy alfalfa these plots yielded more than their mowed counterparts in which top growth had been removed in December. In the case of the foliar fertilizers, a large part of the yield advantage in the unmowed plots was due to weeds (23% of the dry weight) that had filled in where the alfalfa had been reduced by *Sclerotinia* (see Table 2). The January application of Endura significantly increased yields by 0.17 tons/acre compared to plots that were not sprayed. This yield response to the late application is an indication of the effectiveness of this fungicide in controlling *Sclerotinia* and also the favorable environmental conditions that continued to promote the disease into late January and February.

There was no difference in the percent weeds by weight in mowed plots compared to unmowed plots at the first cutting (see Table 2). In the split plots there were more weeds in the untreated control and the plots treated with foliar nutrients only than in any of the other treatments. Plots with higher disease ratings in January were the same ones that also had the most weeds, indicating that loss of crop competition due to disease allowed weeds to grow better in these treatments than in plots with healthier alfalfa. Plots treated with the herbicide Gramoxone Max, with or without foliar nutrients, had the fewest weeds. Disease control provided by Endura or Pristine applications apparently helped the alfalfa compete against weeds, resulting in significantly less weed

Table 3. Disease Ratings, Yield Results, and Stand Evaluations, 2005-2006 Sclerotinia Crown and Stem Rot Trial, Tulare County, CA.[1]

Treatments	Rate/acre	Dates applied	31 Jan Disease Rating (# infection sites per 12 ft[2,3])		May 2 Yield (Tons/acre)		May 2 Stand rating	May 30 Yield (Tons/acre)	
Untreated Control			4.2	b	2.07	cd	9.2	1.69	d
Gramoxone Max early	5.4 fl oz	10-Jan	3.0	ab	2.05	d	9.8	1.86	bc
Gramoxone Max late	10.8 fl oz	6-Feb	6.0	b	2.04	d	9.7	1.75	cd
Gramoxone Max late + Formula 1 + Protect Ag	10.8 fl oz 1 qt 1 qt	6-Feb	5.0	b	2.06	d	9.5	1.74	cd
Pristine[2]	10.5 oz	10-Jan, 24-Feb	0.5	a	2.42	b	10.0	1.96	ab
Pristine[2]	18.5 oz	10-Jan, 24-Feb	0.5	a	2.62	a	10.0	2.05	a
Pristine[2]	10.5 oz	6-Feb	6.2	b	2.22	cd	8.9	1.75	cd
Pristine[2]	18.5 oz	6-Feb	3.8	ab	2.26	b	9.4	1.78	cd
	F		*3.98*		*10.4*		*1.13*	*8.1*	
	Degrees of freedom		*7*		*7*		*7*	*7*	
	P		*0.006*		*0.00*		*0.38*	*0.00*	
	LSD (.05)		*3.3*		*0.2*		*NS*	*0.1*	

[1] Values are the means of 4 replications. Alfalfa was planted in October 2005.
[2] Non-ionic surfactant (Latron B) was applied with all Pristine applications at 0.25% v/v.
[3] Disease rated by counting the number of infections sites in 9 ft^2 per plot.

infestation than in the untreated control and the foliar nutrient treatment.

At the second cutting in May, there were no differences among the split plot treatments. However, the January overspray with Endura produced almost 0.2 tons/acre more than plots not sprayed and this difference was statistically significant.

Pristine, Endura, and Gramoxone Max treatments had a higher percentage of stand remaining after the second harvest than the untreated control or the treatment with foliar nutrients by themselves (Table 2). The stand density in these latter two treatments was probably reduced by the combined impact of *Sclerotinia* and weed competition. The January overspray of Endura increased stand counts significantly, indicating that late season *Sclerotinia* had a significant impact on stand density.

Applications of Gramoxone reduced disease compared to the untreated control and also controlled weeds, but the combination of burning back alfalfa with this contact herbicide and killing weeds resulted in the lowest yields at the first cutting. Endura and Pristine applications provided better disease control than Gramoxone and resulted in the highest yields at first cutting. Foliar nutrients did not improve disease control compared to untreated plots and total yields were no better than untreated controls.

Due to problems with a leaky valve, the area of the field where the plot was located became rutted by equipment and no additional data were collected.

2005-2006 Trial. The 2005-2006 season was not as favorable for disease as the year before and *Sclerotinia* was not as uniform across the plot as it was in the previous trial. Infection sites were less numerous yet more distinct, allowing disease to be evaluated by counting the number of infection sites in the plots (Table 3). The disease rating on 31 January occurred when disease symptoms were near the maximum for the season. The two Pristine treatments applied on 10 January had very low disease counts (0.5 infection sites per 12 ft^2) and the 10 January Gramoxone treatment had the next lowest rating (3.0), but these were not statistically different from a treatment that had not yet received a fungicide spray. Disease counts for four treatments, which at that rating time had not received any sprays, ranged from 3.8 to 6.2, illustrating that disease occurrence and severity was less than the previous year and unevenly distributed.

The first cutting did not occur until early May. The two rates of Pristine applied early resulted in the highest yields, significantly higher than all but one other treatment. In general, plots with more disease tended to yield less than plots that had lower disease counts. There were no differences in stand ratings after that cutting. At the second cutting, the early Pristine treatments again produced the highest yields, significantly higher than all but one other treatment.

Summary

Applications of either Pristine or Endura fungicide shortly after symptoms were first observed significantly reduced disease compared to untreated controls. Gramoxone Max herbicide also reduced disease symptoms, but not to the degree of either fungicide. Pristine and Endura applications also resulted in the highest yields. Gramoxone treatments often had yields lower than the untreated control, due to both the impact of burning off foliage and also of controlling weeds. Under severe disease pressure in the 2004-2005 trial, both fungicides and Gramoxone treatments reduced stand loss. Both Pristine and Endura are distributed by BASF. The company has expressed interest in Pristine for alfalfa but at this time no registration is pending. In the meantime, growers who plant in September or early October run the risk of yield and stand loss from *Sclerotinia* if the winter is wet and foggy. Treatment with Gramoxone may help mitigate stand loss and, in the long run, be beneficial. Applications of Gramoxone when seedlings are large enough for treatment yet before disease is observed and before the crop canopy is so heavy that good burn-back does not occur, might increase effectiveness from the disease prevention aspect while also allowing more time for the plants to recover before harvest. In a location where *Sclerotinia* has been severe in the preceding year, delaying seeding until late January or early February will reduce the chance for disease but will also result in lower yields during the first production year compared to early fall plantings not adversely affected by *Sclerotinia*. Registration of Pristine would provide growers with a useful tool minimize risk while allowing them to plant in September and October, the optimum time for obtaining quick emergence and first season production.

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TESTING USE OF DAZOMET AND/OR SOLARIZATION FOR CONTROL OF SOILBORNE PESTS OF MELON IN THE LOW DESERT. *Thomas A. Turini and Devon Rodriguez, UCCE Fresno County and formerly UCCE Imperial County; Rick Bottoms, formerly UCCE Imperial County; Khaled Bali, UCCE Imperial County; James J. Stapleton, UCIPM, Kearney Ag Center, Parlier.*

Summary

The low desert vegetable production areas of California have seen a recent increase in the use of solarization, which is the practice of covering moist soil with plastic to achieve temperatures lethal to soilborne pests, and trigger other, naturally-occurring biocidal effects. This technique is effective against many pests, but is currently used primarily for weed control in desert spring mix crops. To evaluate the potential benefits of solarization, with or without a chemical soil pesticide for melon production, a trial was conducted at University of California Desert Research and Extension Center in 2006-07. The five treatments compared were: solarization (2 August to 29 September 2006), dazomet (Basamid® G), a granular methyl isothiocyanate-generating material) at 530 and 265 lbs/acre covered with solarization film, dazomet at 530 lbs/acre without film cover, and an untreated control. On 26 March 2007, 'Gold Rush' cv. cantaloupe was direct seeded on the undisturbed beds and irrigated with buried drip. Weed densities, plant vigor, fruit yield and quality parameters, and root disease symptom severity were recorded. All treatments reduced cheeseweed and purslane densities, as compared to the untreated control. Vegetative runner lengths of plants were greater in solarized treatments. However, few differences in yield, ^{o}brix, fruit size or root symptom severity were observed.

Introduction

Solarization is the use of plastic films to cover moist soil during the summer to increase soil temperatures to levels that will kill soil-borne pests, or render them susceptible to additional, naturally-occurring, biological or chemical control effects. In the US, this practice has been used in small-scale organic production for years (Stapleton et al., 2005), but more recently, solarization has been used for weed control in large-scale organic and conventional spring mix crops, destined for bagged salad markets, in the Imperial and Yuma Valleys of California and Arizona (Stapleton, et al., 2007). In spring mix cultivation, leafy vegetables are grown on wide beds and repeatedly mowed for harvest. Weed management is critical, and ineffective control necessitates costly hand-weeding of bed tops.

Solarization is also effective against nematodes and fungal pathogens, but there are some limitations. The effect of solarization on soil temperature is greatest near the surface; therefore, pests that can cause damage from deeper in the soil profile may withstand the use of this technique. In addition, some pest structures, such as the ascospores of the soil-borne fungus causing melon vine decline, *Monosporascus cannonballus*, are tolerant of solarization. However, when used in combination with biological or chemical agents, activity of solarization may be increased against heat-resistant propagules. Effective destruction of *M. cannonballus* propagules, even by chemical fumigation, is difficult (Stanghellini et al., 2003). In the desert growing areas of California and Arizona, soil inoculum levels of this pathogen are currently reduced using a high rate of chloropicrin, which is an expensive and very toxic material. The recent increase in use of solarization in conventional spring mix fields and the potential benefit to melon production, which could be rotated with spring mix, inspired the following field study.

Solarization and the methyl isothiocyanate (MIT)-generating, granular chemical agent dazomet (Basamid® G) were tested, alone and in combination, for soil disinfestation in desert melon production. As MIT is a general biocide, reductions of all soilborne pest organisms might be expected. The combination of solarization and dazomet had been previously reported to be effective in controlling *M. cannonballus* in Israel (Cohen et al., 2000).

Materials and Methods

A field study was conducted at the University of California Desert Research and Extension Center (DREC) in Holtville to assess the effect of solarization and dazomet on weeds, disease, and cantaloupe plant growth parameters and yield. Treatments were as follow:

(a) dazomet 530 lbs/acre, no solarization
(b) dazomet 530 lbs/acre + solarization
(c) dazomet 265 lbs/acre + solarization
(d) no chemical, solarization
(e) no treatment.(control)

Sixty-inch wide beds with 20-inch wide furrows were shaped in an area of Meloland clay loam soil known to be heavily infested with *M. cannonballus*, as well as with a seedbank containing several summer weed pests. Drip irrigation tape was buried at depth of 10 inches. On 28 July 2006, a tractor-mounted drop spreader was used to apply the dazomet, which was mechanically incorporated into the top 6-8 inches of soil. On 31 Jul, two additional lines of drip tape were placed on the soil surface 20 inches from the edges on one half (100 feet) of the length of each bed. All dazomet/solarization treatments were applied over entire 200 foot bed lengths. On 2 Aug, beds to be solarized were covered with 1.25 mil, UV-stablilized film designed for solarization. The sides of the plastic were covered with soil to avoid loss of coverage due to high winds. On 2-3 Aug, the field was drip irrigated 48 hours, for an estimated total of 3.1 inches of water through buried drip and an additional 6.2 inches through the surface drip. Four-channel Hobo® H8 Outdoor/Industrial data loggers fitted with external thermistor probes (Onset Computer Corporation, Bourne, MA) recorded soil temperatures at the center of beds covered with plastic, and in non-covered beds, at depths of 3, 6, 9 and 12 inches. Approximate soil moisture values at 4 and 8 inch depths were monitored 10 inches from the edge of the beds of one solarized and one untreated control treatment for both irrigation configurations with Watermark 900M (Irrometer Inc., Riverside, CA) tensiometers. The solarization film was removed on 29 Sep.

Plots were fallowed over the winter months and were not worked after the treatments were terminated the previous fall. On 26 Mar 2007, 'Gold Rush' (Harris Moran) cantaloupe seed was sown into the beds and irrigated. All irrigations were made through the buried drip tape. Imidacloprid (Admire) insecticide was drip-applied on 13 Apr to control aphids and whiteflies. The crop was tended according to standard practices.

The solarization and/or dazomet treatment effects were assessed by evaluating emergent weed populations, plant vigor, yield components, and root rot. Weeds were identified and counted on 25 feet of bed per plot on 23 Apr 2007. Plant vigor was evaluated by measuring 3 runners per plot on 3 different plants on 11 and 30 May, and on 7 Jun. Fruit were harvested from 25 feet of each plot on 27 Jun, and 2 and 6 Jul. The number of marketable fruit per plot were determined with respect to standard size categories (9, 12 15, 18 or 23 fruit per carton), and number of sunburned fruit was recorded. Five fruit per plot were tested for soluble solids at each harvest date. Disease indices and pathogen signs were obtained by visual and microscopic examination of root systems.

The 100 foot-long area with sub-surface drip and the 100 foot-long area with both sub-surface and surface drip irrigation were evaluated and analyzed as two different trials, although the treatments within each were identical. The experimental design was a randomized complete block with four replications. Analysis of Variance was performed and Least Significant Difference [LSD (P=0.05)] is presented.

For confirmatory purposes, a sample of approximately 12 lbs of soil was taken on 20 Sep 2006 from the upper twelve inches at the center of each plot in the area irrigated with sub-surface drip only on 2-3 Aug 2006. The soil was put in 12" diameter pots washed with 10% household bleach, covered with plastic and held in a covered, paved storage area until April 2007. On 13 Apr, 1.5 oz. of 11-52-00 fertilizer was incorporated into the soil of each pot, three 'Gold Rush' variety seed were placed at the center of each pot, drip irrigation tubing was placed in each pot, and they were irrigated. Seedling plants were thinned to 1 per pot. Weed counts and cantaloupe plant growth measurements were made on 29 May, and roots were evaluated for root symptoms and pathogen signs on 6 Jun.

Results and Discussion

Temperatures under solarization film averaged 100.4^o F at a depth of 3 in and 97.2^o F at a depth of 12 in, and average temperatures in noncovered beds averaged 93.0 ^{o} F at 3 in and 92.5 ^{o} F at 12 in from 11 Aug to 29 Sep 2006 (Figs. 1 and 2). The soil was saturated for a minimum of 3 days following the irrigation beginning 2 Aug (data not shown).

Weed densities were reduced by both solarization and dazomet treatments, as compared to the untreated controls P=0.05 (Table 1). Common purselane (*Portulaca oleracea*) counts were lower in all treatments than in the untreated control and cheeseweed (*Malva parviflora*) densities were lower for all treatments than in the untreated control where the 2-3 Aug 2006 irrigation was made with surface and sub-surface drip P=0.05 (Table 1). However, in the portion of the field in which the 2-3 Aug irrigation was made with sub-surface drip only, dazomet alone did not reduce cheeseweed counts P=0.05 (Table 1).

Differences in plant vigor were present among treatments regardless of the irrigation configuration at the time of the solarization initiation in 2006. Runner lengths were greater in solarized treatments than in the untreated control throughout the season P=0.05 (Table 2). However, in spite of the differences in plant vigor, significant differences in cantaloupe fruit yield were found only in one size category (12 fruit per carton) with sub-surface drip irrigation only, and the total yield values were not statistically separable. Similarly, no differences in sunburn or ^{o}Brix among treatments were found (P=0.05) (Tables 3 and 4). Substantial root rot and perithecia of *M. cannonballus* were present in all treatments

Results from the potted soil trial were consistent with those from the field. Common purslane weed densities were lower in soil from solarized treatments than in the untreated control, and plant runner lengths were longer P=0.05 (Table 5). The percentage of roots with root rot symptoms was not different among treatments P=0.05 (Table 5), and perithecia of *M. cannonballus* were observed on roots of all treatments.

As shown by the 30-year average, maximum air temperature maps (Stapleton, 2008), these trials were conducted later than the optimal July period for solarization in the Imperial Valley. Nevertheless, results confirmed the obvious benefits of the soil treatments in controlling common purslane and cheeseweed on cantaloupe beds. Also, consistent increases in plant vegetative runner length were associated with solarization. However, results with cantaloupe yields, sunburn incidence, and soluble solids were not consistent or not significant. Similarly, as evidence of *M. cannonballus* activity was found on plant roots from all treatments, these trials were unable to confirm the reported control by combined treatments (Cohen et al., 2000). Neither dazomet nor solarization, alone or combined, can be presently indicated as control measures for *M. cannonballus*.

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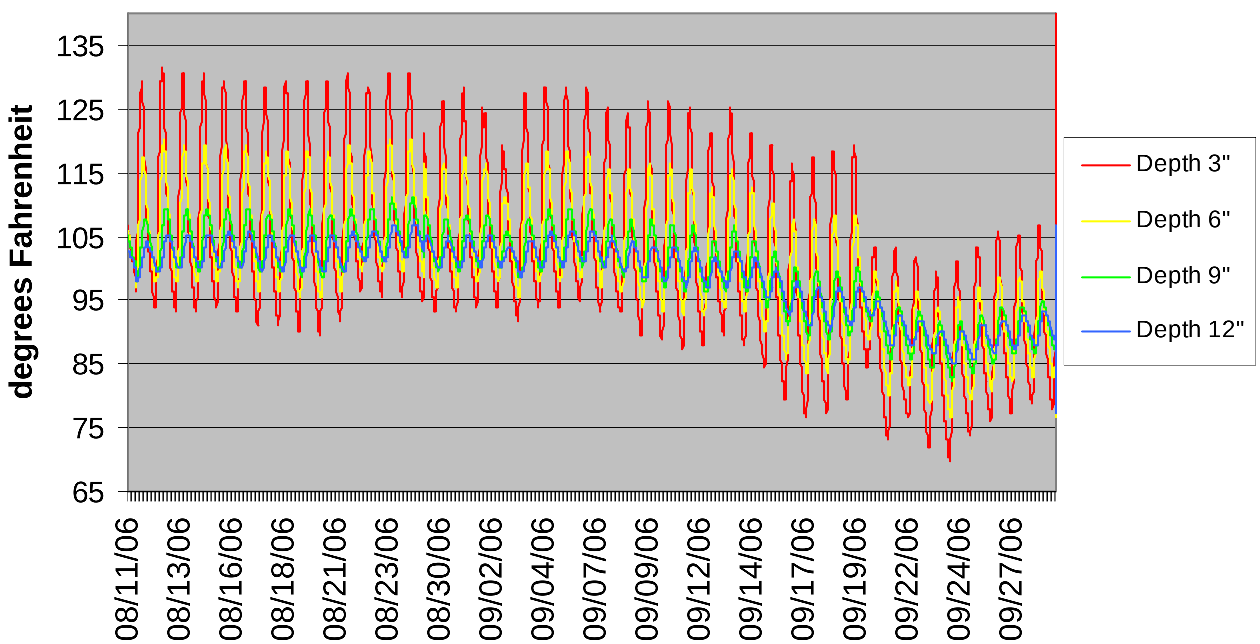

Fig. 1. Soil temperatures at center of 60” bed top covered with 1.25 mil solarization film at University of California Desert Research Extension Center.

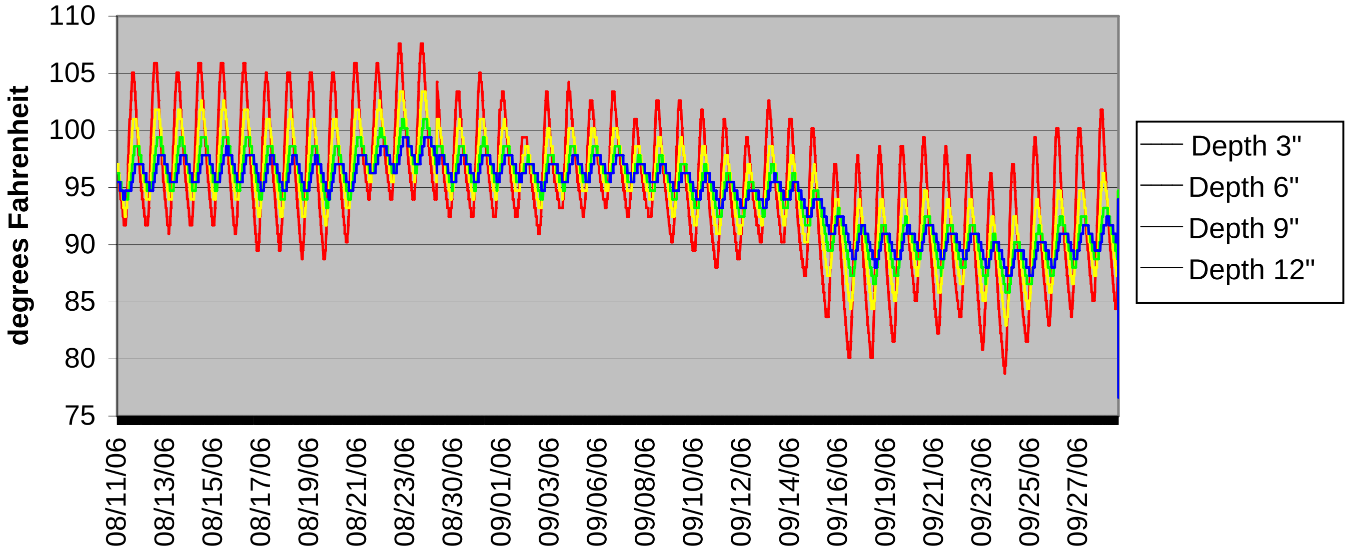

Fig. 2. Soil temperatures at center of 60” bed top covered with 1.25 mil solarization film at University of California Desert Research Extension Center.

Table 1. Effect of Basamid/solarization treatments made in 2006 on weed densities in cantaloupes (seeded and irrigated 26 Mar 2007) on 23 Apr 2007.

	Irrigation method at initiation of trial (2-3 Aug 2006)			
	Sub-surface drip only		Surface and sub-surface drip	
Treatment[z]	Common Purslane[y]	Cheeseweed	Common Purslane	Cheeseweed
Basamid G 530 lbs	17.5	23.0	13.8	8.0
Basamid G 530 lbs + solarization	0.0	4.0	0.0	7.3
Basamid G 265 lbs + solarization	0.0	5.5	0.3	9.0
Solarization	0.0	4.8	0.3	19.5
Untreated	155.3	20.8	62.0	73.8
LSD (P=0.05)[x]	86.6	18.0	32.9	43.8
CV	162.7	100.7	140.2	121.1

[z] On 28 Aug 2006, A tractor mounted drop spreader was used to apply Basamid and the material was mechanically incorporated into the top 6-8 in of soil. On 1 Aug, beds receiving the solarization treatment were covered 1.25 mil solarization film.

[y] On 23 Apr 2007, weeds were identified and counted in 25 ft per plot.

[x] Means separated by a value equal to or greater than the LSD (least significant difference) are significantly different at a probability of 5%.

Table 2. Effect of Basamid/solarization treatments made in 2006 on vigor of cantaloupes seeded and irrigated 26 Mar 2007.

Treatment[z]	Runner length (in)[y]					
	Irrigation method at initiation of trial (2-3 Aug 2006)					
	Sub-surface drip only			Surface and sub-surface drip		
	11 May, 2007	30 May, 2007	7 July. 2007	11 May, 2007	30 May, 2007	7 July. 2007
Basamid G 530 lbs	8.0	38.2	48.9	6.8	38.7	52.2
Basamid G 530 lbs + solarization	17.0	47.5	62.8	15.5	51.6	62.3
Basamid G 265 lbs + solarization	17.8	48.0	63.0	14.5	48.8	63.3
Solarization	14.8	42.2	59.8	13.0	49.2	56.5
Untreated	6.0	36.3	41.0	5.3	26.1	46.3
LSD (P=0.05)[x]	4.3	9.5	8.3	4.2	8.6	9.4
CV	21.9	14.6	9.7	24.8	13.1	10.9

[z] On 28 Aug 2006, A tractor mounted drop spreader was used to apply Basamid and the material was mechanically incorporated into the top 6-8 in of soil. On 1 Aug, beds receiving the solarization treatment were covered 1.25 mil solarization film.

[y] Average runner length as determined by measuring 3 runners from 3 different plants per plot. Averages are resented in inches.

[x] Means separated by a value equal to or greater than the LSD (least significant difference) are significantly different at a probability of 5%.

Table 3. Effect of Basamid/solarization treatments on yield of cantaloupes: Irrigated with sub-surface drip throughout the trial.

Treatment[z]	Cartons marketable fruit/acre[y]						Sunburn fruit per acre[x]	Brix[w]
	9	12	15	18	23	total		
Basamid G 530 lbs	362.8	308.8	162.0	65.3	14.8	909.6	6008.3	9.5
Basamid G 530 lbs + solarization	435.4	289.5	130.6	50.8	0	906.3	4179.7	9.3
Basamid G 265 lbs + solarization	643.3	333.1	156.7	55.1	0	1192.2	4049.1	9.1
Solarization	516.7	489.8	226.4	58.1	3.4	1294.3	4114.4	9.0
Untreated	333.8	148.0	57.5	33.4	3.4	576.1	2481.7	9.1
LSD (P=0.05)[v]	NS[u]	246.0	NS	NS	NS	NS	NS	NS
CV	57.6	51.2	101.7	101.7	179.5	48.8	55.7	7.2

[z] On 28 Aug 2006, A tractor mounted drop spreader was used to apply Basamid and the material was mechanically incorporated into the top 6-8 in of soil. On 1 Aug, beds receiving the solarization treatment were covered 1.25 mil solarization film.

[y] At full slip, fruit were harvested from 25 ft of each plot area on 27 Jun, 2 and 6 Jul. Number of marketable fruit per plot were placed in size categories (9, 12 15, 18 and 23 based on number of fruit per 45 lb carton).

[x] Number of sunburned fruit were recorded.

[w] At each harvest, a representative sample of 5 cosmetically acceptable fruit per plot were tested for soluble solids with a hand-held refractometer.

[v] Means separated by a value equal to or greater than the LSD (least significant difference) are significantly different at a probability of 5%.

[u] No significant difference between means in the column.

Table 4. Effect of Basamid/solarization treatments on yield of cantaloupes: Irrigated with surface and sub-surface drip immediately after application of solarization film and Basamid.

Treatment[z]	Cartons marketable fruit/acre[y]						Sunburn fruit per acre[x]	Brix[w]
	9	12	15	18	23	total		
Basamid G 530 lbs	616.8	239.5	182.9	36.8	0.0	1075.4	4114.4	6.1
Basamid G 530 lbs + solarization	333.8	255.8	100.1	50.8	11.4	751.9	4702.1	9.1
Basamid G 265 lbs + solarization	442.6	201.4	95.8	14.5	2.8	757.1	2220.4	9.0
Solarization	348.3	179.6	139.3	25.4	5.6	698.3	3853.1	8.5
Untreated	522.5	315.7	152.4	43.5	0.0	1034.0	4571.5	6.1
LSD (P=0.05)[v]	NS[u]	NS	NS	NS	NS	NS	NS	NS
CV	85.5	69.1	96.4	94.7	76.3	76.3	69.94	29.0

z On 28 Aug 2006, A tractor mounted drop spreader was used to apply Basamid and the material was mechanically incorporated into the top 6-8 in of soil. On 1 Aug, beds receiving the solarization treatment were covered 1.25 mil solarization film.

y At full slip, fruit were harvested from 25 ft of each plot area on 27 Jun, 2 and 6 Jul. Number of marketable fruit per plot were placed in size categories (9, 12 15, 18 and 23 based on number of fruit per 45 lb carton).

x Number of sunburned fruit were recorded.

w At each harvest, a representative sample of 5 cosmetically acceptable fruit per plot were tested for soluble solids with a hand-held refractometer.

v Means separated by a value equal to or greater than the LSD (least significant difference) are significantly different at a probability of 5%.

u No significant difference between means in the column.

Table 5. Weed counts, cantaloupe plant vigor and root rot severity in soil taken from Basamid/ solarization treated areas and placed in pots.

Treatment[z]	Common purslane/pot on 29 May	Plant/runner length (in) 29 May	Root rot (%) 6 Jun
Basamid G 530 lbs	5.5	7.2	20.0
Basamid G 530 lbs + solarization	2.0	17.3	75.0
Basamid G 265 lbs + solarization	2.0	14.3	72.5
Solarization	2.8	12.4	57.7
Untreated	9.8	5.0	40.0
LSD (P=0.05)[y]	6.3	3.9	NS[x]
CV	92.9	21.7	89.9

z On 28 Aug 2006, A tractor mounted drop spreader was used to apply Basamid and the material was mechanically incorporated into the top 6-8 in of soil. On 1 Aug, beds receiving the solarization treatment were covered 1.25 mil solarization film. Twelve lbs soil was sampled from each plot and placed in pots on 20 Sep 2006. On 13 Apr 2007, 'Gold Rush' variety cantaloupe seed was planted and irrigated.

y Means separated by a value equal to or greater than the LSD (least significant difference) are significantly different at a probability of 5%.

x No significant difference between means in the column.

ABSTRACTS

2008 ENTOMOLOGICAL SOCIETY OF AMERICA, PACIFIC BRANCH, March 30-April 2, Napa, CA.

Integrated pest management of vine mealybug, *Planoccocus ficus* (Signorete), in three grape production systems. *W.J. Bentley, Kearney Agricultural Center.*

Vine mealybug management in raisin, wine, and table grapes is primarily achieved with insecticides. However, the intensity of the insecticide use and the integration of cultural, physical, and biological controls are quite dependent upon the grape production system. Export of table grapes exacerbates the need for insecticides. This is not true of raisin and wine grapes. Net return per acre for raisin, wine and table grapes grown in the San Joaquin Valley is $645, $1,164, and $3,042 respectively. Per acre profit influences what level of IPM a farmer will utilize. More importantly are export requirements for table grape farmers, even though they are much more able to afford a truly integrated program that includes monitoring, they are less inclined to do so. This is primarily because almost 40% of the crop is exported, which accounts for nearly 70% of gross table grape revenue. Restrictions on movement of pests such as vine mealybug and black widow spider impose a zero threshold for these pests.

***Lygus hesperus* movment at the landscape level: Are our "traditonal" concepts accurate?**
P.B. Goodell and D. Cary, Kearney Agricultural Center.

Lygus hesperus is a key pest in multiple crops in the Westside of the San Joaquin Valley of California. In addition, many plants can act as hosts for population development and eventual movement into susceptible crops, such as dry beans, cotton and seed alfalfa. The concept proposed by Stern in the 1960s described the landscape components as sources from which *Lygus* move or sinks into which *Lygus* remain. In 2007, as part of a USDA-CREES RAMP grant, 41 cotton fields across approximately 70 miles were sampled weekly in four quadrants during June through September. Surrounding crops were georeference-mapped into a GIS data base. Surrounding crops were sampled, but less frequently than the focus cotton fields. As expected, cotton located adjacent to crops known to be high risk (seed alfalfa, safflower, sugar beets, weedy fields) for *Lygus* populations had higher adult populations then those cotton fields surrounded by cotton. Alfalfa hay could serve as a source or a sink, depending on how the fields were harvested. As more safflower is planted in this area, the accuracy of our understanding of *Lygus* population development on safflower has been questioned.