EVALUATION OF CANDIDATE INSECTICIDES FOR CONTROL OF THE CORN LEAFHOPPER, *DALBULUS MAIDIS*, IN THE SAN JOAQUIN VALLEY.

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Abstract

Candidate insecticides were evaluated for their ability to control the corn leafhopper. Thimet and Admire, applied at planting, reduced leafhopper population for approximately 30 days after application. Foliar applied Capture, Admire and Meta Systox R reduced leafhopper populations for approximately 10 to 14 days. Prescribe seed treatment failed to maintain leafhopper populations below those of the untreated control. Due to the lateness of the season and cool weather, we were unable to determine if reductions in leafhopper populations resulted in a reduction in the incidence of corn stunt disease. Not all insecticides evaluated are currently registered for use on silage corn.

Introduction

The corn leafhopper, *Dalbulus maidis* (DeLong and Wolcott), is found on corn (*Zea mays* L.) throughout much of the southeastern and southwestern United States. In addition to yield losses caused by feeding injury (Bushing and Burton 1974), corn leafhopper is an important vector of corn stunt disease caused by *Spiroplasma kunkelii* (CSS). Corn stunt is a debilitating disease that can cause even greater yield losses than those attributable to leafhopper feeding alone (Nault 1985). In the United States, both feeding injury and corn stunt disease have been of greatest significance on late planted corn (Pitre et al. 1967, Bushing and Burton 1974). However, since 1996, the problem in California has appeared earlier each year and in 2002, significant losses occurred as early as June. In California, the corn leafhopper has been reported from Los Angeles, Riverside, Kern, Kings, Tulare and Fresno counties (Bushing and Burton 1974, Bushing et al. 1975). In 2002 we recovered corn leafhoppers from Madera, Merced, Stanislaus, San Joaquin, Sacramento, Solano and Yolo counties. *S. kunkelii* was also detected (using PRC techniques) in leafhoppers from Sacramento county.

Corn leafhopper was first reported causing injury to field corn in Fresno and Tulare counties in 1942 (Frazier 1945). It is not known when CSS was first introduced, but Frazier (1945) described a ". . . disease of corn apparently hitherto unreported from California . . . " that fits the description of the disease caused by S. *kunkelii*. Corn leafhopper was reported in the late 1960's (Bushing and Burton 1974, Bushing et al. 1975) and in 1981. Damage was due solely to leafhopper as no evidence of corn stunt disease was reported. Historically, corn leafhopper outbreaks have lasted only one or two years. In 1996, however, corn leafhopper populations reached extremely high levels on late maturing corn in Fresno, Tulare and Kings counties and many fields had a high incidence of corn stunt. Since then, leafhopper populations and corn stunt disease have continued as a yearly problem, increasing in severity in the southern San Joaquin Valley.

Insecticides evaluated for corn leafhopper control appear to give mixed results with most providing only minimal, short-term protection (Bhird and Pitre 1972, Bushing and Burton 1974, Bushing et al. 1975, Summers and Stapleton 2002). This current study was conducted to determine the efficacy of some standard and several new insecticides for control of the corn leafhopper in the San Joaquin Valley.

Materials and Methods

Location. Trials were conducted at the University of California Kearney Research and Extension Center, Parlier CA.

Corn Leafhopper Infestation. In order to insure a large population of corn leafhoppers, we planted 12 rows (30 inch centers, 220 feet in length) of silage corn dubbed "the nursery field" on 17 June 2002. Beginning in July, we collected leafhoppers on a weekly basis from silage fields in Kings and Tulare counties and released them in the nursery field.

Insecticide Plot Preparation. Raised planting beds were formed with a tractor drawn bed shaper-tiller (B. W. Implement Co., Buttonwillow, CA). The distance between bed centers was 30 inches. Granular fertilizer (15-15-15) at 800 pound per acre was applied using a Vicon applicator. Dual Magnum herbicide (Syngenta, Greensboro, NC) at 1.33pints /acre, was applied to the beds in 50 gal. of water per ha with an FMC hydraulic sprayer, Model DP20 3PT (FMC, Jonesboro, AR) equipped with Tee Jet 8004 (Spraying Systems Co., Bellwood, IL) nozzles. Both fertilizer and herbicide were incorporated to a depth of 6 inches with a second pass of the bed shaper after which the beds were ring-rolled.

Plot Layout, Experimental Design and Planting. Treatments (insecticides) were arranged in a randomized complete block design with five (5) replications. There were a total of 12 treatments and the design used resulted in six plots (treatments) planted on one side (north) of the nursery strip and six on the other (south) side of the nursery strip. Each plot consisted for four (4) rows, 30 feet long. There was a 10 foot walk way between each plot and two unplanted rows (ca. 5 feet), the full length of the field, between each set of plots. The blank rows provided easy access for spraying and sampling without disturbing the plots. Plots were planted on 3 September 2002 using a tractor drawn John Deere planter. Seed (Asgrow RX913) was planted approximately 1.5 inches deep and 4-5 inches apart within the row. Prescribe (imidacloprid, Gustafson, Plano, TX) treated seed (Pioneer 3223) was planted on 4 September 2002 using a Planet Jr. hand planter. The planter was calibrated to deliver the same seeding rate at the same depth as the tractor drawn John Deere planter. All plots were furrow irrigated the following day to facilitate germination and activate the soil applied insecticides.

Insecticide Applications. Pre-plant Soil Applications. Thimet and Admire were applied pre-plant. Thimet granules were applied using a Clampco applicator (Clampco, Inc., Salinas, CA). Granules were place approximately one (1) inch off the center of the row and 1-1.5 inches below the seed placement. A lay-by application was made in the same manner. Admire insecticide, in the equivalent of 20 gal H_20, was injected into the soil on using a tractor drawn shank. The insecticides were injected approximately one (1) inch off the center of the row and 1-1.5 inched below the seed placement.

Foliar Applications. Foliar applications were made using a CO_2 powered back-pack sprayer. Materials were applied in the equivalent of 20 gal. H_2O per acre at 40 psi using TX12 Conejet nozzle tips (Spraying Systems Co., Bellwood Il.). See Table 1 for application dates and rates and formulations of all insecticides.

Movement of Leafhoppers from Nursery Corn to Insecticide Trial. To facilitate the movement of the corn leafhoppers from the nursery corn to the trial corn, the former was cut, using a sickle bar mower, on 20 September 2002. Although some leafhoppers had move from the nursery to the trial field, this is considered as the infestation date. The corn was allowed to "dry" for one (1) week allowing all of the adult leafhoppers to move to the newly emerged trial corn. After which the nursery corn was shredded, forcing any remaining leafhoppers into the trial corn. Prior to cutting, leafhoppers were collected and tested for the presence of *S. kunkelii* by PCR techniques to make sure that the population was infective.

Leafhopper Sampling. Leafhopper populations were sampled by taking D-vac suction samples from 1 meter (39 inches) of row in one of the two center rows. Stand counts were taken in all plots and final leafhopper numbers are presented as number of individuals per plant.

Corn Stunt Determination. On 12 November, 10 leaves from 10 plants in each plot were selected at random and tested by ELISA for the presence of *S. kunkelii.*

Statistical Analysis. The leafhopper population was evaluated by analysis of variance and the means separated with Fisher's Protected LSD (Abacus Concepts, 1989).

Table 1. Dates and rate of insecticide application for the control of corn leafhopper. Parlier CA.

Material	Formulation	Rate a.i./A	Application Date
Control	--	--	--
Thimet-Planting	20G	1.2 lbs	30 Aug. 2002
Thimet-Lay-by [1]	20G	1.2 lbs	14 Oct. 2002
Thimet-Planting & Lay-by [1]	20G	1.2 + 1.2 lbs	30 Aug./14 Oct. 2002
Capture	2EC	0.10 lbs	27 Sept. 2002
Capture + Comite	2EC & 6.55EC	0.05 + 2.46 lbs	27 Sept. 2002
Capture + Dimethoate	2EC + 4EC	0.10 + 0.50 lbs	27 Sept. 2002
Admire-Planting	2F	0.33 lbs	30 Aug. 2002
Admire-Foliar	2F	0.25 lbs	27 Sept. 2002
Prescribe Seed Trt.	-	-	3 Sept. 2002
MSR	2EC	0.50 lbs	27 Sept. 2002
Comite	6.55EC	2.46 lbs	27 Sept. 2002

[1] Not sampled for leafhoppers due to rainy weather conditions following the application.

Results and Discussion.

Leafhopper Testing for *S. kunkelii*. Five lots of five leafhoppers each, taken at random from the nursery field prior to cutting, all tested positive for the presence of *S. kunkelii.*

Leafhopper Control. In samples taken on 1 October 2002, all materials except Comite reduced adult leafhopper numbers below those in the untreated check (Table 2). Capture alone worked as well as the combinations of Capture and Comite or Capture and Dimethoate. The soil applied Thimet and Admire (imidacloprid) continued to maintain leafhopper populations below those of the untreated check for up to 5 weeks after application, which was about 4 weeks following seedling emergence (Table 2). The seed treatment, Prescribe (imidacloprid), failed to keep adult populations below those of the untreated control (Tables 2 and 3). It is interesting that the soil and foliar applied Admire significantly ($P < 0.05$) reduced leafhopper populations below that of the untreated control, but Prescribe treated seed did not. Both contain imidacloprid as the active ingredient. The reason is not known, but needs to be evaluated again next year. By 14 days post treatment (foliar sprays) and 6 weeks after the materials were applied pre plant to the soil, control by all materials was beginning to break down with considerable statistical overlap present (Table 4). At this point, another application would have been needed to maintain control.

Corn Stunt Determinations. All samples were negative (ELISA) for *S. kunkelii.* We determined that due to the lateness of the season and cool temperature, the titer of *S. kunkelii* was too low to detect. This was confirmed by re-testing 10 leaves from 10 plants from the control plots, which all gave negative results. We then dug the plants up, placed them in pots, treated them with Thimet to kill any leafhoppers and moved them into the greenhouse where they were maintained at an approximately 85:50° F. day/night temperatures. These same 10 plants, 10 leaves from each plant, were re-tested 30 days later and all were strongly positive for *S. kunkelii.*

Conclusions and Recommendation. The corn leafhopper is fairly easy to control with a number of insecticides although the length of control leaves something to be desired. The real question remains, can controlling the leafhopper result in a reduction in the incidence of corn stunt disease. This question will require additional evaluation although Summers and Stapleton (2002), working with sweet corn, found that while foliar sprays and soil applied materials significantly reduced populations of corn leafhopper, neither reduced the incidence of corn stunt infected plants. It appears that a pre-plant treatment of Thimet or Admire may provide up to 4 weeks of leafhopper control. It is not know at this time if this reduction in leafhopper populations results in a reduction in the incidence of corn stunt disease or if the protection afforded provided sufficient time for the corn to develop beyond the stage where corn stunt had a significant impact on yield. Hruska and Peralta (1997) found that protection from infection from the seedling to whorl stage resulted in a significant reduction in the effects of corn stunt. While leafhopper feeding alone can cause yield and quality losses (Bushing et al. 1975) the greatest threat is corn stunt disease. This, together with the relationship between leafhopper control and the incidence of corn stunt disease are areas of badly needed research.

Due to bad weather, we were unable to take any leafhopper samples following the lay-by application of Thimet so we do not know the possible impact of this treatment, either alone on in combination with the pre plant application. Plans for the coming year include: (1) An earlier trial where we can access the impact of insecticides and leafhopper control on the incidence of corn stunt disease. (2) A lay-by application of Thimet four (4) weeks after planting. (3) A combination of soil applied and foliar Admire or a pre plant and lay-by treatment with Admire.

Cautionary Statement.

Admire, either as a soil application or a foliar spray, is currently **not** registered for use on silage corn. Growers are advised not to use this material in their production of silage corn. Likewise, Meta Systox R is currently registered **only** on sweet corn and does not have a registration for silage corn. Similar caution is advised.

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Table 2. Number of Adult Leafhoppers per Plant. 1 October 2002. [1]

	Mean			
Capture	0.164	a		
Capture + Dimethoate	0.192	a		
Thimet @ planting	0.224	a		
MSR	0.246	a		
Thimet planting / lay-by	0.404	a		
Capture + Comite	0.526	a		
Admire @ planting	0.536	a		
Admire – Foliar	1.078	a	b	
Prescribe seed treatment	1.710		b	c
Comite	1.748		b	c
Control	2.156			c
Thimet @ lay-by [2]	2.206			c

[1] Means followed by the same letter(s) are not significantly different a P < 0.05. Fishers LSD

[2] Treatment had not been applied at time to sampling.

Table 3. Number of Adult Leafhoppers per Plant. 4 October 2002. [1]

	Mean			
Capture + Dimethoate	0.146	a		
Capture + Comite	0.170	a		
Thimet @ planting	0.206	a		
Capture	0.254	a		
Admire @ planting	0.270	a		
MSR	0.288	a		
Thimet planting / lay-by	0.294	a		
Admire – Foliar	0.412	a		
Control	1.092		b	
Prescribe seed treatment	1.164		b	
Comite	1.598		b	c
Thimet @ lay-by [2]	2.014			c

[1] Means followed by the same letter(s) are not significantly different a P < 0.05. Fishers LSD
[2] Treatment had not been applied at time to sampling.

Table 4. Number of Adult Leafhoppers per Plant. 10 October 2002. [1]

	Mean				
Capture + Dimethoate	0.396	a			
Thimet planting / lay-by	0.440	a			
Capture + Comite	0.592	a	b		
Capture	0.602	a	b		
Thimet @ planting	0.690	a	b	c	
Admire – Foliar	0.770	a	b	c	
MSR	0.866	a	b	c	
Admire @ planting	1.164	a	b	c	
Comite	1.230	a	b	c	
Control	1.854		b	c	d
Thimet @ lay-by [2]	2.060			c	d
Prescribe seed treatment	2.764				d

[1] Means followed by the same letter(s) are not significantly different a P < 0.05. Fishers LSD
[2] Treatment had not been applied at time to sampling.

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