Control of stink bugs in tomatoes

Michael P. Hoffmann □ Lloyd T. Wilson
Frank G. Zalom

The southern green stink bug, new to California, has joined other species as a pest of processing tomatoes. With a wide host range, it is a potentially serious pest on other crops.

Consperse stink bug is the most common.

Redshouldered stink bugs vary in color.

Say stink bug is the least important.

Fresh market and processing tomatoes grown in central and northern California are periodically infested by one or more species of stink bug. The most common are the consperse stink bug, *Euschistus conspersus;* redshouldered stink bug, *Thyanta accerra;* and Say stink bugs, *Chlorochroa* spp.

The consperse stink bug is the species most frequently observed damaging fields of processing tomatoes. The adult bug is about ½ inch long, is greenish brown with numerous small black dots covering the upper body and legs, and has distinctly pointed shoulders. The immature stages are similar in appearance but lack wings.

The adult redshouldered stink bug is generally uniformly pale green with a reddish band across the back. Color varies considerably; late-season populations are brownish. Adults are about the same length as the consperse stink bug but are narrower and have rounded shoulders.

In 1985, we observed Say stink bugs infesting the edge of a processing tomato field in Yolo County, northern California, but they were greatly outnumbered by consperse stink bugs. Adult *Chlorochroa* spp. are slightly larger than the consperse or redshouldered stink bug, and they are bright green with white spots on the upper surface. *Chlorochroa uhleri* and *C. sayi,* which are similar in appearance, are frequently referred to as Say stink bugs, but this common name is approved only for *C. sayi.* Of the species infesting tomato fields, these appear to be the least important.

A new species in California, the southern green stink bug, *Nezara viridula,* was collected from a heavily infested field of processing tomatoes in Yolo County in September 1986. A few specimens were actually collected in 1985 in Yolo County but were not examined and identified as the southern green stink bug until recently. This species is the largest (about 9/16 inch long) of the stink bugs we have observed in tomato fields. It is uniformly bright green with a few distinct spots along the forward edge of the triangular region on the back of the adult.

Surveys by the California Department of Food and Agriculture and personnel from County Agricultural Commissioners' offices indicate that the southern green stink bug is present in Yolo, Solano, and Sacramento counties and is most likely permanently established. On a worldwide basis, this species is considered one of the most important stink bug pests of agricultural crops. It has a very wide host plant range including fruit and nut tree crops, vegetables, field crops, and weeds. It is thus a potentially serious pest of tomatoes as well as many other crops in California.

Stink bug eggs are usually barrel-shaped and are laid in masses of up to several dozen on nearly all parts of the tomato plant, but most commonly on leaves. Egg masses have also been collected from dried leaf material on the soil and from dirt clods. Early-stage nymphs initially stay near the egg mass from which they emerged, then gradually disperse. Nymphs may be similar to adults in color, as with the consperse, or distinctly different and brightly colored, as with the southern green stink bug.

Stink bugs usually overwinter as adults in protected areas, such as under leaf litter or brush. Early in the spring, they begin feeding on weeds or on lush crop plants, if available. As these dry or mature, bugs may move into tomato fields. Consequently, fruit damage in tomato fields is often limited to the field edge nearest an alternative host crop or weed patch.

Feeding on tomatoes produces white corky areas just below the skin. Such damage appears as light-colored blemishes and is generally not of major concern to processing tomato growers. Stink bugs are important in green-pick fresh market tomatoes and whole-pack processing tomatoes, however, because the damage lowers quality at harvest. Stink bugs also have been reported to transmit a yeast, *Nematospora* spp., that may cause tomato fruit decay. The relative importance of consperse, redshouldered, and Say stink bugs as transmitters of *Nematospora* has not been established, but work by researchers outside California has clearly demonstrated that the southern green stink bug is capable of transmitting the yeast.

Since neither treatment thresholds nor reliable sampling methods have been developed for stink bugs in tomatoes, pest

Stink bugs lay their barrel-shaped eggs in large masses on nearly all parts of the tomato plant, but most often on the leaves. Eggs have also been found on dried leaves on or in the soil.

managers frequently take a conservative approach to minimize possible stink bug damage. The resulting treatments may not be economically justified. To help ensure optimal control if insecticides are applied, we conducted a series of studies in 1985 and 1986 evaluating the efficacy of commonly used insecticides, comparing coverage by ground and aerial applications, and investigating whether the stink bugs' daily movement patterns on tomato plants could be of importance to control. We also wanted to determine if parasitoids were present and to measure their importance in stink bug control.

The consperse stink bug was used in all cage studies, because it was the most frequently seen in processing tomatoes, is readily collected from weeds in the spring, especially cheeseweed, and is easily reared in the laboratory.

Time of day and irrigation

Preliminary field observations suggested that the vertical distribution of stink bugs on tomato plants varied, depending on the time of day or temperature. A better understanding of such movements up and down the plant could be useful in sampling for stink bugs and in timing insecticide applications.

To determine if the vertical distribution of consperse stink bugs changed within the plant canopy at different times of day, we placed wire mesh cages (35 inches wide × 35 inches long × 35 inches high) over single processing tomato plants (UC 82) in 1985 and put 20 consperse stink bugs in each cage. In 1986, we conducted a similar study, but the cages were larger (47×53×45 inches), made of polyester organdy cloth, and contained four fresh market tomato plants (Peto 19) spaced 14 inches apart. At about 7:00 and 10:00 a.m. and 3:00 and 7:30 p.m., we counted the stink bugs on the plants and all bugs on or in the top 1 to 2 inches of soil. About 13 percent of the bugs were on the walls of the cages; these are reported as being on the plant.

Once tomato plants became damaged by the sampling process, cages were moved to different plants. A minimum of 48 hours elapsed between observations, allowing the bugs time to redistribute on plants. The distribution of stink bugs was recorded for four replicates (cages) on two dates at each time of day for a total of eight cages observed at each time of day per year. Data were added together across dates of observation by time of day, then converted to percentages of total bugs on the plant and percentages on or in the soil.

Results from the 1985 studies on processing tomatoes did not show a significant shift in the vertical distribution of consperse stink bugs relative to the time of day (table 1). At sunset, however, bugs apparently did move out of the soil subsurface. Average bug location across times of day showed that more than half of the bugs were on the plant, about 30 percent on the soil surface, and the remaining bugs in the soil.

The distribution of bugs on fresh market tomatoes in 1986 was similar to observations from processing tomatoes the previous year, with more than half on the plant. At 3:00 p.m., significantly more bugs were on the plant than on or in the soil.

In 1986, we observed the distribution of consperse stink bugs at sunrise and sunset under irrigated (wet soil) and dry soil conditions. When soil was wet, as within a few days after a furrow irrigation, all bugs moved off of the soil. This result was significantly different ($P<0.05$) when compared with 44 percent on or in the soil under dry conditions.

TABLE 1. Distribution of consperse stink bugs on tomato plants and soil at different times of day

	Percent at each location*				
	Processing (Aug-Sep 1985)			Fresh market (Jul-Sep 1986)	
	Soil				
Time	Surface	Subsurface	Plant	Soil	Plant
7:00 a.m.	24.0 bcd	16.5 de	59.5 ab	41.3 ab	58.8 ab
10:00 a.m.	33.5 abcd	14.3 de	52.0 abc	39.0 ab	61.0 ab
3:00 p.m.	31.0 abcd	21.5 cde	47.5 abcd	27.8 b	72.3 a
7:30 p.m.†	37.8 abcd	4.0 e	59.0 a	55.3 ab	44.8 ab
Mean for day	31.6 B	14.1 C	54.5 A	40.8 B	59.2 A

* Percentages followed by similar upper or lower case letter(s) within year not significantly different at 5% level (DMRT) Data transformed to arcsin before ANOVA.
† Based on one observation date in 1985; for all others, two dates are combined.

Spray coverage

Our observations of the distribution of consperse stink bugs and their feeding damage suggest that most are low in the tomato plant canopy. To determine how much spray material actually penetrates into the plant canopy, we tested ground and aerial applications using a marker dye (Rhodamine B) and Kromekote spray droplet indicator cards to determine coverage at the upper and middle canopy, and at ground level. The cards (⅞ × 3⅛ inches) were attached to tomato leaves with paper clips before applications in a randomized complete block design.

On July 19, 1986, marker dye at 2.7 ounces per acre in 20 gallons of water along with an insecticide was applied by fixed-wing aircraft to a commercial field of fresh market tomatoes in Merced County. Cards (20 per level) were retrieved three days after the application. On August 21, dye was applied by ground equipment to a single row of fresh market tomatoes at the UC Davis Vegetable Crops facility; the rate was 2.7 ounces of dye in 45 gallons water per acre applied at 35 pounds per square inch (psi) with three overhead and two drop fan nozzles. Sixteen cards had been placed at each level on the tomato plants. In both tests, the tomato crop was about three weeks from first-pick maturity.

We used an ultraviolet light source to fluoresce dye droplets on the cards, and estimated coverage by recording the percentage of area with dye on two ¼- by ¼-inch areas per card. Coverage was over three times better at the upper canopy than at ground level when applied by ground equipment, and about seven times better than at ground level when applied by air (significantly different at $P<0.05$) (fig. 1). These results indicate that little spray material especially when applied by air, reaches the part of the tomato plant canopy occupied by about 40 percent of the stink bugs.

Insecticide efficacy

We tested four registered insecticides applied by ground equipment in a field of processing tomatoes infested with consperse stink bugs near Davis, Yolo County. The treatments were 15 feet wide (three single-row beds) and 500 feet long, replicated three times in a randomized complete block design. Nudrin 1.8 (methomyl), Pydrin 2.4EC (fenvalarate), Thiodan 3EC (endosulfan), and Monitor 4 (methamidophos) at 0.68, 0.19, 1, and 1 pound active ingredient per acre, respectively, were applied at 15 psi in 20 gallons water per acre on the morning of August 29, 1986, with a full-coverage tractor-mounted boom sprayer.

Insecticide efficacy was indicated by the number of live stink bugs found by picking up and shaking tomato plants onto a 14- by 9-inch tray and by searching the soil beneath the tray to a depth of 1 to 2 inches. Twenty-four samples were taken from each replicate before and after treatment, on August 28 and September 3 and 4, respectively. The few redshouldered stink bugs present were combined with consperse stink bug counts for data analysis. We have presented the data as the mean percentage change from pre- and post-treatment to minimize pre-existing differences among treatments (fig. 2a).

In another Yolo County field of processing tomatoes heavily infested with southern green and consperse stink bugs, we tested the efficacy of Pydrin 2.4EC, Thiodan 3EC, Monitor 4, and Methyl Parathion 5 Spray at 0.2, 1, 1, and 1.25 pound active ingredient per acre, respectively. Treatments, in 10 gallons per acre and at 25 psi, were applied shortly after sunrise by fixed-wing aircraft on September 15, 1986; plots 42 feet wide by 800 feet long were separated by a 38-foot unsprayed buffer.

Twelve 6.5-foot-long sections of a middle bed from each treatment were sampled by cutting off the tomato plants at ground level and shaking them onto a drop cloth. The number of bugs on the drop cloth and in the upper 2 inches of soil was recorded on September 12 (pre-treatment) and September 19 (post-treatment). Because this test was unreplicated, we present the results as the percent change from pre- to post-treatment (fig. 2b,c).

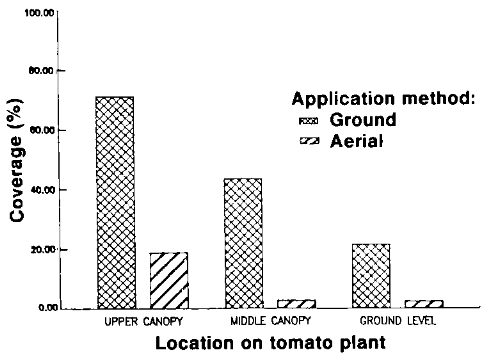

Fig. 1. With both ground and aerial application, spray coverage was poorer at ground level, where about 40 percent of stink bugs are usually found.

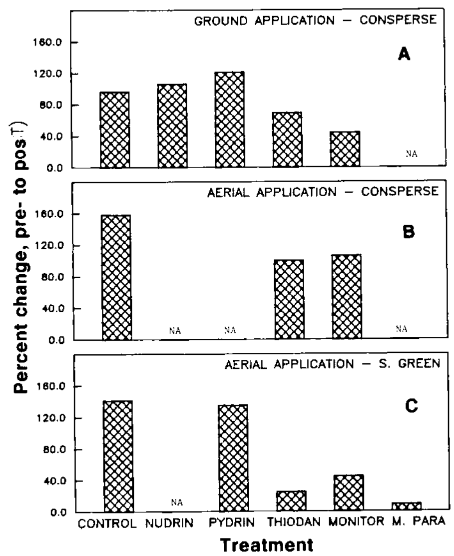

Fig. 2. Control of consperse stink bug was poor, but some insecticides were effective against southern green stink bug.

Although Monitor reduced consperse stink bug densities by up to 56 percent, no treatments applied by ground equipment were significantly different ($P<0.05$) from the untreated control (fig. 2a). Aerial applications had minimal effect on consperse stink bug populations, but Methyl Parathion, and to a slightly lesser degree Thiodan and Monitor, provided adequate control of the southern green stink bug (Fig. 2b,c). Control of consperse stink bug by air with Pydrin and Methyl Parathion could not be evaluated because of very low populations before and after treatment.

Parasitoids

A large portion of stink bug eggs collected were parasitized by small wasps of the family Scelionidae. During June through August 1986, field collections of 507 eggs of redshouldered and consperse stink bugs showed parasitism per egg mass to range from 38 to 100 percent.

From several hundred adult and immature stink bugs collected in Yolo and Solano counties in 1985 and 1986, we recorded only a single parasitoid of the family Tachinidae (Diptera). These are reported to be of some importance in other geographic areas.

Preliminary findings suggest that native parasitoids are not parasitizing eggs of the southern green stink bug and that more effective natural enemies may need to be imported. We have recently initiated this process and hope to introduce specific egg parasitoids into California this year.

Conclusions

Considering that about 40 percent of the consperse stink bugs are on or in the soil, where spray coverage is poor, it is not surprising that control with insecticides was inadequate. Control of the southern green stink bug, however, was adequate with three of the four materials tested. This finding may have resulted from differences in susceptibility or from greater exposure to the insecticides due to differences in distribution on the tomato plants. Australian researchers have reported that the southern green stink bug does move to the upper canopy early in the morning.

In both insecticide efficacy trials, the tomato fields were heavily infested with powdery mildew, resulting in an open canopy. Control under more lush growth conditions might have been even less effective. Stink bug control may be improved by using ground equipment to get maximum coverage and by taking advantage of times or conditions under which stink bugs are more exposed to the pesticides applied.

The importance of the southern green stink bug to California agriculture is difficult to predict. The effect of native natural enemies and the influence of environmental conditions and agronomic practices on this species are not known. Because of its wide host range, it is a potentially serious pest on several crops. The California Department of Food and Agriculture (CDFA) has asked anyone finding what appear to be southern green stink bugs to submit specimens to the CDFA or the County Agricultural Commissioner for positive identification.

Michael P. Hoffmann is Staff Research Associate, and Lloyd T. Wilson is Associate Professor and Associate Entomologist, Department of Entomology; Frank G. Zalom is Integrated Pest Management Specialist, IPM Implementation Group. All are with the University of California, Davis. *The authors acknowledge the assistance of Dave Bryson, Department of Entomology, UC Davis, and of the growers who permitted use of their tomato fields. This research was supported in part by a grant from the California Fresh Market Tomato Advisory Board. All photographs are by Jack Kelly Clark, Visual Media, Cooperative Extension, UC Davis.*