

# Effects of Girdling by the Threecornered Alfalfa Hopper on Symptom Expression of Soybean Stem Canker and Associated Soybean Yields

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## ABSTRACT

Russin, J. S., Boethel, D. J., Berggren, G. T., and Snow, J. P. 1986. Effects of girdling by the threecornered alfalfa hopper on symptom expression of soybean stem canker and associated soybean yields. *Plant Disease* 70:759-761.

Soybean (*Glycine max*) stems with and without basal stem girdles induced by the threecornered alfalfa hopper (*Spissistilus festinus*) were inoculated artificially at upper (internode 10) and lower (internode 2) sites with the stem canker fungus (*Diaporthe phaseolorum* var. *caulivora*). Lengths of resultant cankers were significantly greater on girdled stems than on nongirdled stems. Canker lengths also were greater at upper sites than at lower sites regardless of girdle status of stems. Yields of seed from individual plants were consistently lowest for stems that were both girdled and cankered.

Stem canker of soybean (*Glycine max* (L.) Merr.), incited by *Diaporthe phaseolorum* (Cke. & Ell.) Sacc. var. *caulivora* Athow & Caldwell, is relatively new to the southeastern United States, but its incidence has increased rapidly since the first report in 1973 (1). The great potential for economic loss caused by stem canker has stimulated interest to better understand the etiology and control mechanisms for this disease (1,7,11). However, little attention has been given to the possible interactions of this disease with insect pest species that occur on soybean in the Southeast.

One of the insects of economic importance to soybean is the three-cornered alfalfa hopper (TCAH) (*Spissistilus festinus* Say) (Homoptera: Membracidae). The most visible aspect of TCAH damage to soybean is the pro-

duction of characteristic main-stem-feeding girdles. These girdles can affect yield by causing plant death, reducing the number and weight of beans, or creating harvesting difficulties resulting from lodging or breakage (9).

TCAH girdles were shown to restrict translocation in affected plants (5). These girdles also were reported to predispose soybean seedlings to infection by *Sclerotium rolfsii* Sacc., causal agent of southern blight of soybean (4). The purpose of this study was to evaluate severity of stem canker and consequent yield reductions on soybean stems with and without basal girdles induced by TCAH.

## MATERIALS AND METHODS

Inocula of the stem canker fungus were prepared according to a technique similar to that described by Crall (2). The fungal isolate was maintained on potato-dextrose agar (PDA) (Difco) with a photoperiod of 16 hr of light/8 hr of darkness under ambient laboratory temperatures. Mycelia were grown on sterile PDA that supported autoclaved quill-type wooden toothpicks. Petri plates were sealed with Parafilm and left for 4-6 wk to allow mycelia to overgrow

and infest the toothpicks. Immediately before inoculation, infested toothpicks were cut into thin sections about 5 mm long. Soybean stems were inoculated by inserting infested toothpick sections into vertical incisions (10 mm long) made in the stems. Sites of inoculation were not protected by a sealing compound.

Inoculations were made on Bragg soybean planted 9 July 1985 on 0.76-m row spacing in a 0.03-ha section of a research plot at the LSU Burden Research Plantation, Baton Rouge, LA. At the V<sub>6</sub> (3) stage, 120 plant pairs were identified that were girdled or not girdled near stem bases by TCAH. Plants then were divided into two groups that each contained 60 pairs of girdled and nongirdled stems. The first group of stem pairs was inoculated according to the following format. Thirty pairs received fungal inoculations at sites low on stems (i.e., internode 2). This location was 5-10 cm above girdles on stems. The remaining 30 pairs received control inoculations of sterile toothpick sections at comparable locations on nongirdled stems. When plants were at R<sub>2</sub>, fungal and control inoculations were conducted similarly on the second group of 60 stem pairs at sites high on stems (i.e., internode 10). This location was two or three nodes below the plant apex.

Test plants were removed from the field at R<sub>6</sub> and brought to the laboratory for assessment. Values for percent mortality of test plants were compared by chi-square analysis. Total lengths of stem cankers were compared among treatments by analysis of variance. Lengths of stem cankers that developed above and below sites of inoculation were analyzed within treatments by Student's *t* test. Yields of seed from individual plants were compared among treatments by analysis

Accepted for publication 6 March 1986 (submitted for electronic processing).

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of variance. Means generated by analyses of variance were separated by Duncan's new multiple range test.

## RESULTS

Typical stem canker symptoms had developed by  $R_6$  on fungus-inoculated plants. Isolations from symptomatic, surface-disinfested tissue verified the presence of the pathogen in cankered stems. Plants that received sterile toothpick sections as inocula did not show symptoms typical of stem canker. Rather, these were surrounded by small necrotic areas and generally were slightly swollen.

Mortality of test plants did not differ significantly ( $P > 0.05$ ) between fungal or control inoculations at internode 10 and control inoculations at internode 2 (mean = 15.6%). Significant ( $P < 0.001$ ) increases in test plant mortality were observed only for fungal inoculations at internode 2 (mean = 41.7%). This mortality was independent of TCAH girdling damage.

The presence of TCAH girdles near stem bases significantly ( $P < 0.01$ ) increased total canker lengths compared with those on nongirdled stems at both upper and lower inoculation sites (Fig. 1). In addition, cankers initiated at upper sites were significantly ( $P < 0.01$ ) longer than those at lower sites on both girdled and nongirdled stems despite the shorter time allowed for development of cankers at upper sites (Fig. 1). Similar results were reported by Keeling (6) for eight soybean cultivars. In our study, differences also were observed in the extent of upward and downward elongation of cankers (Fig. 1). At internode 2, canker elongation above inoculation sites on girdled stems was significantly ( $P < 0.05$ ) greater than that below inoculation sites. On nongirdled stems, canker lengths tended ( $P = 0.079$ ) to be greater above than below inoculation sites. At internode 10, canker elongation above and below inoculation sites did not differ significantly on either girdled or nongirdled stems. It should be noted, however, that cankers at the upper site frequently extended to plant apices, thus precluding accurate measurements of canker lengths above inoculation sites.

Yields of seed from individual plants demonstrated an apparent additive relationship between TCAH girdles and stem canker severity (Fig. 2). Plants that were girdled/cankered consistently had seed yields significantly ( $P < 0.05$ ) lower than those for control (i.e., nongirdled/noncankered) plants. Plants that were girdled/noncankered or nongirdled/cankered generally had intermediate seed yields. Under our experimental conditions, stem cankers in the absence of TCAH girdles had little effect on yields from individual plants.

## DISCUSSION

Results from our study show that

severity of stem canker symptoms may be increased and resultant individual plant yields decreased on soybean stems with basal girdles induced by TCAH. Such girdles also were reported to increase incidence of southern blight of soybean (*S. rolfii*), reportedly by providing avenues of entry for the fungus (4). In our study, however, increased lengths of stem cankers in girdled stems probably indicate TCAH girdles affecting host

plant physiology rather than simply acting as infection courts.

TCAH girdles have been reported to alter certain aspects of soybean physiology. Hicks et al (5) demonstrated levels of  $^{14}C$ -labeled glucose in stems immediately above girdles that were significantly higher than those below girdles. In addition, main-stem girdles have been shown to reduce both root dry weight and numbers and dry weight of *Rhizobium*

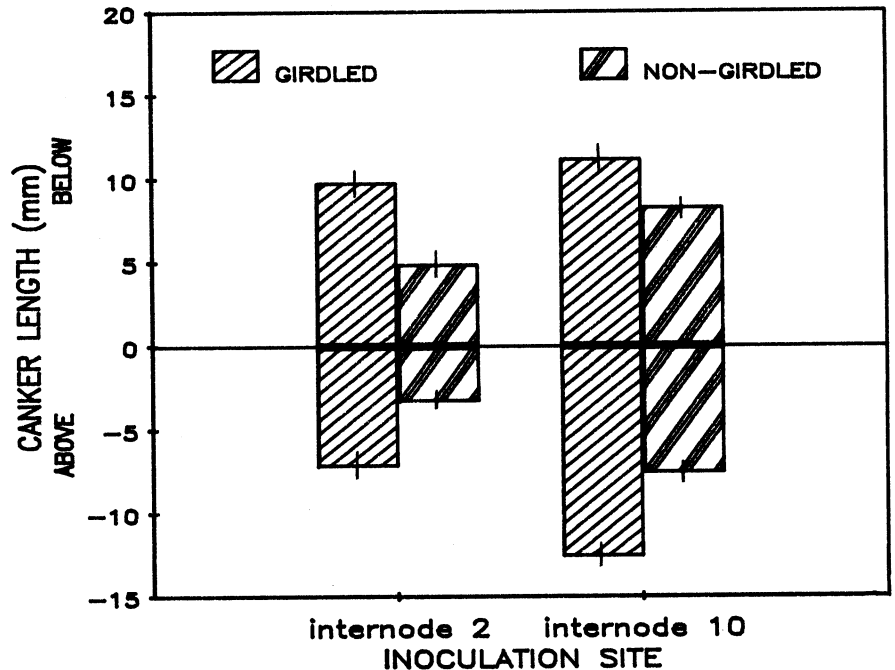


Fig. 1. Lengths of stem cankers that developed above and below points of inoculation at two sites on soybean stems that were girdled or not girdled by the threecornered alfalfa hopper. Vertical lines delimit standard errors of means.

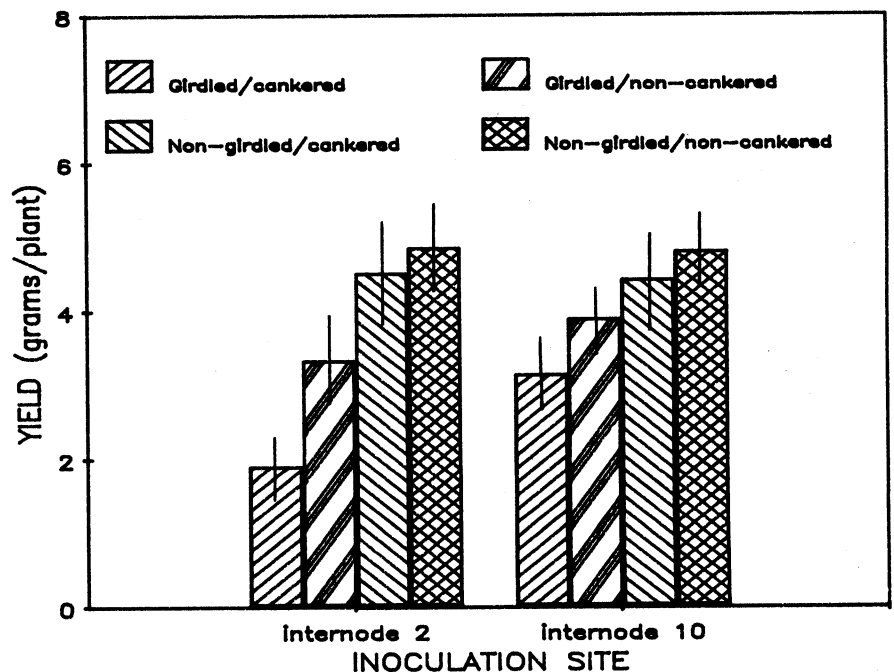


Fig. 2. Seed yields from individual soybean plants that were girdled or not girdled by the threecornered alfalfa hopper and cankered or not cankered by the stem canker fungus at two sites on soybean stems. Vertical lines delimit standard errors of means.

nodules and also to reduce total leaf area (5). Greenhouse studies have shown further that soybean plants with lower main-stem girdles were shorter and had fewer nodes than did nongirdled plants (J. S. Russin, *unpublished*). It is possible that a general reduction in vigor, which is characteristic of plants with lower stem girdles, was involved in the increase of canker lengths and decrease of yields observed on girdled stems in this study.

TCAH is a common pest of soybean in the Southeast and is present in all southeastern states where stem canker has been reported (1,8). Our results may be significant when consideration is given to the frequency at which these girdles can occur in soybean fields. For example, incidence of main-stem girdles was reported to be as high as 85% in Texas (10) and nearly 45% in Louisiana (12). Furthermore, multiple girdling of stems, branches, and petioles by TCAH is common. Additional research is needed to further understand the relationships

between TCAH and development of this and other soybean diseases.

#### ACKNOWLEDGMENTS

We wish to thank D. LaBar for technical assistance. This research was supported in part by funds from the Louisiana Soybean Promotion Board.

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