

# EFFECTS OF FEEDING BY THREECORNERED ALFALFA HOPPER NYMPHS (HOMOPTERA: MEMBRACIDAE) ON HYPOCOTYLS OF V1 AND V3 STAGE SOYBEAN PLANTS<sup>1</sup>

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## ABSTRACT

Hypocotyls of vegetative V1 and V3 stage soybean, *Glycine max* (L.) Merrill were subjected to feeding by third, fourth, and fifth instars of the threecornered alfalfa hopper, *Spissistilus festinus* (Say). Significant differences in feeding injury, plant responses, fresh and dry root weights, and plant stage development occurred due to fourth instar feeding on V1 stage plants. Most soybean plants responded to partial and complete girdles by producing swelling and/or adventitious roots above the girdle.

**Key Words:** Threecornered alfalfa hopper, *Spissistilus festinus*, soybean, hypocotyl feeding.

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## INTRODUCTION

Many studies have been conducted to evaluate the effects of threecornered alfalfa hopper (TCAH) girdling on the soybean plant. Differences in yield may occur on an individual plant basis, but no differences occur on an acreage basis unless extremely high injury occurs (Mueller and Dumas 1975). Mueller and Jones (1983) showed that yield reductions occur when 65% or greater of the plants are girdled. Girdling visibly affects the vigor of many plants, but due to compensation by undamaged adjacent plants, no correlation was found between girdling and yield (Tugwell and Miner 1967). TCAH females lay a large majority of their eggs in the nodes and terminal of the plant and girdling is not a prerequisite for oviposition (Rice and Drees 1985). Wildermuth (1915) first reported stem enlargement and indicated possible translocation disruption in plants due to TCAH feeding. In radiotracer studies, Hicks et al. (1984) observed that girdling of soybean plant petioles effectively blocked movement of assimilates in the phloem.

Moore and Mueller (1976) reported that the first evidence of girdling by nymphs is by the third instar and that fourth instars are the most injurious. Mueller (1976) reported that in the laboratory, adult girdling was confined at the upper petioles while in the field, feeding also was observed on the mainstems. Rice and Drees (1985) reported that only adult TCAH cause mainstem girdling during the first 2-2.5 weeks after plant emergence. Mueller and Jones (1983) described five different plant responses to TCAH girdling near the stem base ranging from plant mortality to complete plant recovery. Mainstem girdling, which

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may cause plants to break later in the season, occurs before a plant height of 20-25 cm is reached (Davis and Laster 1968; Bailey et al. 1970). Progressively less damage occurs as time of infestation is delayed with preferred feeding sites shifting to leaf petioles and smaller stems. Rice and Drees (1985) reported that nymphs were responsible for girdling later in the season, principally on petioles. The purpose of this study was to examine the effects of girdling by third, fourth, and fifth TCAH instars on hypocotyls of V1 and V3 (Fehr et al. 1971) stage soybeans.

## MATERIALS AND METHODS

A laboratory reared culture of TCAH field collected from alfalfa (*Medicago sativa* L.) were maintained on green bean (*Phaseolus vulgaris* L.) pods and served as a source of nymphs for this study. Each combination of third, fourth and fifth TCAH instar and V1 and V3 stage potted greenhouse soybean plant was replicated ten times in a randomized complete block design. Ten replicates of uninfested soybean plants of each growth stage served as controls. A nymph was confined on the hypocotyl of each plant by circumventing the stem with a 35 mm diameter paper disk immediately below the cotyledonary node. A 5 mm diameter central hole with radiating cuts allowed for stem growth without constriction. Disks were tightened around the stem and taped so that they sloped downward, requiring nymphs to walk upside down and downward in order to move above the disk. Nymphs seldom moved downward and off the stem so barriers were not used at the soil surface. Control plant hypocotyls also were fitted with disks. Nymphs were held on plants for seven days. Nymphs which molted, died, or escaped were replaced with newly molted nymphs of the same nymphal stage. Seven days after nymph and disk removal, the following data were recorded:

1. Feeding injury categories (FIC): 1 = no girdle (includes random punctures), 2 = partial girdle, 3 = complete girdle. Swelling and/or adventitious root growth which can accompany partial and complete girdles was also noted.
2. Plant response categories (PRC): 1 = no apparent damage, 2 = partial or complete girdle but plant remaining upright and vigorous, 3 = partial or complete girdle with plant remaining upright but weak and spindley, 4 = plant mortality. Another possible category, plant broken at girdle site, did not occur in this study so was not included.
3. Fresh/dry aerial and root weights ( $\pm 1$  milligram). Fresh weights were recorded immediately after removal from pots by cutting plants at the soil line and separating the aerial and washed root portions. Dry weights were obtained after drying the plant parts at  $> 90^{\circ}\text{C}$  for 4 hours.
4. Plant growth stages (Fehr et al. 1971)- recorded at the conclusion of the experiment.

Data were statistically analyzed by analysis of variance tests and means were separated by Duncan's Multiple Range Test (Duncan 1955).

## RESULTS AND DISCUSSION

Feeding injury on V1 stage plants by fourth instars ( $2.80 \pm 0.13$ ) was significantly greater than injury by third instars ( $1.70 \pm 0.26$ ), but was not significantly greater than injury by fifth instars ( $2.20 \pm 0.29$ ). Feeding injury by third instars consisted

of no, partial, or complete girdles (Table 1). Swelling and/or adventitious root growth accompanied all except one of the partial girdles and all of the complete girdles. Feeding injury by fourth instars consisted of partial or complete girdles (Table 1). Swelling and/or adventitious root growth accompanied all of the partial girdles and all except one of the complete girdles. Feeding injury by fifth instars consisted of no, partial, or complete girdles (Table 1). Swelling and/or adventitious root growth accompanied all partial and complete girdles.

Table 1. Frequency distribution of TCAH nymphal feeding injury categories (FIC) and plant response categories (PRC) on V1 stage soybean plants by third, fourth, and fifth nymphal instars.

Category*,†	Nymphal Instar					
	FIC 3	PRC	FIC 4	PRC	FIC 5	PRC
1	5	5	0	0	3	3
2	3	2	2	3	2	4
3	2	3	8	6	5	3
4	—	0	—	1	—	0

\* Feeding injury categories (FIC): 1 = no girdle (includes random punctures), 2 = partial girdle, 3 = complete girdle. Category 4 does not apply.

† Plant response categories (PRC): 1 = no apparent damage, 2 = partial or complete girdle but plant remaining upright and vigorous, 3 = partial or complete girdle with plant remaining upright but weak and spindley, 4 = plant mortality.

Plant responses by V1 stage plants were significantly greater when infested with fourth instars ( $2.80 \pm 0.20$ ) than with third ( $1.80 \pm 0.29$ ) or fifth ( $2.00 \pm 0.26$ ) instars. No damage (PRC 1) was observed to plants when third instars did not girdle plants (FIC 1) (Table 1), the response which occurred most often. When partial or complete girdles (FICs 2&3) occurred with third instars, plants remained upright but 60% of those plants appeared weakened. Plant responses to fourth instar partial or complete girdle feeding injury were plant remaining upright and vigorous, plant remaining upright but weak and spindley, or plant mortality with the highest frequency occurring in the second category. Plant responses to fifth instar feeding injury consisted of no damage, partial, or complete girdles with plants remaining upright and vigorous, or partial or complete girdles with plants remaining upright but weak and spindley with the highest frequency occurring in the second category.

No significant differences in FICs or in PRCs occurred among third (FIC = 1.2, PRC = 1.3), fourth (FIC = 1.5, PRC = 1.6) and fifth (FIC = 1.5, PRC = 1.4) instars on V3 stage plants and no significant differences were found among average responses by all plants to FICs 2 (V1 = 2.14, V3 = 2.20) and 3 (V1 = 2.87, V3 = 2.00).

FICs 2 (partial girdle) and 3 (complete girdle) were 23.3 (7/30) and 50.0 (15/30) percent of the V1 stage plant responses for all instars, respectively. All plants except one in each of these categories developed swelling and/or adventitious root growth, indicating that whenever there is a partial or complete girdle by a TCAH nymph, a V1 stage soybean plant will usually produce these growths above the girdle. Approximately 27 percent (8/30) of the V1 plants were in FIC 1 (no girdle but includes random punctures). Only third and fifth instars were associated with this category (Table 1). Random feeding punctures on the stem can be visually identified by the presence of small, dark brown spots. Significant differences

occurred with fourth instars between FIC's and also PRC's for V1 and V3 stage plants, indicating that V1 plants are more susceptible to girdling and subsequent swelling and/or adventitious root growth than V3 plants.

No significant differences occurred between means of fresh or dry aerial weights of all plants and fresh or dry root weights of V3 plants. Fresh root weights of V1 plants subjected to fourth instars were significantly less than those subjected to zero, third, or fifth instars (Fig. 1). Dry root weights of V1 plants subjected to fourth instars were significantly less than those subjected to zero or third instars but not to fifth instars. This coincides with the predominantly weak and spindley plant growth responses to fourth instar feeding injury. Growth stage development of V1 stage plants was significantly reduced when infested with fourth instars than with zero, third, or fifth instars. Most plants infested with zero, third, or fifth instars were V4-5 at the conclusion of the experiment while fourth instar infested plants were generally V3-4. No significant differences occurred among growth stages of V3 stage plants at the conclusion of the experiment.

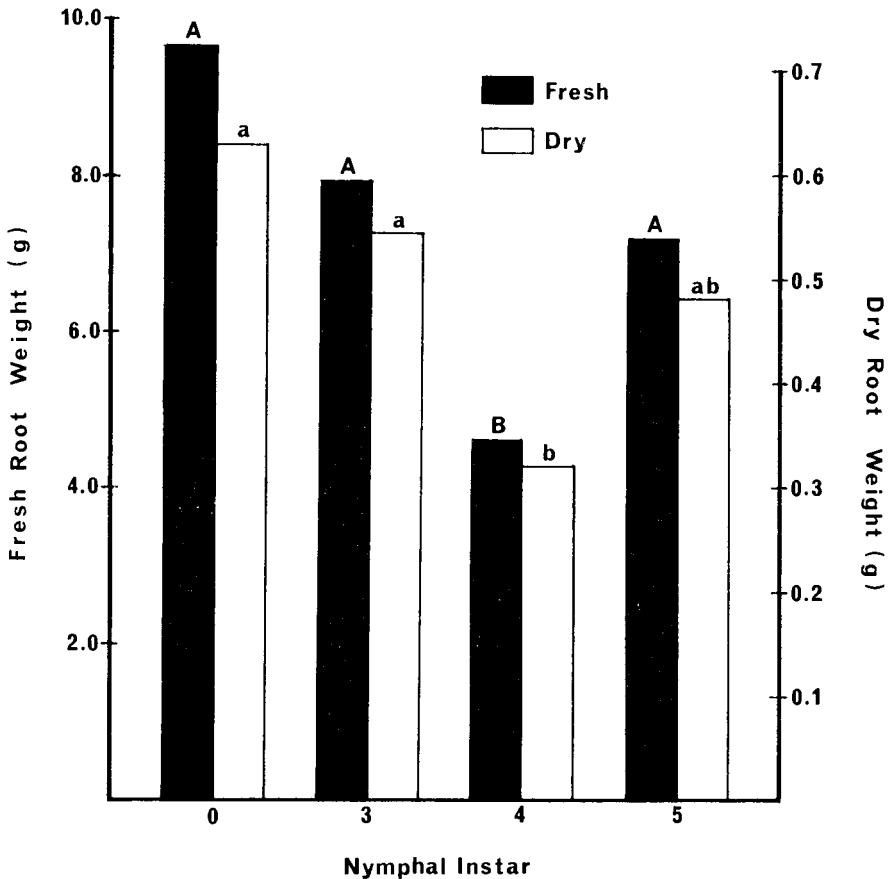


Fig. 1. Fresh and dry root weights of control V1 stage soybean plants and those infested with third, fourth, and fifth TCAH instars. Columns representing the same type of root weight headed by the same letter are not significantly different ( $P < 0.05$ ; Duncan's (1955) multiple range test).

The results of this study indicate that fourth instar TCAH nymphs are more injurious than third or fifth instar nymphs on V1 stage soybean plants. This agrees with a previous study done with 6l cm tall greenhouse-grown soybean plants that also found the fourth instar the most injurious stage (Moore and Mueller 1976). Although early season girdling is reported to be done only by adult TCAH (Rice and Drees 1985), based on developmental rates, fourth instars could potentially be found approximately 18 days after oviposition in newly emerged soybean (Jordan 1952; Mitchell and Newsom 1984). Egg incubation periods as short as 4 days (Wildermuth 1915) would shorten the time between oviposition and the fourth instar to ca. 15 days. Under simulated normal growing conditions, soybean plants would be in the V1 growth stage from 10-17 days following emergence (Johnson et al. 1960). Under environmental factors which prevent optimal plant growth (e.g. moisture stress, herbicide damage, and/or staggered plant emergence), fourth instars may attack the early vegetative stages of soybean, providing the development of TCAH eggs and nymphs is not inhibited.

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