Effects of Corn and Selected Weed Species on Feeding Behavior of the Stalk Borer, *Papaipema Nebris* (Lepidoptera: Noctuidae)

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EFFECTS OF CORN AND SELECTED WEED SPECIES ON FEEDING BEHAVIOR OF THE STALK BORER, *PAPAIPEMA NEBRIS* (LEPIDOPTERA: NOCTUIDAE)

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ABSTRACT

Experiments were conducted in an outdoor insectary to examine behavioral interactions between fifth instar stalk borers, *Papaipema nebris*, and potential host plant species. Plants tested included 6- and 8-leaf stage corn, *Zea mays*, and ten weed species (six broadleaf and four grass) commonly associated with corn production in southern Wisconsin.

Broadleaf plants found to be acceptable hosts included *Ambrosia trifida, Amaranthus retroflexus, Rumex crispus,* and *Chenopodium album; Asclepias syriaca* and *Abutilon theophrasti* were not acceptable as host plants. Corn and the other grass species (*Agropyron repens, Bromus inermis, Dactylis glomerata,* and *Setaria faberi*) were found to be acceptable hosts. All acceptable plants also supported larval development to the pupal stage, though on 6-leaf stage corn and the small-stemmed grasses the majority of larvae dispersed before completing development. Larvae developing on corn, *A. trifida,* and *A. retroflexus* pupated within the plant stem, whereas larvae developing on the other plants pupated in the soil near the plant on which they fed. Stalk borer larvae required substantially less time to bore into corn stalks than into the stems of the broadleaf plants. In a limited preference experiment, corn was clearly preferred as a host plant over the three broadleaf and one small-stemmed grass species tested.

The stalk borer, *Papaipema nebris* (Guenée), has long been recognized as a potential crop pest (Decker 1931), but its pest status on corn in the midwestern U.S. has recently increased due to widespread adoption of conservation tillage practices (Rubink and McCartney 1982, Stinner et al. 1984, Bailey and Pedigo 1986). The stalk borer is univoltine with a larval developmental period that extends from May through late July or August in Iowa and typically requires seven to nine molts (Decker 1931). Stalk borer larvae utilize a progression of host plants during this protracted developmental period, beginning in small-stemmed weeds and often ending up in a corn plant. Host plants are abandoned when larvae either outgrow the stem or kill the plant. Decker (1931) listed plant species recorded as stalk borer hosts in Iowa and elsewhere, but little information is available on the suitability of host plants for sustained larval development or the influence of different plant species on the behavior of stalk borer larvae. The objective of this research was to provide this type of information for corn and 10 weed species commonly associated with corn production in southern Wisconsin. Experiments were conducted with

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fifth instar stalk borers to determine acceptance and suitability (for completion of larval development) for each plant species, and preference by larvae for individual hosts in selected three-species plant combinations. The fifth instar was used because it is one of the main stages involved in moving from weed hosts to corn (Alvarado 1985, Lasack et al. 1987).

MATERIALS AND METHODS

Experiments were conducted during 1984 in an outdoor, screened insectary on the University of Wisconsin Agricultural Research Station at Arlington. Plant acceptance and suitability for stalk borer larvae were evaluated for corn, *Zea mays,* and for the following ten weed species—Asclepiadaceae: *Asclepias syriaca* (common milkweed); Malvaceae: *Abutilon theophrasti* (velvetleaf); Chenopodiaceae: *Chenopodium album* (lambsquarters); Polygonaceae: *Rumex crispus* (curly dock); Amaranthaceae: *Amaranthus retroflexus* (redroot pigweed); Compositae: *Ambrosia trifida* (giant ragweed); Gramineae: *Setaria faberi* (giant foxtail), *Dactylis glomerata* (orchardgrass), *Bromus inermis* (smooth bromegrass), and *Agropyron repens* (quackgrass).

Plants were assessed as to whether they provided feeding and/or pupation sites. A plant was considered acceptable as a host when a larva fed on it for a nontrivial (> 1 hr) length of time, and a plant was considered suitable as a host when a larva completed its development and pupated in or near the plant.

For the preference experiment, four combinations of three host plant species each were exposed to stalk borer attack. Insect response was measured by the number of larvae that fed on and/or pupated in a particular host. For this experiment, host species were selected from those found to be acceptable in the first experiment. The plant combinations selected were: (1) corn + smooth bromegrass + giant ragweed; (2) corn + smooth bromegrass + lambsquarters; (3) corn + smooth bromegrass + redroot pigweed; and (4) giant foxtail + smooth bromegrass + orchardgrass.

For both experiments, weed species were transplanted from the field into 3.8 liter pots. Grass weeds selected had at least ten stems, which were tied loosely to stakes to keep them upright, and broadleaf plants selected had stems > 4 mm in diameter. Only those plants that were vigorous a week after transplanting were used in the experiments. Corn was grown from seed (two seeds per pot) with two plantings a week apart to provide plants in two stages of growth for the experiments. Six- and 8-leaf stage corn plants (Ritchie and Hanway 1982) were used in the acceptance/suitability experiment, and 8-leaf stage plants were used in the preference experiment. For the preference experiment the three host plants were grown in one pot.

Five pots (replications) per plant species or plant combination were utilized. Pots were arranged in a completely randomized design on the floor of the insectary and were separated from each other by at least 0.5 m. Saucers were placed under the pots to facilitate watering, plus the saucer borders were coated with Tangle Trap adhesive to capture larvae attempting to disperse from the pots. Pots were infested with two newly-molted fifth instars placed within 3 cm of the plant stem in the acceptance/suitability experiment and at the center of the pot in the preference experiment. For cases in which the larvae avoided the plants entirely a second infestation was attempted; in this case the larvae were placed directly on the plant. To obtain fifth instars, larvae in the fourth instar were collected from nearby corn fields and reared on an artificial black cutworm diet (Bioserv #924LO) until the next molt occurred. Only those larvae that molted within 2 days of collection were used. Instar determination was based on measurements of head capsule width (Decker 1931).

The frequency of observations varied according to the phase of the experiment. On the day of infestation each larva was observed at frequent (ca. 30 min.) intervals until it had entered a plant or non-acceptance was recorded. Hosts were considered unacceptable when the larvae wandered for at least 2 hrs. or were caught in the adhesive without feeding. The time required for larvae to bore into and enter corn and selected broadleaf

Table 1. Behavior of stalk borer larvae on selected plant species.

Plant	Acceptance		Suitability			Pupation	
	yes/no		yes/dispersed/died			plant/soil	
Broadleaf:							
common milkweed	0	10	—	—	—	—	—
velvetleaf	0	10	—	—	—	—	—
lambsquarters	10	0	8	0	2	0	8
curly dock	10	0	8	0	2	0	8
redroot pigweed	10	0	9	0	1	9	0
giant ragweed	10	0	9	0	1	9	0
Grass:							
giant foxtail	9	0	2	6	1	0	2
orchardgrass	10	0	3	6	1	0	3
smooth bromegrass	10	0	2	6	2	0	2
quackgrass	10	0	4	5	1	0	4
corn (6-leaf)	10	0	2	7	1	2	0
corn (8-leaf)	10	0	10	0	0	10	0

plant stems was also recorded (five larvae per plant species). After infestation, observations were made twice a week. Observations were terminated a week after fresh feeding (recognized by signs of recent tunneling activity or frass production) was no longer apparent on a plant. At that time stalk borer pupae (or dead larvae for those that did not survive to pupation) were collected by dissecting the plant stem and sifting the soil from the pot, and the location of pupae (stem vs. soil) was recorded. Experiments were begun in July and concluded at the end of August.

RESULTS

Results of the test of host acceptance (Table 1) were unequivocal. Among the broadleaf plants, common milkweed and velvetleaf were unacceptable as stalk borer hosts. In fact, common milkweed seemed to have a repellent effect: larvae released on the soil did not climb the plants, and larvae placed directly on plants did not feed and quickly dispersed, often by making a string of silk to reach the soil. All grass species tested were acceptable as stalk borer hosts.

All the plants that were acceptable were found also to be suitable for the completion of development for at least some of the larvae (Table 1). Among the acceptable broadleaf plants, all surviving larvae completed development on the plant initially infested (though there was some larval mortality that could not be attributed to any known cause on these and the other plants). All larvae surviving on giant ragweed and redroot pigweed pupated within the plant stem, whereas all larvae surviving on curly dock and lambsquarters pupated in the soil of the pot.

The small-stemmed grasses (i.e. all species except corn) were able to support the development of some larvae to pupation, though for each species more larvae dispersed in search of a new host than completed development. Larval tunneling and feeding in these grasses resulted in the death of individual stems, but plants often compensated for this damage by producing new tillers. Larval movement among grass stems could be recognized by signs of newly damaged stems. All larvae that completed development on the small-stemmed grasses pupated in the soil of the pot.

In corn, host suitability was influenced by the stage of plant development. Feeding by fifth instars on 6-leaf stage plants resulted in plant death, which explains why most of the larvae dispersed in search of a new host. The 8-leaf stage plants were not killed by stalk borer feeding, and all larvae tested completed development and pupated within the corn stalk.

Table 2. Time required for stalk borer larvae to bore into plant stems.

Plant	Time (min.) ($\bar{X}$ ± S.D.)
corn	8 ± 0.5
giant ragweed	35 ± 1
redroot pigweed	50 ± 2
curly dock	53 ± 2
lambsquarters	58 ± 2

Table 3. Feeding preference of stalk borer larvae for hosts in 3-species combinations.

Host Combination	Number of Larvae
corn	8
giant ragweed	2
smooth bromegrass	0
corn	10
lambsquarters	0
smooth bromegrass	0
corn	9
redroot pigweed	1
smooth bromegrass	0
giant foxtail	2
smooth bromegrass	3
orchardgrass	5

Within the group of large-stemmed accepted hosts (corn + four broadleaf plants), differences were observed in the time required for stalk borer larvae to enter the plant stem (Table 2). The time needed to bore into corn stalks was substantially shorter than for the broadleaf plant stems. The amount of time required for larvae to enter the stems of the small-stemmed grasses was not recorded, but it was observed to be similar to the time required for corn.

In the preference experiment (Table 3), stalk borer larvae clearly preferred corn over all other host species tested. However, larvae confined in pots with small-stemmed grasses showed no clear preference and tended to move among plants for feeding; six of the ten larvae dispersed prior to completing their development.

DISCUSSION

The stalk borer is a polyphagous species that is recorded to feed on more than 100 plant species (Decker 1931). Our results on host acceptability agree for the most part with Decker's observations in Iowa, though we found two species not listed by Decker to be acceptable: lambsquarters and giant foxtail. In addition to host acceptability, our results demonstrate further differences among host plants, including suitability for sustained larval development, preference exhibited by larvae, time required for larvae to enter plant stems, and the location chosen by larvae for pupation. Of course, these data were obtained for the fifth instar and do not necessarily represent other, and particularly earlier, larval stages. Nevertheless, the evidence suggests that species composition of the plant community supporting a stalk borer population can have important effects on the dynamics of the population.

In addition to plant effects on larvae, the impact of stalk borer larval feeding on subsequent plant development and mortality varied depending on the host plant species attacked. Especially noteworthy was the differential sensitivity to feeding injury by corn plants that differed in age by only one week, which has implications with regard to yield loss in corn (Alvarado 1985, Bailey and Pedigo 1986) and to the number of corn plants attacked by an individual stalk borer larva.

ACKNOWLEDGMENTS

We thank J. Doll for advice on transplanting and culturing of weeds, and S. Gottlieb for technical assistance. This research was supported by the College of Agricultural and Life Sciences, University of Wisconsin-Madison.

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