HERBIVORY BY *Thrips tabaci*

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Herbivory by *Thrips tabaci* (Lindeman) affects both the bulb yield and phytohormone balance in its major host plant, the onion (*Alium cepa* L.). Seasonal changes in the susceptibility of onion yield to *T. tabaci* feeding were examined during the three growth stages of onion; prebulbing, bulbing and sizing (Kendall & Capinera 1987). The prebulbing stage is characterized by rapid leaf initiation. Increased bulb size and decreased leaf initiation occurs during bulbing. Further bulb growth and collapse of the leaf bundle characterizes the sizing stage.

Thrips feeding also stimulates increased production of the phytohormone ethylene which affects the physiology of the plant. Ethylene is responsible for a wide variety of effects including fruit ripening and leaf senescence (Abeles 1973). On the biochemical level, ethylene is a secondary messenger responsible for the production of defensive compounds in plants (Yang & Pratt 1978). Our objective was to distinguish mechanical induction of ethylene evolution from enhanced production associated with thrips feeding (Kendall & Bjostad 1989).

Materials and Methods

Susceptibility of Onion Growth Stages

Two field studies (1982 and 1983) and one greenhouse study (1984) were conducted. In order to assess seasonal changes in the susceptibility of the onion to herbivory, thrips populations were allowed

to build up to specific densities only within each growth period. Onions were sprayed with diazinon during the remaining growth stages. Weekly estimation of thrips densities per plot was determined by visual examination. Yield measurements were conducted 30-60 days after harvest. Bulb weights (50 onions per plot) were measured to the nearest 0.1 g on an electronic balance (Fisher 250). BMDP was used to analyze the regression analyses. For further detail see Kendall & Capinera (1987).

Ethylene Production

One-time mechanical damage (Experiment 1). Glass tubes (23 ml) fitted with rubber septa were placed over onion plants, and weather-stripping putty (Mortite) was secured to the bottoms to prevent contact with the soil. The onions were treated in one of two ways: twenty second-instar thrips larvae were introduced or twenty 2 mm incisions were made with a sterile 00 insect pin. Control plants were left undamaged and empty control tubes were included to check for the presence of ethylene in the collection system. Tubes were stoppered with rubber septa and allowed to incubate for 48 hours. Sample size consisted of four plants per treatment. After 24 and 48 hours, ethylene analysis was performed, yielding eight ethylene readings each for uninfested, infested, and mechanically damaged tissues. After the 48-hour reading, plants were weighed to the nearest hundredth of a milligram. After 24 hours a 1-ml gas sample was withdrawn from the headspace of each vial using a pressure-lok syringe, and analyzed for ethylene. A model 5890 Hewlett-Packard gas chromatograph equipped with a flame-ionization detector, and a Hewlett-Packard model 3390A integrator recorder were used in the analysis.

Semi-continuous mechanical damage (Experiment 2). To more closely approximate the continuous feeding damage exhibited by thrips, intact plants were wounded every 12 hours with a sterile 00 insect pin attached to a wire entering the septum. In this manner, damage could be inflicted without opening the tubes. A piece of wire was also inserted into the septa of the remaining tubes. Experimental design was identical to the previous experiment. Sample size consisted of four

plants per treatment. Readings were taken after 14, 16, 19, 36, 39, 42, 60, 72, 84, and 94 hour incubation times. After 96 hours, the plants were dried and weighed to the nearest hundredth of a milligram. The wounds were measured to the nearest hundredth of a millimeter.

Thrips extract (Experiment 3). Thrips were placed in a sterile saline solution and macerated into a thick paste. An extract of ten thrips was placed in each of ten 5 mm wounds made with a sterile 00 insect pin. Mechanically damaged plants were treated in an identical manner to those with the thrips extract, except only sterile saline solution was placed in the wounds. A third of the plants remained unwounded. Sample size consisted of four plants per treatment. Readings were taken every 12 hours for 96 hours. After 96 hours, the plants were dried and weighed and the wounds were measured as described previously.

Statistical Analyses

All data were analyzed by one-way analysis of variance using BMDP. For further detail see Kendall & Bjostad (1989).

Results

Susceptibility of Onion Growth Stages

A significant relationship between thrips numbers and yield was not found during the pre-bulbing or sizing stages. During the bulbing stage, a significant negative relationship between thrips numbers and bulb size was observed (Fig. 1). Similar results were obtained for the 1983 field season and the 1984 greenhouse study (Kendall & Capinera 1987).

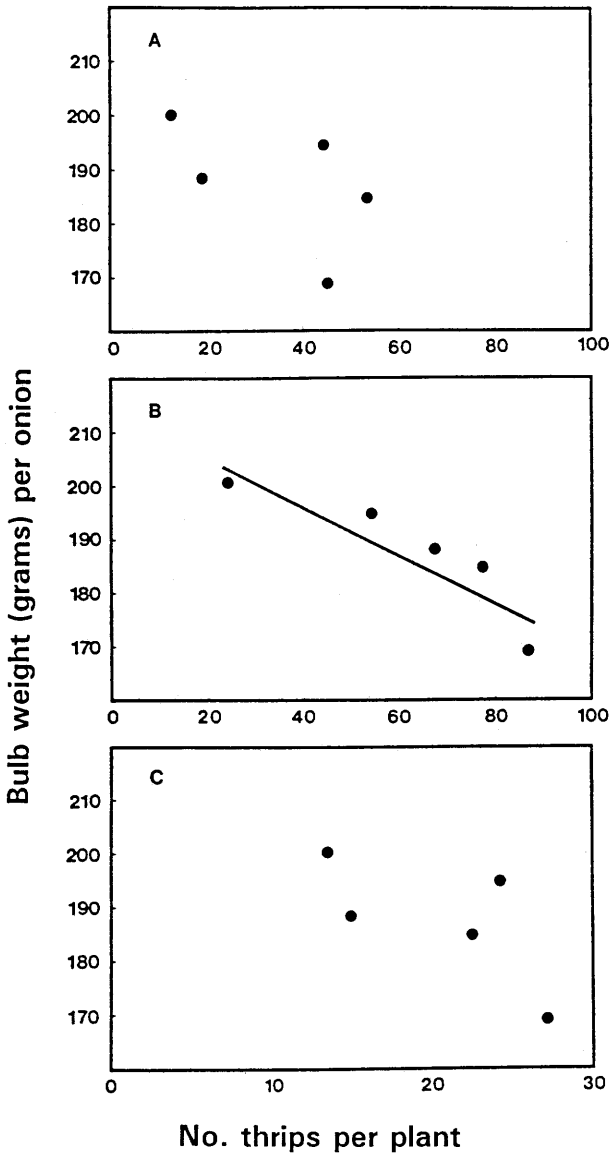

Figure 1. Effect of thrips herbivory on bulb size in 1982: (A) prebulbing ($P > 0.05$), (B) bulbing, $r^2 = 0.81$ ($P < 0.05$), (C) sizing ($P > 0.05$) (Kendall & Capinera 1987).

Ethylene Production

In the first experiment, thrips-infested tissue produced significantly greater ethylene compared to uninfested plants and to foliage that was mechanically damaged at the beginning of the experiment (Table 1). Ethylene evolution from mechanically damaged and unwounded plants was not significantly different ($P < 0.05$) (Table 1). In Experiment 2 significant differences existed between thrips-infested and semi-continuous mechanically-wounded plants and to unwounded foliage from 19 to 96 hours incubation time (Fig. 2).

Table 1. Ethylene production from infested, uninfested and mechanically wounded intact onion plants

Incubation	Ethylene production (pmole/g)[a]		
Hours	Infested	Mechanically wounded	Unwounded
24	14.87 ± 3.33a	4.59 ± 0.96b	4.50 ± 0.69b
48	21.27 ± 5.10a	5.23 ± 1.00b	3.64 ± 1.23b

[a] Mean and standard errors.

Means followed by the same letter in one row are not significantly different (Duncan's Multiple Range Test, $P \leq 0.05$).

Mechanically-wounded and unwounded plants did not produce significantly different levels of ethylene (Fig. 2). The third experiment produced similar results. Plants inoculated with thrips extract produced significantly greater levels of ethylene than mechanically-wounded and unwounded foliage from 60 to 96 hours incubation time (Fig. 3). Ethylene evolution from mechanically damaged and unwounded plants was not significantly different ($P < 0.05$) (Fig. 3).

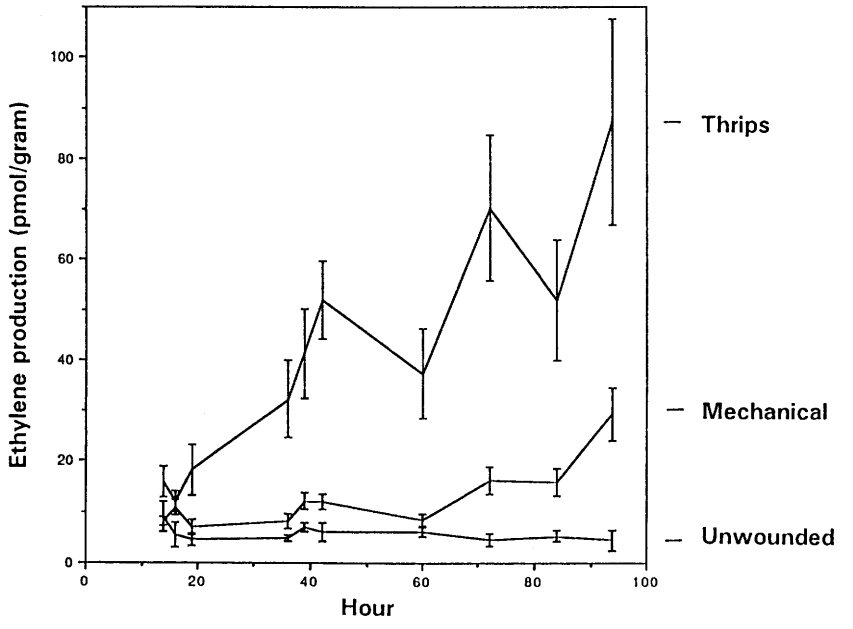

Figure 2. Ethylene production from thrips infested, semi-continuously mechanically-wounded, and unwounded intact onion plants. Vertical lines depict standard errors for the mean (Kendall & Bjostad 1989).

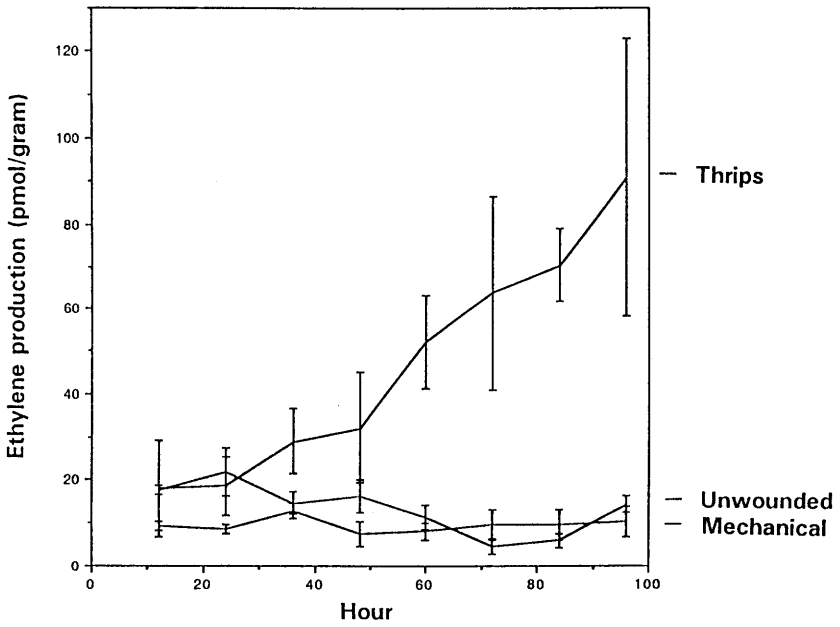

Figure 3. Ethylene production from plants inoculated with thrips extract, mechanically-wounded plants, and unwounded foliage. Vertical lines depict standard errors for the mean (Kendall & Bjostad 1989).

Discussion

Susceptibility of Onion Growth Stages

Growth stages of the onion exhibit differential responses to feeding by *T. tabaci*. The prebulbing and sizing stages are relatively insensitive to herbivory, but the bulbing stage is highly susceptible. During bulbing, nutrients from the foliage are shunted into the bulb which acts as a resource sink. If nutrients are removed from the foliage at this time, bulb weight will be reduced (Kendall & Capinera 1987). Management practices should concentrate on protection of this highly susceptible growth stage. The growth stages of many plant species exhibit similar responses to herbivore pressure (Bardner & Fletcher 1974). The maple may also exhibit seasonal changes in susceptibility to pear thrips.

Ethylene Production

Thrips feeding induced significantly greater ethylene evolution that would be expected from mechanical damage alone, presumably because thrips introduce cues during feeding that induce ethylene production by the plant. Because mechanical damage is directly proportional to ethylene production, measurement of ethylene evolution from maple trees may represent a novel, relatively simple and inexpensive technique to quantitatively assess defoliation injury in maples.

References Cited

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