# COMPETITIVE INTERACTIONS OF ALFALFA AND ANNUAL WEEDS AS AFFECTED BY ALFALFA WEEVIL (COLEOPTERA: CURCULIONIDAE) STUBBLE DEFOLIATION

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## ABSTRACT

The impact of stubble defoliation by alfalfa weevil, *Hypera postica* (Gyllenhal), larvae on the establishment and growth of selected annual weeds in alfalfa was examined under controlled conditions in the greenhouse. Weed species were large crabgrass, *Digitaria sanguinalis* (L.) Scop., yellow foxtail grass, *Setaria lutescens* (Weig.) Hubb., redroot pigweed, *Amaranthus retroflexus* L. and common lambsquarters, *Chenopodium album* L. Stubble defoliation increased the survival of all weed species except foxtail grass. Dry matter production of aerial portions of crabgrass, foxtail grass, pigweed and lambsquarters was 28.4, 7.2, 23.7, and 7.3 times greater, respectively, when growing with defoliated than undefoliated alfalfa. Stubble defoliation also enhanced plant height and leaf number of most weed species. Stubble defoliation reduced dry matter accumulation and delayed development of alfalfa regrowth. Alfalfa root dry weight was more adversely affected than top dry weight by stubble defoliation. The presence of weeds did not significantly ($P > 0.05$) affect the growth and development of defoliated and undefoliated alfalfa. This result suggests that stubble defoliation by alfalfa weevil larvae reduced the competitive ability of alfalfa which allowed weeds to grow and occupy gaps within the alfalfa canopy.

Key Words: Alfalfa, alfalfa weevil, *Hypera postica,* weeds, insect/weed interactions.

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## INTRODUCTION

A vigorous stand of alfalfa, *Medicago sativa* L., can effectively compete with most summer annual weeds (Peters and Peters 1972). Practices such as overgrazing and frequent cutting that retard or prevent rapid regrowth reduce that competitive ability of alfalfa, which encourages the establishment and growth of annual weeds (Leach 1979; Peters and Peters 1972). Stubble defoliation by insects also could be expected to reduce the competitive ability of alfalfa and favor weed encroachment.

Larvae of the alfalfa weevil (AW), *Hypera postica* (Gyllenhal), damage the first cutting of alfalfa (Hintz et al. 1976), and may defoliate stubble after cutting which can result in a delay of regrowth or several days to two weeks or more (Liu and Fick 1975; Fick 1976). Liu and Fick (1975) found that AW larvae reduced yield by 31% during the second growth of a 3-cut system as a result of stubble defoliation which delayed regrowth for 5 to 15 days. Yield loss was porportional to the severity and duration of stubble damage (Fick 1976). Stubble defoliation by the variegated cutworm, *Peridroma saucia* (Hübner), has been found to reduce alfalfa yield (Buntin and Pedigo 1985a, 1985b) and to enhance weed density, biomass and percentage by weight in alfalfa at harvest (Buntin and Pedigo 1986). Stubble defoliation by AW larvae also probably reduces the competitive ability of alfalfa sufficiently to encourage weed establishment and growth. Berberet et al. (1987) found in a field study that infestations of annual weeds were reduced when AW was controlled with an insecticide during the first cutting. The impact of stubble defoliation by AW larvae on alfalfa weed interactions, however, has not been investigated in detail. This study was conducted to examine how stubble defoliation by AW larvae alters the competitive interactions of alfalfa and selected summer annual weeds under controlled conditions.

## MATERIALS AND METHODS

The study was conducted in a glasshouse located at the Georgia Experiment Station in Griffin, Georgia. *Medicago sativa* cv. Apollo, was established in 20 cm diameter plastic pots containing a 2:1 mixture of Applying sandy loam and sand. Pots were watered three times per week, and 300 ml of a complete nutrient solution (200 ppm N:P:K plus soluble trace elements) was applied weekly to each pot. Temperature during the experiment was 20 - 28°C with maximum levels of photosynthetically-active-radiation being 600 to 700 μE $m^{-2}s^{-1}$.

Twenty alfalfa plants were established in each pot, with plants being arranged in 4 rows of 5 plants with 2 cm between each plant. After 3 months of growth, alfalfa plants were clipped to a stubble height of 3 cm. Ten treatment combinations of AW stubble defoliation and weeds were established. The two alfalfa defoliation treatments were (1) no defoliation and (2) stubble defoliation by AW larvae resulting in a complete suppression of regrowth. All pots were covered with a cylindrical aluminum screen cage that was 30 cm high, 20 cm in diameter and covered with a clear plastic petri dish. Half the pots containing alfalfa were infested with 75 AW larvae per pot and the remainder of the pots were not infested. Fourth-stage larvae were collected in the field and placed in cages the day after cutting. Defoliation occurred for 10 days, at which time cages were removed, and all pots were sprayed with malathion to kill the larvae.

Five weed-species treatments were established within the two defoliation treatments. Weed species were large crabgrass, *Digitaria sanguinalis* (L.) Scop., yellow foxtail grass, *Setaria lutescens* (Weig.) Hubb., redroot pigweed, *Amaranthus retroflexus* L. and common lambsquarters, *Chenopodium album* L. A weed-free treatment also was included. Three weed seeds, which were soaked in water for 12 h before planting, were sown at 4 locations between the two center rows of alfalfa. Weeds were thinned to 1 plant per location when the cages were removed. Each weed species also was sown in a pot containing no alfalfa to measure weed growth in the absence of alfalfa competition. All 14 treatments (10 treatments with alfalfa and 4 treatments with weeds only were arranged in a randomized complete block design with 7 replications.

Plants were harvested 40 days after cutting by washing soil from the roots of alfalfa and weeds. Alfalfa plants were separated into leaf, stem and root portions, and stem number per pot, stem height, leaf number per stem, leaf percentage by weight, and root and top (i.e., stems plus leaves) dry weights were measured. The percentage of flowering stems also was recorded. Weeds were separated into top and root portions, and weed density, culm number per plant of the grasses, stem height (extended leaf height of grass species), leaf number per plant, and top and root dry weights were measured. All plant material was oven-dried at 70°C for 48 h before weighing.

Alfalfa plant measurements were analyzed with an analysis of variance (ANOVA) using a factorial arrangement of defoliation and weed-species treatments. The effect of alfalfa competition level (i.e., undefoliated alfalfa, defoliated alfalfa and no alfalfa) on weed parameters was analyzed by weed species using an ANOVA, and Least Significant Difference was used to separate competition-level treatment means (SAS Institute 1985). The effect of AW defoliation on the competitive ability of alfalfa was examined in a separate analysis by comparing weed measurements between the undefoliated and defoliated alfalfa treatments within each weed species using Student's t-test.

## RESULTS

Stubble defoliation by AW significantly affected most alfalfa growth parameters (Table 1). Defoliation reduced stem density and delayed alfalfa maturity as measured by percentage of flowering stems. Defoliation also reduced the number of nodes per stem, but internode length increased resulting in no significant difference in final stem height. Defoliation reduced final leaf number per stem by an average of 30.3%, but did not affect the percentage of leaves by weight. Top and root dry weights also were significantly reduced by AW defoliation. Root dry weight was reduced by 35.6%, but dry weight of tops was reduced by 11.0%. The larger impact on roots than tops significantly increased the top:root ratio of defoliated alfalfa. The presence of weeds did not affect any alfalfa growth parameter ($P > 0.05$), and no defoliation by weed treatment interaction was significant ($P > 0.05$).

Table 1. Response of alfalfa growth parameters to stubble defoliation by alfalfa weevil larvae.

| Growth | Stubble defoliation | | |
|---|---|---|---|
| Parameter | Undefoliated | Defoliated | F-value |
| Stem density (No./pot) | 42.1 | 35.9 | 25.02** |
| % flowering stems | 29.5 | 0.1 | 157.12** |
| Stem height (cm) | 45.5 | 46.8 | 1.39 |
| Nodes per stem | 11.8 | 9.3 | 58.30** |
| Internode length (cm) | 3.8 | 5.0 | 47.30** |
| Leaves per stem | 29.4 | 20.5 | 89.40** |
| % leaves | 38.1 | 38.4 | 0.16 |
| Dry weight (mg) per stem | 185.4 | 204.0 | 2.40 |
| Top dry weight (g/pot) | 11.8 | 10.5 | 9.00** |
| Root dry weight (g/pot) | 10.4 | 6.7 | 89.88** |
| Top: Root | 1.17 | 1.63 | 34.13** |

** Indicates significant F-value ($P < 0.01$; ANOVA).

The response of weeds to the intensity of alfalfa competition is shown in Table 2. Weed mortality was not significantly increased for any species by competition from the defoliated alfalfa. Competition by the undefoliated alfalfa, however, significantly reduced plant densities of crabgrass, pigweed, and lambsquarter by 27.5, 57.5%, and 25.0% respectively, as compared with the defoliated alfalfa. Density of foxtail grass was not affected by the level of alfalfa competition. The presence of alfalfa significantly reduced the number of culms per plant of both grasses and significantly reduced plant height, leaves per plant, and dry weight of tops and roots of all weed species. The one exception was top dry weight of foxtail grass which was not significantly reduced by competition from the defoliated alfalfa.

Comparison of weed growth measurements between the infested and noninfested alfalfa treatments revealed that height of all species except lambsquarter and leaf number per plant of all species except crabgrass were significantly greater in the defoliated than the undefoliated alfalfa treatments. Grass tillering did not increase when alfalfa was defoliated. Reduced competition from the defoliated alfalfa also significantly increased top dry weight of all weed species and root dry weight of both grass weed species. Root dry weights of both broadleaved species were very low in both alfalfa treatments and were not different between AW defoliation treatments. Top weights of crabgrass, foxtail grass, pigweed, and lambsquarter were 28.4, 7.2, 23.7, and 7.3 times greater, respectively, in the AW-defoliated treatments as compared with the undefoliated treatments. Alfalfa stubble defoliation enchanced root dry weights of these weeds by 13.6, 4.5, 3.8, and 1.6 times, respectively. The greater response of weed tops to stubble defoliation caused the largest top: root ratio to occur in the pots with defoliated alfalfa. Crabgrass, however, was the only weed species where the top:root ratio was significantly different between AW-defoliated and undefoliated treatments.

## DISCUSSION

Results of this study support previous findings (Liu and Fick 1975; Fick 1976) that stubble defoliation by AW larvae can suppress dry matter accumulation and delay development of alfalfa regrowth. Furthermore, stubble defoliation reduced the competitive ability of alfalfa resulting in greater survival and substantially increased dry matter production of all weed species. Weed tops, however, responded to a much greater extent than roots to the reduction in interference from defoliated alfalfa. Undefoliated alfalfa shoots began to regrow almost immediately after cutting, consequently new shoots had a large chronological growth advantage over emerging weed seedlings. Stubble defoliation delayed alfalfa regrowth and allowed weeds time to germinate and emerge without interference.

The lack of significant effects of weeds on any alfalfa plant parameter indicates that, under the conditions of this study, the weeds did not affect the growth and development of defoliated or undefoliated alfalfa during the period of weed establishment. This result is consistent with the findings of Buntin and Pedigo (1986) who found in a field study that stubble defoliation by the variegated cutworm enhanced the encroachment of annual weeds into alfalfa. Weeds, however, did not suppress alfalfa dry matter production during the damaged and subsequent cuttings. Instead, the weeds supplemented the alfalfa by occupying gaps in the canopy rather than by replacing alfalfa biomass which resulted in little decrease in total forage production. Although the weeds did not suppress alfalfa biomass

Table 2. Response of plant density, growth and dry matter production of four weed species to competition by alfalfa with and without stubble defoliation by alfalfa weevil larvae.

| Weed species | Alfalfa competition | Plant density | Clums per plant | Plant height (cm) | Leaves per plant | Dry weight per plant (mg) Tops | Dry weight per plant (mg) Roots | Top:Root |
|---|---|---|---|---|---|---|---|---|
| Crabgrass | Undefoliated | 2.9 a+ | 1.0 a | 4.3 a | 3.7 a | 6.1 a | 2.1 a | 3.33 a |
| | Defoliated | 3.9 b* | 1.1 a | 17.4 b** | 3.8 a | 173.5 a* | 28.5 a | 6.51 b* |
| | No alfalfa | 4.0 b | 5.4 b | 40.0 c | 20.5 b | 689.8 b | 830.2 b | 0.91 a |
| Foxtail grass | Undefoliated | 4.0 a | 1.0 a | 12.2 a | 2.8 a | 54.3 a | 14.0 a | 5.86 a |
| | Defoliated | 4.0 a | 1.0 a | 31.0 b** | 3.7 a* | 391.9 b | 63.3 a** | 6.11 a |
| | No alfalfa | 4.0 a | 3.1 b | 56.4 c | 12.3 b | 561.3 b | 1349.7 b | 0.44 b |
| Pigweed | Undefoliated | 1.7 a | 1.0 a | 2.9 a | 1.6 a | 2.0 a | 1.2 a | 5.30 ab |
| | Defoliated | 3.6 b** | 1.0 a | 5.6 a** | 3.6 a** | 47.3 * | 4.5 a | 10.26 a |
| | No afalfa | 4.0 b | 1.0 a | 21.5 b | 9.6 b | 637.1 b | 698.7 b | 0.94 b |
| Lambsquarter | Undefoliated | 3.0 a | 1.0 a | 3.6 a | 2.5 a | 4.4 a | 1.4 a | 5.84 b |
| | Defoliated | 3.9 a | 1.0 a | 5.1 a | 3.9 a* | 31.9 a | 2.2 a | 14.11 a |
| | No alfalfa | 4.0 a | 1.0 a | 19.8 b | 14.3 b | 557.7 b | 470.2 b | 1.15 b |

+ Means within a column and weed species followed by the same letter are not significantly different (P = 0.05; Least Significant Difference Test).
*, ** indicate significant difference within weed species between defoliated and undefoliated alfalfa treatments at the 0.05 and 0.01 levels, respectively (Students t-test).

production during the initial phase of weed encroachment, weeds do reduce alfalfa quality (Cords 1973; Temme et al. 1979), and could be expected to reduce long-term vigor of an alfalfa stand (Berberet et al. 1987).

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