Aphid (Homoptera: Aphididae) Management in Alfalfa by Spring Grazing with Cattle[1]

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ABSTRACT The effect of continuous, intensive grazing by cattle on aphid populations was examined in the first growth cycle of 'Alfagraze' and 'Apollo' alfalfa which are tolerant and not tolerant to grazing, respectively. Populations were almost entirely pea aphid, *Acyrthosiphon pisum* (Harris). The effect of grazing on aphid populations was examined in small plot exclusion studies in 1991 and 1992, and the effects of grazing and use of an early insecticide application with ≤7 day grazing restriction were examined in large plot exclusion trials in 1993 and 1994. Grazing reduced aphid populations by 66% to 90% when numbers exceeded ~1 aphid per stem. Populations were not significantly reduced by grazing when numbers did not exceed 1 per stem. Permethrin reduced aphid numbers for up to 7 wks and was more effective than carbofuran. Effects of grazing were similar regardless of insecticide usage. Coccinellid beetle populations in 1993 and 1994 were composed of *Coccinella septempunctata* L., *Harmonia axyridis* (Pallas), and *Coleomegilla maculata* DeGeer. Coccinellid numbers were much lower in grazed than ungrazed plots when aphid numbers were reduced by grazing in 1993, but were not greatly affected by grazing in 1994 when aphid numbers were low. Coccinellid numbers paralleled trends in aphid numbers. Continuous, intensive grazing or the early application of an insecticide at a low rate followed by grazing were effective approaches for suppressing pea aphid in alfalfa.

Key Words Alfalfa, *Acyrthosiphon pisum,* ladybird beetle, coccinellid, grazing, integrated pest management

The pea aphid, *Acyrthosiphon pisum* (Harris), is a ubiquitous pest of alfalfa. Feeding injury can directly reduce dry-matter yield and forage quality of susceptible alfalfa cultivars (Kindler et al. 1971, Harvey et al. 1971, Cuperus et al. 1982). Large numbers of pea aphids also produce substantial amounts of honeydew which promotes growth of sooty mold, thereby indirectly reducing forage quality. In the southeastern United States, pea aphid populations occasionally increase to outbreak levels during the first growth cycle in late

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winter and spring. Aphids usually are managed by curative application of a broad spectrum insecticide when populations exceed an established economic threshold. Grazing by livestock may be an effective alternative tactic for suppressing insects such as aphids that occur in the middle and upper canopy of alfalfa.

Little research has been conducted on the effects of grazing on insect populations in growing alfalfa. Alfalfa typically is cut for hay because continuous grazing of traditional varieties by livestock is detrimental to stand survival and productivity (Van Keuren and Matches 1988, Smith et al. 1989). However, grazing for several weeks may not adversely affect alfalfa productivity (Allen et al. 1986, Wolf and Allen 1990). Development of the grazing tolerant cultivar 'Alfagraze' (Bouton et al. 1991) permits intensive spring grazing during the time when pea aphids are active without adversely affecting stand productivity (Smith et al. 1989, Smith et al. 1992, Smith and Bouton 1993).

We examined the effect of continuous, intensive grazing by cattle and use of an early application of insecticides at low rates with short, i.e., ≤7 d, grazing restrictions, to suppress larval populations of the alfalfa weevil, *Hypera postica* (Gyllenhal), in the first growth cycle of alfalfa (Buntin and Bouton 1996). The study was conducted with Alfagraze and Apollo alfalfa which are tolerant and not tolerant of grazing, respectively. Grazing reduced alfalfa weevil larval numbers by 32 to 65% after 3 wks. However, a combination of an early application of an insecticide treatment with a short grazing restriction followed by continuous grazing was most effective in controlling alfalfa weevil larvae.

Pea aphid populations in alfalfa typically are regulated by a complex of natural enemies including predatory arthropods, parasitic wasps and under certain environmental conditions pathogenic fungi (Fraser et al. 1981, Hutchison and Hogg 1985, Pickering and Gutierrez 1991). Coccinellid beetles are the most important predators of aphids in alfalfa during the spring. Adults are opportunistic and move away from areas with few aphids in search of high aphid numbers (Ives 1981, Frazer et al. 1981). Here we report on the effect of continuous, intensive grazing by cattle and use of an early application of several insecticides at low rates on populations of aphids and their primary early-season predator, coccinellids.

Materials and Methods

Studies were conducted at the University of Georgia Central Branch Experiment Station near Eatonton, GA. Detailed description of the study sites and procedures are presented by Buntin and Bouton (1996).

Small-plot studies. In 1991 and 1992, trials were conducted in two 0.5-ha grazing paddock of Apollo and Alfagraze alfalfa. Two treatments of grazing and no grazing were randomly assigned to paired plots each measuring 1.44 m^2 with movable wire mesh exclosures being placed over ungrazed plots 1 d before grazing began. Grazed plots were not covered. For each cultivar, treatments were arranged in randomized complete block design with 5 replicates. The entire paddock was grazed with cross-bred yearling steers during the first alfalfa growth cycle using animal stocking rates as described previously by Smith and Bouton (1993).

Aphids were sampled weekly by collecting 20 stems per plot and placing samples in Berlese funnels to extract insects (Buntin and Isenhour 1989). Insect counts were analyzed by cultivar and date using an analysis of variance. Means were separated using a least significant difference test (LSD) at $P < 0.05$.

Large-plot grazing trials. Trials were conducted within a 2-ha grazing paddock using a split-strip plot experimental design with 4 blocks (Little and Hills 1978). Main plots were either continuous grazing or no grazing, and the split plots were the two cultivars, Apollo and Alfagraze. Cattle were excluded from each no-graze whole plot with portable electric fences. Strip plots were insecticide treatments applied across both varieties. Insecticide treatments were: (1) untreated control, (2) permethrin (Pounce 3.2EC, FMC Corp., Philadelphia, PA) at 0.11 kg (AI) /ha, (3) carbofuran (Furadan 4F, FMC Corp. Philadelphia, PA) at 0.28 kg (AI) /ha, and (4) carbofuran at 0.84 kg (AI / ha in the ungrazed area. Grazing restrictions for treatments 2, 3, and 4 were 0 d, 7 d, and 21 d, respectively. Treatment 4 was replaced in the grazed areas in 1993 by chlorpyrifos (Lorsban 4E, DowElanco, Indianapolis, IN) at 0.28 kg (AI) /ha and in 1994 by phosmet (Imidan 2.5EC, Gowan Comp., Yuma, AR) @ 1.05 kg (AI) /ha, which both have restrictions of 7 d. Insecticide treatments were applied 7 d before grazing began on 9 March 1993 and 7 March 1994. Cattle intensively and continuously grazed the paddock during the first alfalfa growth cycle using a put-&-take system to maintain a 12-cm stubble height (Smith and Bouton 1993).

Aphids were sampled weekly by collecting 20 stems per split-strip plot beginning 5 march 1993 and 15 February 1994. Stems were placed in Berlese funnels for 72 h to extract insects (Buntin and Isenhour 1989). Coccinellid larvae and adults also were sampled in untreated, grazed and ungrazed plots in 1993 and in the grazed and ungrazed plots of insecticide treatments 1 and 2 in 1994 by taking 20 sweeps with a 38-cm diam sweep net. Larvae and adults were identified to species and counted.

Results were analyzed by sample date with an analysis of variance for a strip-split plots with a randomized complete block design for whole plots (Little and Hills 1978). Single degree-of-freedom contrasts were used to examine selected treatment comparisons. Where grazing by insecticide treatment interactions were significant ($P < 0.05$), insecticide means were analyzed within grazing treatments and were separated using least significant difference test.

Results

Alfalfa stem height in grazed plots fluctuated between 8 and 14 cm indicating that we were successful at maintaining a constant grazing pressure in grazed areas.

Aphid populations. Alfalfa variety did not significantly affect aphid number after 1 March in any year ($F = 0.05 - 5.80$; df = 1, 3; $P > 0.05$); therefore, results were pooled among varieties for presentation. Aphid populations in all years were almost entirely the pea aphid, *Acyrthosiphon pisum* (Harris), in March and early to mid-April. The spotted alfalfa aphid, *Therioaphis maculata* (Buckton), became prevalent (up to 50% of the population) on the last two sample dates in 1993 and the last sample date in 1994.

Aphid numbers in the small-plot trials in 1991 were small (≤0.15 aphids/stem) and were not significantly affected by grazing (F = 0.31 - 4.72; df = 1,4; $P > 0.05$; data not shown). Aphid numbers were much greater in 1992 (Fig. 1). Grazing in 1992 significantly reduced aphid numbers in March and early April (F = 0.31 - 4.72; df = 1,4; $P < 0.05$) and reduced peak aphid numbers on 28 March by ~90%.

Aphid populations in the large plot trial in 1993 peaked at 9 aphids per stem in the ungrazed untreated plots (Fig. 2). Permethrin effectively reduced aphid numbers for 7 wks until aphid numbers declined to low levels on 27 April. Both treatments of carbofuran reduced aphid numbers for 4 wks and were significantly less effective than permethrin. Grazing significantly reduced aphid numbers after 10 d beginning on 30 March and continued to suppress aphid numbers through 27 April in all insecticide treatments (Fig. 2). Grazing during this period reduced aphid numbers by 73, 66, and 77% in the untreated, permethrin, and low rate of carbofuran treatments, respectively.

Aphid numbers in 1994 were small (Fig. 3). Grazing did not significantly reduce aphid numbers on any sample data. However, all insecticide treatments significantly reduced aphid numbers for 5 wks after application and were similar in efficacy.

Predator populations. Coccinellids were the only beneficial insect collected in any numbers in sweep samples in the large-plot trials. Virtually all coccinellid larvae collected were the sevenspotted lady beetle, *Coccinella septempunctata* L. Adult populations were composed of *C. septempunctata* (47.6% in 1993, 71.4% in 1994), *Harmonia axyridis* (Pallas) (36.2% in 1993, 26.2% in 1994), *Coleomegilla maculata* DeGeer (14.3% in 1993, 2.4% in 1994) with 1.9% in 1993 being other species.

Coccinellid populations were larger in 1993 than 1994, and the effect of treatments paralleled the effects on aphid numbers in each year (Fig. 4 and 5). Very few adults were collected before 30 March 1993 and 25 March 1994. In 1993, larval numbers were significantly lower in grazed than ungrazed plots on all dates after 6 April (F = 9.96 – 35.58; df = 1,6; $P < 0.05$). Adult number were significantly reduced by grazing on 6, 13, and 27 April (F = 15.34 - 58.58, $P <$ 0.05). Grazing in 1994 did not significantly reduce larval numbers on any date and did not significantly reduce adult numbers except on the last sample date (Fig. 5).

The grazing by insecticide interactions in 1994 were not significant for coccinellid larvae or adults on any date (F = 0.03 – 1.17; df = 1,6; $P > 0.05$), thus main effect means of permethrin treatments are presented in Fig. 5. No larvae or adults were collected on sample dates before and after permethrin was applied on 7 March 1994. Nevertheless, except for the last sample date, larval and adult numbers were lower where permethrin was used, although this effect was significant only for larvae on 1 and 7 April (F = 7.42 and 5.85, $P < 0.05$, respectively).

Discussion

Aphid populations consisted almost entirely of pea aphids when grazing substantially reduced aphid numbers in March and April of 1992 and 1993. Grazing reduced peak aphid numbers by 90% in 1992 and 78% in 1993.

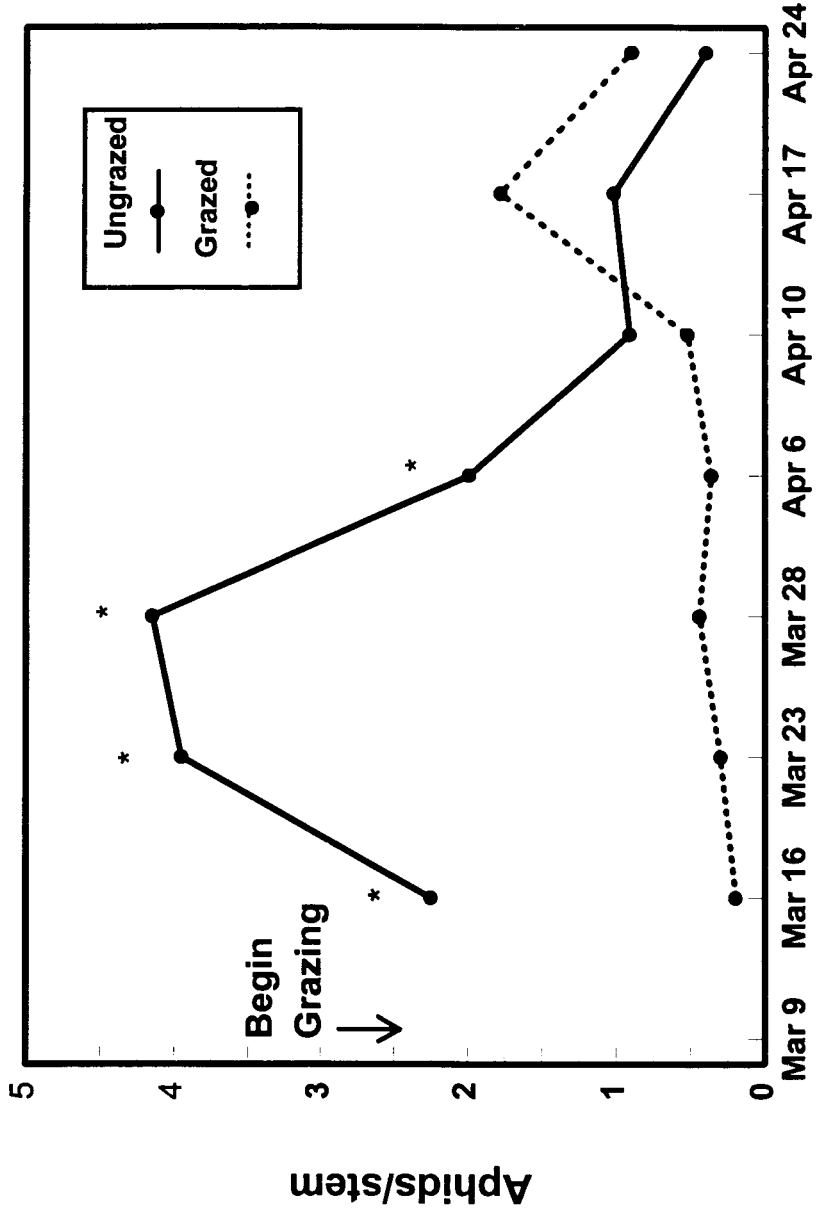


Fig. 1. Effect of grazing on aphid numbers in alfalfa in 1992; * indicates significant difference between means on a given sample date ($P < 0.05$; LSD).

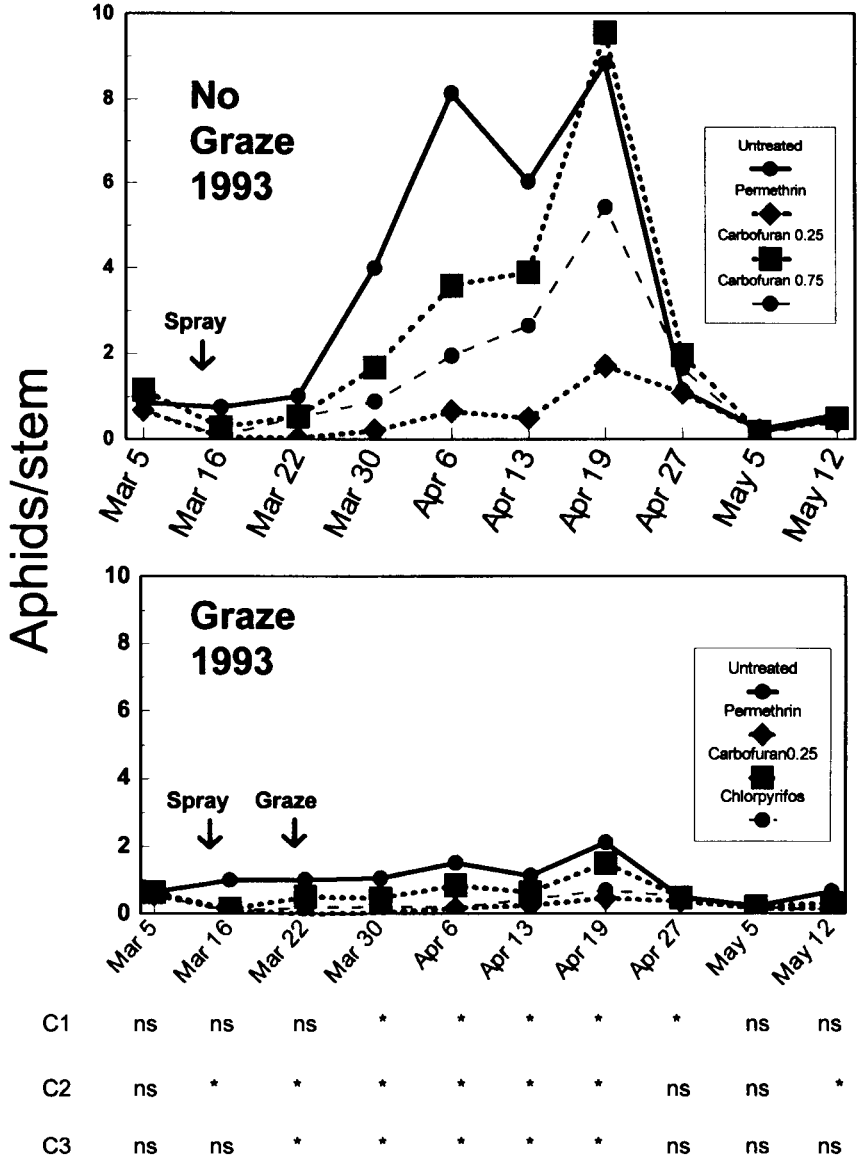
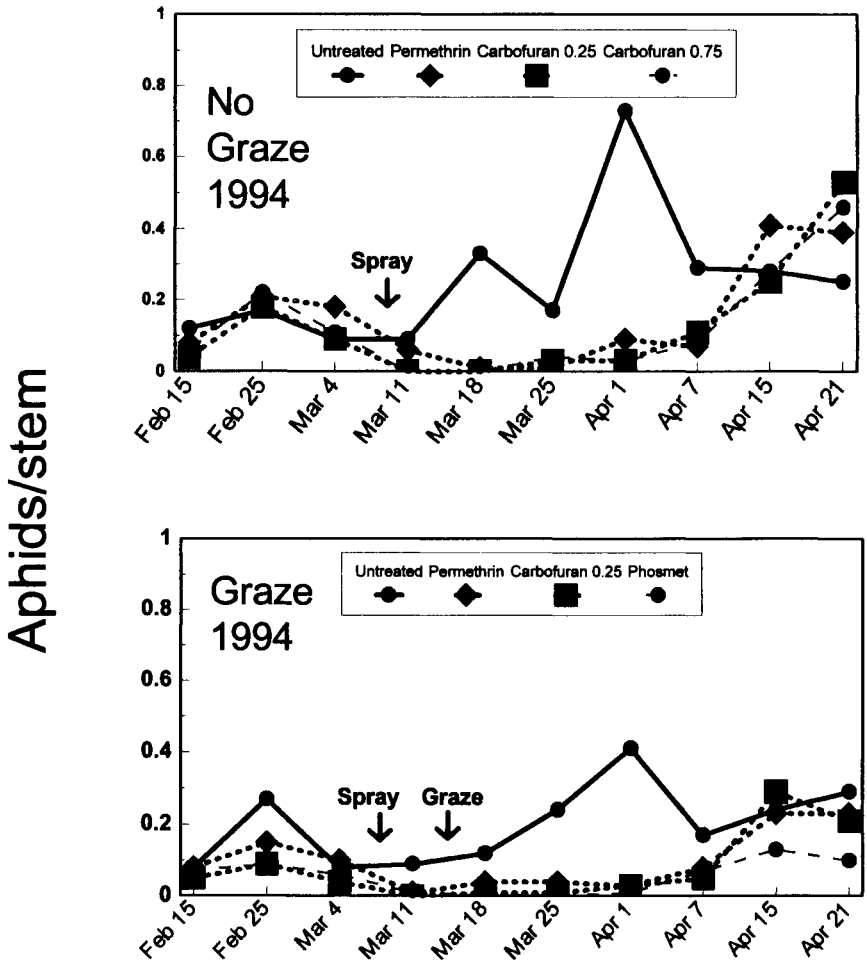


Fig. 2. Effect of grazing on aphid numbers in alfalfa in 1993. Average of two varieties. Contrasts are: C1 – graze vs. no graze, C2 – untreated vs. treated, and C3 – permethrin vs. carbofuran @ 0.28 kg (AI) /ha; * indicates significant contrast F value on a given sample date ($P < 0.05$).



C1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
C2	ns	ns	ns	*	*	*	*	*	ns	ns
C3	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Fig. 3. Effect of grazing on aphid numbers in alfalfa in 1994. Average of two varieties. Contrasts are: C1 – graze vs. no graze, C2 – untreated vs. treated, and C3 – permethrin vs. carbofuran @ 0.28 kg (AI) /ha; * indicates significant contrast F value on a given sample date ($P < 0.05$).

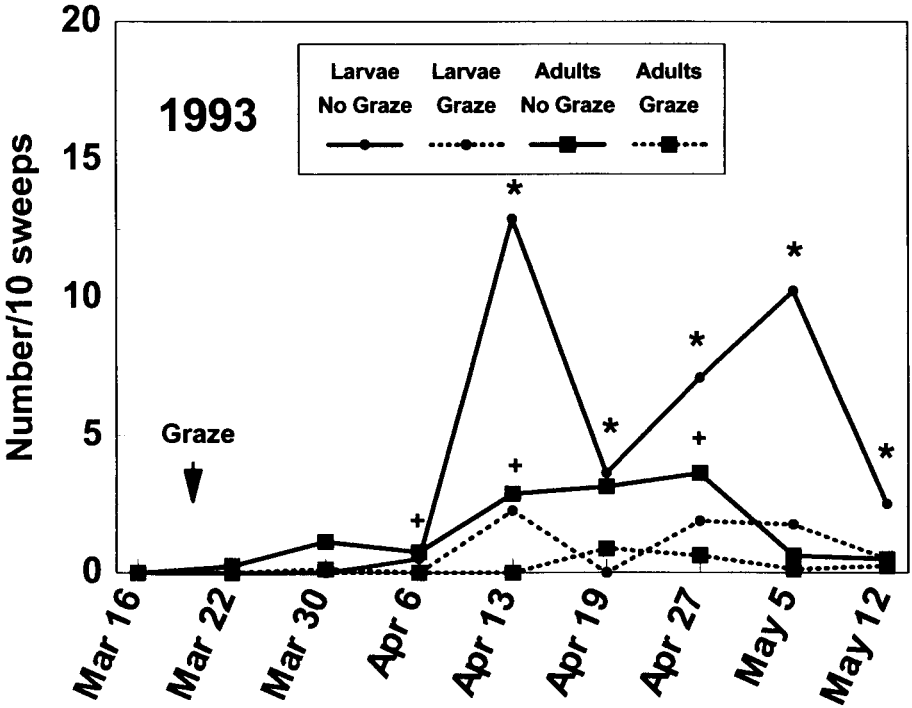


Fig. 4. Response of coccinellid larval and adult numbers to grazing of alfalfa in 1993; * and + indicates significant difference between mean numbers of larvae and adults, respectively, on a given sample date ($P < 0.05$; LSD).

Grazing did not reduce aphid numbers in 1991 and 1994 when populations were below 1 aphid per stem. Permethrin at half the standard rate also was very effective at reducing aphid numbers, whereas carbofuran was less effective. Although, aphid numbers were reduced the most by a combination of an application of permethrin followed by grazing, aphid infestations were effectively controlled by grazing alone. However, aphid populations never exceeded ~10 aphids per stem in any year which is well below the economic threshold for pea aphids of 40 aphids per stem for stems measuring ≤25 cm (Hudson and Buntin 1996). It seems likely that grazing by cattle would be effective in suppressing economic infestations of pea aphid, but this should be examined further.

Coccinellid numbers also were much lower in grazed than ungrazed plots in 1993, presumably because they mostly colonized ungrazed plots where aphids were present. Coccinellid numbers were low in all plots in 1994, but generally

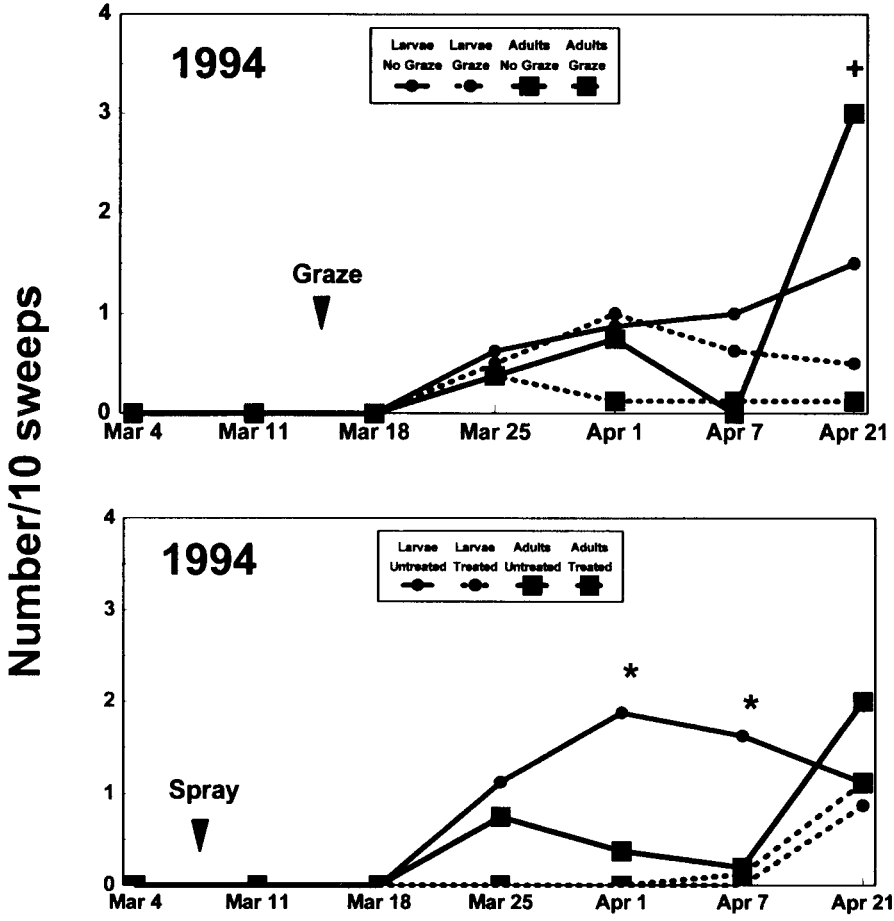


Fig. 5. Response of coccinellid larval and adult numbers to grazing (top) and permethrin applied at half the standard rate (bottom) to alfalfa in 1994, * and + indicates significant difference between mean numbers of larvae and adults, respectively, on a given sample date ($P < 0.05$; LSD). Solid lines are no graze or untreated; dashed lines are graze or treated.

were greatest in plots having the highest aphid numbers. This is consistent with previous studies (e.g., Ives 1981, Fraser et al. 1981) in that coccinellids most likely responded to differences in aphid populations between treatments rather than to the direct effect of grazing. Therefore, pea aphid infestations can be managed by grazing with cattle without adversely affecting coccinellid activity and natural regulation of aphid populations in alfalfa.

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