Impact of Pest Herbivores on Weeds

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Does damage to one plant affect neighboring plants? An elementary understanding of plant competitive interactions suggests that it does. What if the affected plant is a crop or other desirable vegetation and the neighboring plants are weeds? Specifically, what types of impacts do pest herbivores have on weeds? In this case, a pest herbivore is any biological organism (i.e. insect, disease, or vertebrate) that selectively feed or infects the desired plant with little or no impact on the weedy neighbors. For a subject that seems so intuitively obvious, there is very little in the published literature, especially the agronomic literature that documents or substantiates this phenomenon, so some of what is presented here will be based upon observations and anecdotal accounts.

The best papers on this subject are studies of insect damage to crops, mostly alfalfa, which resulted in increased weed growth in subsequent harvests. A review of this subject by Norris and Kogan (2000) cites several papers that verify the indirect impact of alfalfa weevils on weeds because of the deleterious effect on the crop. In a paper by Berberet, Stritzke, and Dowdy, (1987) the authors demonstrated that using an insecticide to control alfalfa weevil not only reduced the percentage of grasses in the next hay harvest, the overall hay yield was higher (see Table 1). Alfalfa weevil is a serious defoliator of alfalfa. Similar studies conducted in California by Carl Schoner and Robert Norris (see Norris and Schoner, 1975 and Schoner and Norris, 1975 in Norris and Kogan, 2000) produced similar results. Buntin and Pedigo (1986) showed that the density of variegated cutworms feeding in alfalfa had a direct correlation to weed biomass in later hay harvests (see Table 2). The conclusion that is drawn from these types of experiments is that when a pest damages alfalfa, opportunistic weeds will grow more vigorously and produce more biomass.

Examples from annual cropping systems are more varied, depending upon when in the stage of crop development the insect feeding occurs and how severe the feeding injury is to the crop. Norris and Kogan (2000) cite studies in soybean, potato, and wheat where insect feeding on the crop resulted in increased weed growth. In other studies, however, insect damage to a crop did not affect the weeds, probably because it was too late in the season and the competitive relationships between the plants was already established. These studies suggest that there is probably a greater likelihood that competition will be shifted in favor of weeds when damage occurs during the 'critical period'. The critical period is a "window of time during which weeds must be removed or suppressed to avoid yield loss at harvest" (Radosevich, et al.1996, pg 205). This critical period starts sometime after crop emergence and ends after a certain stage of crop development.

Another excellent review of herbivory and plant competition is provided by Louda, Keeler, and Holt (1990). Again, most of the examples are insect related studies, illustrating how insect feeding on one plant species can increase growth of a competitive species. One study citing a nematode-plant competition interaction is reviewed. In this experiment (a replacement series) oats were able to out-compete barley when grown together, except when a nematode that fed just on oat roots was present.

An unpublished experiment conducted by the author provides an example of how plant diseases can influence weed growth. In this experiment, yield samples were collected from the same plots in several alfalfa fields at the first through the fourth cutting (February to July). When the alfalfa was separated from the summer annual grasses infesting the fields, an interesting and pertinent correlation was discovered. This was that the yield of alfalfa in February, before the grass had germinated in the field, would predict the yield of the grass infesting the plot in July. The correlation coefficient in this experiment was about -0.8, meaning that about 80% of the variation of the grass biomass is predicted by the alfalfa biomass 5 months earlier. Another way to view this result relevant to weed/crop competition is that as the alfalfa yields decreased, the grass yield increased. The loss of stand (crop population) in alfalfa in the low desert is typically caused by fungal root diseases, facilitated by water-logged soils, that debilitate the alfalfa over the two to four years that a crop generally lasts. Within any alfalfa field, areas will stay healthy and others will die, with lots of gradation in-between. The healthy areas will not have any grass and the weak areas will be weedy.

Examples of the relationship of vertebrate pests and weeds are hard to come by. There is lots of literature on the how grazing by large herbivores (e.g. sheep, cattle, horses) can increase or decrease the weediness of pastures or rangelands (see Bell, et al, 1996 and Harker, et. al, 2000). The grazing animal, however, is not a pest, it is the 'crop', and the premises of this paper is the impact of a pest herbivore on weeds. The author has seen incidents where gopher mounds in alfalfa fields are visible in the summer because of weedy grasses that infest the bare areas that resulted from the feeding damage of the pest. Since all herbivorous vertebrates feed selectively on some plant species in preference to others, there are undoubtedly many examples of vertebrate pests that increase weed populations because of the damage caused to the crop or desirable vegetation.

Louda, Keeler, and Holt (1990, page 420) present their reasons why selective or pest herbivory alters competition between plants. Their premise is that "herbivory can change the ability of a plant to acquire limited resources by altering key morphological traits". According to the authors, "herbivory may also change (1) internal allocation of resources, (2) root: shoot ratios, (3) nutrient turnover rates, and (4) litter accumulation", which can influence plant growth and development. The review by Louda, et al. focuses on plant competition in natural environments, which differs from the Norris and Kogan paper that discusses agricultural settings. The principals remain the same, but the desirability of the outcomes can be different. In a natural environment, there may not be any real interest in one plant "winning" the competition like there is in agriculture. But the invasive plant issue, i.e. weeds of natural areas, is of interest to this society. Louda, Keeler and Holt (1990) present a comprehensive conclusion for the role of pest herbivory on weed growth when they say, "The evidence suggests that, if competition for limited resources vary in either direction among co-occurring plants, then herbivores could be critical in the determination of relative competitive ability. In such cases, herbivory leads to patterns in the plant community that would be unlikely in the absence of herbivory."

Table 1. The influence of alfalfa weevil control on weed yield in alfalfa.

	1981			1982		
Treatment	Hay yield MT/ha	Weeds Percent	Alfalfa yield MT/ha	Hay yield MT/ha	Weeds Percent	Alfalfa Yield MT/ha
Insecticide + Herbicide	12.2	3.9 a	11.7 a	9.3 a	2.1 c	9.2 a
Insecticide only	12.5	11.1 b	10.9 a	10.1 a	23.8 b	8.1 ab
Herbicide only	10.6	4.6 a	10.0 a	8.0 b	2.2 c	7.8 b
Untreated control	11.7	17.0 c	9.2 b	7.6 b	43.6 a	4.6 c

Numbers followed by the same letter in a column are not significantly different (DMRT.05).

Table 2. How increasing variegated cutworm (VCW) density in alfalfa increases weed yield.

VCW density Numbers/0.1 meter square	Alfalfa yield Kg/ha	Weed yield Kg/ha
0	4805 a	219a
1.5	4037 ab	311a
3	4322 ab	429 a
6	4180 ab	612 ab
9	3232 bc	836 bc
12	2594 c	1199 c

Numbers followed by the same letter in a column are not significantly different (DMRT.05).

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