# INFLUENCE OF NITROGEN LEVELS ON COTTON PLANT/INSECT INTERACTIONS IN A CONSERVATION TILLAGE SYSTEM

D. M. Olson[1], S. C. Phatak[2] and W. J. Lewis[1]

*AUTHORS:* [1] USDA-ARS, Insect Biology and Population Management Research Laboratory, P. O. Box 748, Tifton, GA 31794, [2]University of Georgia, 100 Horticulture Department, Coastal Plain experiment Station, Tifton, GA 31794. Corresponding author: D. M. Olson, Email: dolson@tifton.cpes.peachnet.edu

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## INTERPRETIVE SUMMARY

A total system approach to pest management requires that we consider crop plants as active components of multi-trophic interactions. Plants can have both direct and indirect defenses against herbivores and pathogens and these defenses can be affected by plant nutrition and other environmental factors. Examples of direct defenses are production of toxins or digestibility reducers, or through physical defense by trichomes or toughness, or by a combination of the two, as with glandular trichomes or resins. Indirect defenses are when a plant benefits from the natural or applied enemies of herbivores. Indirect defenses may be brought about by the attraction of the natural enemy species to damaged plants that have been induced to produce and emit volatile chemical signals in response to herbivory. Evidence from a field test of induced resistance to herbivores and plant fitness, indicate that previous damage by herbivores decreases subsequent herbivory and enhances the seed mass of radishes. This field test did not examine plant nutrition effects on herbivory and plant fitness, and recent studies indicate that these can have a large effect on a plant's ability to produce direct and indirect defenses against herbivory. Recent evidence suggests that high nitrogen levels decreases the release of induced chemical volatiles from damaged cotton plants and the subsequent attraction to these plants by *Microplitis croceipes* (Cresson) a parasitoid of major cotton pests, *Helicoverpa zea* (Boddie) and *Heliothis virescens* (Boddie). In addition, although these cotton plants maintained their ability to produce antifeedants under all nitrogen levels tested, the high nitrogen plants received significantly higher leaf area damage than low nitrogen plants. Thus, awareness of plant effects on multi-trophic systems is essential in integrating plant breeding and biological control using natural enemies.

Experiments were conducted to test the effects of various nitrogen levels in a cotton field conservation tilled with plants previously damaged and not previously damaged by *Spodoptera exigua* (Hübner) larvae on the abundance of pests and predators, fruit production and damage, and total plant yield. A more focused study involving fitness effects of species showing strong response to these treatments will be the subject of subsequent field studies.

There was a general pattern of increasing numbers of *H. zea* and *H. virescens* eggs with increasing nitrogen. In addition, previous plant damage had a significant effect on the number of eggs found only at the higher nitrogen levels. As a result of these ovipositions, the larvae of these species also follow this general trend. It is not clear what the mechanism(s) is that allows for increased presence of these species on damaged plants in high nitrogen plots. Predation/parasitism of eggs and larvae may be lower on high nitrogen plants that had been previously damaged, and/or moths may be responding to differences in the chemical/visual properties of high nitrogen plants that had been previously damaged. Plants were taller in the highest nitrogen plots and previous reports indicate that several lepidopteran species prefer to lay their eggs on taller plants with high nitrogen. However, this cannot explain the preference for the previously damaged over the previously undamaged plants. If we assume that high nitrogen plants in our study were compromised in their ability to attract natural enemies and of moths to detect the previous damage, then oviposition should have been similar on damaged and undamaged plants. If higher nitrogen plants that had been previously damaged are not so compromised, then we would expect parasitism of eggs and larvae to be higher and that adults would avoid laying their eggs on these 'activated' plants. We did not assess predation/parasitism of eggs and larvae in this study and the eggs had not hatched at the final sampling. Further investigations of *H. zea* and *H. virescens* responses to higher nitrogen and previously damaged plants and the effect on their survival will be the subject of subsequent studies.

Aphids increase in numbers with nitrogen but at the highest nitrogen levels they begin to decline producing a dome shaped distribution across nitrogen amounts. The distribution of fire ants closely followed that of aphids. It may be that aphids respond to nitrogen in a linear manner and that the population on the highest nitrogen plots began to crash at an earlier date. Aphids did not respond to previously damaged or undamaged plants across the nitrogen levels examined.

Total fruit production and damage was highest in the plots with the highest nitrogen, but neither fruit production or damage was influenced by previous plant damage by *S. exigua*. The yield across all nitrogen levels, even in the plots where no nitrogen was applied (crimson clover only) were not significantly different.

Lacewing eggs follow the same pattern as *H. zea* and *H. virescens* eggs and larvae. More lacewings eggs were found on higher nitrogen plants that had been previously damaged. As a result of these ovipositions, the number of larvae and pupae of these species also follow this trend. Very few lacewing larvae or pupae were found throughout the season compared to the number of eggs that were found. Lacewing eggs hatch in 3-4 days which suggests high larval and pupal predation early in the season. The lacewing eggs found later in the season had not hatched at the time of final sampling. Therefore, further investigations of lacewing responses to higher nitrogen and previously damaged plants and the effect on their survival will be the subject of subsequent studies.

There was a strong interaction between nitrogen, previous plant damage and the insect species present with a general pattern of increased fruit damage on higher nitrogen plants. Based on an earlier study showing that plants could improve their fitness through previous damage by attracting parasitoids of the pest species, we would expect to find decreased oviposition on previously damaged plants. We found higher oviposition in the case of *H. zea* and *H. virescens* and lacewings. However, this preference was more the case with high nitrogen, thus indicating that the nature of plant signals may have been altered by nitrogen rates in such a manner that the pest perceives a weakened plant and the predator perceives higher numbers of prey.

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