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INTERCROPPING PECAN ORCHARDS WITH LEGUMES: ENTOMOLOGICAL IMPLICATIONS

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Conservation of natural enemies is achieved in certain crops by reducing the risks to natural enemies of low plant diversity and insecticide toxicity in the crop. Predators of the pecan aphids are conserved by intercropping the orchard floor and selective insecticides. Recent research has indicated that: the aphidophaga are more abundant in the orchard floor when intercrops are present; ants tending pecan aphids reduce predator populations; ladybeetles can be attracted from the intercrop into the tree crown. However, the response of pecan aphid populations is quite variable to intercrops, predator attractants, and insecticide barriers to partition red imported fire ant foraging. Insecticides commonly used in pecan pest management are highly toxic to ladybeetles. Lacewings have some tolerance to the insecticides. The resurgence response of pecan aphid populations to carbaryl and other insecticides occurs whenever these materials are applied against nut pests. Biological control of pecan aphids was attempted by enhancing aphidophaga with a series of relay intercrops planted in the tree rows between the herbicide strips. Intercropped orchards had more aphidophaga on the orchard floor than mowed sod. Pecan aphid populations were reduced in some orchards, particularly, during the initial logarithmic increase phase of aphid population development. Consistent reductions in pecan aphisd will require more aggressive conservation methods.

When organophosphate and carbamate insecticides became ineffective for control of pecan aphids in the late 1970's. The pyrethroids, fenvalerate and cypermethrin were developed for broad spectrum insect control. The development of resistance in pecan aphids to pyrethroid insecticides (Dutcher and Htay 1985) and the sparse number of chemical alternatives led to an increased interest in host plant resistance and biological control and more effective placement of systemic insecticides (Dutcher and Harrison 1984). Host plant resistance is evident in a few cultivars (Kaakeh & Dutcher 1994) but is difficult to implement in established orchards of susceptible cultivars. For these locations research has focused on enhancement techniques for native aphidophaga (naturally occurring insect predators and parasites of the pecan aphids). Low plant diversity and insecticide toxicity are the main risk factors to predatory insects in many cropping systems and conservation of predators can be achieved by many techniques (Dutcher 1993) that reduce these risks. The problem with relying on native aphidophaga alone for control of pecan aphids is that they arrive after the pecan aphid populations have caused a considerable amount of damage. The pecan aphids have high rates of natural increase (Kaakeh and Dutcher 1992a) and aphid populations quickly outpace the predator populations before biological control is achieved. Intercrops can be used to raise alternative prey aphids and in turn raise aphidophaga. Legumes as intercrops have the added benefits of improving the soil and controlling weeds and these are balanced by the risks of bringing kernel-feeding Hemipterans and possibly root-feeding nematodes into the orchard. They also may compete with the pecan tree for nutrients in the soil. These risks are minimized when the intercrops are harvested before they set seed and planted in the middle of the sod strip in the tree row.

Pesticides applied to control nut-feeding insect pests are highly toxic to the aphidophaga (Hurej and Dutcher 1994a and 1994b, Mizell and Schiffhauer 1990) and aphid diseases (Pickering et al. 1990). Resurgence of aphids following the application of pesticides is quite common (Dutcher and Htay 1985). Pecan aphid control options include: preventive control with the systemic insecticide, aldicarb, applied to the soil; foliar sprays of insecticidal soap, methomyl, disyston or endosulfan or dimethoate when aphids increase to an injurious level; enhancement of natural biological controls. Preventive treatment with aldicarb offers good aphid control but rainfall may reduce the residual efficacy. Foliar sprays have mixed efficacy between orchards and between seasons. Native biological controls are not reliable or may not be present in sufficient populations to control pecan aphids. Abiotic factors, particularlytemperature extremes (Kaakeh and Dutcher 1992) and rainfall Kaakeh and Dutcher 1993) can regulate pecan aphid populations but are not reliable.

Conservation of natural enemies with intercropping shows some promise. The type of plants used as intercrops in pecan orchard effect the densities of alternate prey aphids and aphid predators on the orchard floor (Bugg and Dutcher 1989, 1993, Bugg et al. 1990). A full season intercropping strategy has been proposed (Bugg et al. 1991). Up until this time the intercropping had little or no effect on the density of pecan aphids in the tree. In fact, there was some indication that an alternate prey aphid population in the intercrop could attract predators out of the pecan tree if both pecan aphids and alternate prey aphids were present at the same time (Bugg and Dutcher 1989). Also, red imported fire ants, when tending an aphid infestation to obtain honeydew, are important regulators of aphid predators either in the intercrop (Bugg and Dutcher 1989) or in the tree (Tedders et al. 1990). A more aggressive orchard floor management scheme was tested during 1993 and 1994 in Sumter Co., Georgia and the first years results are reported here. In this study, tree trunks were treated with chlorpyrifos to prevent ant foraging in the tree and intercrops were cut when pecan aphids became abundant.

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METHODS AND MATERIALS

An experiment was set out to measure the impact of intercrops on the abundance of pecan aphids and beneficial insects in Sumter Co. The site had intercrops of the hairy indigo, *Indigofera hirsuta* and hemp sesbania, *Sesbania exaltata*, sown into the sod in mid-June (at a seed rate of 12 kg/ha of actual tilled area) as summer annuals in 2.6 m wide mowed strips between the tree rows with a no-till planter of pecan orchard to determine the ability of the intercrops to provide alternate prey items for general predators that feed on pecan aphids. The strips were mowed with a sickle bar mower in mid- September to prepare the orchard as a harvesting surface. The intercrops were planted among trees with and without chlorpyrifos barrier (Lorsban 4E (Dow Chemical Co.) at a concentration of 20 ml formulation per liter) sprayed on the trunk to prevent foraging of the red imported fire ant in the trees. Pecan aphids and associated beneficial insects were sampled on two consecutive days each week so that population size and relative growth could be estimated.

RESULTS AND DISCUSSION

At Sumter Co., in 1993, hemp sesbania sustained low populations of the greenhouse whitefly and cowpea aphid during the early fall and these were associated with a convergent lady beetles. We did not attract significant populations of the sevenspotted ladybeetle, *Olla v-nigrum*, or *Harmonia axyridis* (Coleoptera: Coccinellidae) to the intercrop. Hairy indigo grew very poorly at the Sumter Co. site. Red imported fire ant foraging was high in the trees and on the ground during the entire season. The intercrops were cut in the second week of September and the pecan aphids responded in several ways. The combined populations of yellow pecan aphid and blackmargined aphid (Figs. 1-11) peaked and declined from mid-September to mid-October (Day 257 - 286) in the intercrop and fire ant exclusion treatments. As aphid populations in the Schley trees first started to increase populations were higher were ants were foraging in the tree (Fig. 2) and there was no intercrop effect. On the same day in Stuart trees the aphids were lower in the trees with intercrops and ants did not have an effect. On the following day (258, Fig. 3) there was a significant effect of ant and intercrop treatments that was the most consistent of any of the sample dates. Here, the pecan aphids in both varieties were highest when both ants and intercrops were not present, otherwise, aphids were low. One week later on Day 264 (Fig. 4) there were no apparent differences between treatments with respect ot pecan aphid density. On day 265 (Fig. 5) trees without ants had fewer aphids. On the next to sample date (271, Fig. 6) aphids were significantly higher in the Stuart than in the Schley trees. On Day 272 (Fig. 7), a consistently large population of aphids occurred in the 'Stuart' trees with intercrops and without ants. During Days 278 and 279 (Fig. 8 & 9) only variety differences were significant. Then on Day 285 (Fig. 10) in Schley trees pecan aphids were higher with ants and without intercrops. In the Stuart trees pecan aphids were higher without ants and with intercrops than in any other treatments. Finally, on Day 286 (Fig. 11) there were no significant differences in aphid density, sexual forms were common on all trees and parthenogenetic populations were declining. These results can be interpreted in several ways but indicate that an even more aggressive set of treatments, such as a relay cropping scheme (Fig. 12) need to be applied to acheive consistent reductions in pecan aphids. In 1994, attractants were applied to the pecan trees to move ladybeetles into the trees while the intercrops were in the field. The effects of these treatments will be the subject of another article.

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