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Project report submitted to the Organic Farming Research Foundation:

Project Title:

Habitat manipulation to improve biological control in apple orchards

FINAL PROJECT REPORT

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Overview

This project will assess the impact of perennial flowering habitat plantings on biological control of several insect and mite pests of apples. This document reports our progress during 1995, the first year of this 3 to 4 year study. During 1995, plant species were chosen and the habitat plantings were established at two commercial apple orchards in Wisconsin; one orchard is certified organic and the other is managed using conventional IPM practices. To date, no insect sampling has been conducted.

Plant Selection

We chose to use perennial rather than annual plants for this study primarily because they should involve substantially less management in the long term. Plantings of annual plants would require yearly seedbed preparation, planting, and cultivation early in the growing season when orchardists have many other demands on their time. Unfortunately, most published information on plants attractive to beneficial insects refers to annual plants. We therefore had to choose plant species based on criteria other than known attractiveness to beneficial insects. Specifically, we considered:

1) Taxonomic relation to plants known to be attractive to beneficial insects. 2) Flower morphology, especially depth and width of corolla. 3) Adaptation to soil type, soil moisture, climate, and light requirements. 4) Management requirements, such as dead heading, division, staking, etc. 5) Timing and duration of blooming period.
6) Potential to serve as alternate host plants for known pests of apple. 7) Presence of extrafloral nectaries.

Based on these criteria, we decided to use the plant species listed in Appendix 1. Interestingly, all but one (lovage) of the species chosen are native prairie wildflowers. This was a result of considerations 3 and 4 above.

Changes to Proposed Experimental Design

After consultation with a statistician and the participating orchardists, several modifications to the proposed experimental design were necessary. First, we decided to conduct the majority of the research at the organic orchard and only replicate a portion of the study at the conventional orchard. To increase statistical power, we increased the number of replicates of the habitat plantings from 8 to 16. Since apple variety changes every two rows throughout most of the organic orchard, we decided to establish additional large plantings in two single variety blocks of trees isolated from the rest of the plantings. These blocks will be used to determine the spatial effects of the habitat plantings, since distance from the planting will not be confounded by different apple varieties. Only this spatial effects study will be conducted at the conventional orchard. Since preliminary sampling showed that pest mites were quite uncommon in this orchard, we decided to sample leafrollers and their natural enemies rather than mites and their natural enemies. Aphids and spotted tentiform leafminers and their respective natural enemies will also be sampled as intitially proposed. Finally, the manager of the organic orchard chose to have the habitat plantings located in the middle of the grass alleys rather than in the tree rows. Plantings at the conventional orchard were placed in the tree rows as originally proposed.

Establishment of Habitat Plantings

A sequence of tillage and cover crops was begun in late summer of 1994 to reduce pressure from perennial weeds. In locations where habitat plantings were to be established, the entire grass alley was plowed, tilled and sown to buckwheat. After approximately 7 weeks, this was chopped and plowed in, and winter rye was sown. In early June, as the rye reached boot stage, it too was chopped. The plots were tilled in late June in preparation for transplanting of the habitat plants.

Seeds of the habitat plants were obtained from commercial sources. Seed dormancy was broken through a pretreatment with plant hormones (gibberellins) followed by a 2-3 week cold stratification. In mid-March, 1995, seeds were then sown in seedling flats, which were kept on propagation benches in the greenhouse. As seedlings became well-established, seedling flats were moved to standard greenhouse benches. Seedlings were transplanted individually to deep tube growing trays, which provide for substantial root development in a conical plug. Approximately 1300 of each species were grown. In late June, most of the plants were ready to be transplanted, and were transported to the orchard. Each planting consists of 2 rows of plants, with 30 cm spacing both within and between rows. Plant species are arranged in a consistent order throughout the orchard, and the two rows in a single planting are staggered by 5 plants. All transplanting was done by hand. Water was provided using hoses attached to the pump of an old air blast orchard sprayer. Unfortunately, 1995 had the hottest summer on record in Wisconsin, combined with a six week drought. This required us to spend additional time replacing plants that failed to establish. In late August, the soil surrounding each planting was tilled again, and perennial ryegrass was broadcast and raked in. This non-invasive grass is intended to slow the encroachment of weeds while providing a functional work surface for orchard management operations. Hand weeding and hoeing was conducted throughout the summer as necessary. Excess plants were planted in large rectangular beds in isolated parts of the orchard. These plants, along with additional plants started in the greenhouse in February of 1996, will be used to replace plants that failed to survive the winter.

Goals for 1996

Intensive insect sampling will be conducted on the apple trees on both sides of the 16 replicated habitat plantings and on the trees that comprise the paired control plots. Specifically, we will be recording abundance of the three target pests (aphids, tentiform leafminers, and leafrollers) and associated damage. Natural enemy abundance will be assessed directly through timed visual counts, and indirectly, by rearing pests to determine parasitism rates. Natural enemies will also be sampled in the habitat plantings, and particular natural enemies will be caged on flowers to assess the effects of floral resources on natural enemy fecundity and longevity. At intervals throughout the season, the spatial effects of habitat plantings will be examined by sampling trees at several distances from the large spatial effects plantings. In addition, an undergraduate student will be conducting a small research project on pest mites and their natural enemies in both orchards. Finally, weeding, plant replacement, and other plot maintenance will be conducted in the habitat plantings as necessary.

Appendix 1: Plant Species Selected for Use as Natural Enemy Habitat

Scientific Name	Common Name	Plant Family
Asclepias tuberosum	butterfly weed	Asclepiadaceae
Aster ericoides	heath aster	Asteraceae
Coreopsis palmata	prairie coreopsis	Asteraceae
Echinacea purpurea	purple coneflower	Asteraceae
Eryngium yuccafolium	rattlesnake master	Apiaceae
Euphorbia corollata	flowering spurge	Euphorbiaceae
Heliopsis helianthoides	oxeye sunflower	Asteraceae
Levisticum officinale	lovage	Apiaceae
Potentilla arguta	prairie cinquefoil	Rosaceae
Tradescantia ohioensis	spiderwort	Commelinaceae
Zizia aurea	golden alexanders	Apiaceae