PROGRESS REPORT - CSANR Organic Cropping Research for the Northwest

Title: Nitrogen Supply and Partitioning in Managed Understories of Organic Apples

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Abstract: Intense cultivation of the understory of organic orchard systems is a common practice used to control weeds. However, this can lead to a reduction in soil organic matter, degraded structure, reduced water infiltration and aerated pore space, and other beneficial soil characteristics for a robust apple crop. In addition, this can accelerate nutrient cycling and result in loss of valuable nutrients from the system. Alternative organic understory management practices that include reduced tillage with the use of a Wonder weeder, organically approved herbicide or residues with natural herbicidal abilities, wood chip mulch, and living cover mulches, have been identified as viable alternatives that may result in an increase in soil tilth and quality. However, these systems may alter nutrient cycling and partitioning. Thus, research is needed to determine N-use efficiency and optimize fertility guidelines in these systems. An integrated study was established in spring 2005 to address these issues. Three rates of nitrogen were applied as split plot treatments across Wonder weeder, wood chip and living cover mulch plots. A number of analyses are being performed on the soil, living cover mulch biomass and tree leaves to track N and C partitioning and cycling.

Objectives:

1. Determine the influence of understory management practices on the mineral nutrient status of organically managed apple trees.
2. Determine how understory management practices influence N and C partitioning between covercrop and soil components in organic apple orchards.
3. Develop an extension publication on organic orchard floor management alternatives for the Pacific Northwest.

Procedures to meet above objectives:

The trial was implemented in May of 2005 and is being conducted at the Wenatchee Valley College organic orchard research site in East Wenatchee, WA.

Orchard floor management strategies include: no disturbance + Matran herbicide, no disturbance + wood chip mulch, minimal disturbance with integration of Brassicae seed meal residue, reduced disturbance through the use of a Wonder weeder, and living cover mulch crops previously identified by Granatstein et al. (2004) as producing sufficient biomass and effective weed control ability (Table 1). The living cover mulch crops are either planted on the entire plot or limited to a strip within the tree row in a "sandwich" system. Each wood chip, Wonder weeder, and living mulch strategy is split into 3 subplots to compare 3 rates of N application. In addition, small plots with zero fertilizer amendments were included.

Table 1. Summary of treatments in Integrated Multiple Mulch Trial

Weed Control	**fertilizer**	**Starter N**
No disturbance (flame-weed or herbicide)	*0 - MINI-PLOTS !*	0
No disturbance (flame-weed or herbicide)	1x chicken manure compost	1x
No disturbance (Brassicae seedmeal)	0.5x chicken manure compost	0.5x
Wonder weeder	0.5x chicken manure compost	0.5x
Wonder weeder	1x chicken manure compost	1x
Wonder weeder	1.5x chicken manure compost	1.5x
Wonder weeder	1x mint compost	1x mint
Wood chips	1x chicken manure compost	1x
Wood chips	1.5x chicken manure compost	1.5x
Living mulch - legumes	0	0.5x
Living mulch - legumes	0.5x chicken manure compost	0.5x
Living mulch - legumes	1x chicken manure compost	1x
Living mulch - non-legumes	0.5x chicken manure compost	0.5x
Living mulch - non-legumes	1x chicken manure compost	1x
Living mulch - non-legumes	1.5x chicken manure compost	1.5x
Sandwich - legumes	1x chicken manure compost	1x
Sandwich - non-legumes	1x chicken manure compost	1x

The integrated apple trial was established on land taken out of cherry production early in spring 2005. This consisted of stump removal, disking and subsequent planting of young apple transplants, living cover mulches and grassed alleyways. A new fertilizer system was installed. Wood chip mulch and Bio-gro fertilizer at appropriate rates were subsequently applied. Extensive irrigation was applied early in the season to facilitate establishment of the living cover mulch plants. Due to saturated soil conditions and establishment of the grassed alleys, hand hoeing was performed early in the season to simulate machine tillage by the Wonder Weeder. Brassicae residue was incorporated into soil of one treatment for comparison of its potential for weed control and N supply. All trees were cut back in June to stimulate root growth so that the transplanted trees could withstand wind pressure at the site.

By mid-July all trees in the research area appeared to be suffering from N deficiency. This may be due to leaching of the spring fertilizer application as a result of extra irrigation used to establish the living cover mulches and grassed alleys. Trees in the Brassicae treatment seemed to be slightly healthier than the other treatments, which may

have been due to the fact that this residue was applied later in the season and may mineralize slower (over a longer period) than the fertilizer applied in all other plots. To help the trees recover from deficiency, all trees were sprayed weekly with a foliar fertilizer. In addition, a high-N bloodmeal tea was injected into the root zone of each tree in September as an emergency treatment. This emergency treatment was applied at the three established relative N application rates. Visual estimates and data from SPAD readings indicate that most trees recovered from this deficiency. However, the living cover mulch plots still appear to be N-deficient.

Baseline soil samples were collected this spring prior to planting and air dried for analysis. Mid-season soil samples were collected alongside living cover mulch and associated weed biomass samples in July. The soil has been kept in storage at 4C and the biomass samples were oven dried and ground for subsequent analysis. A set of fall samples will be taken shortly. All soil and biomass sample analysis will be conducted this fall.

All living cover mulch plots were mowed biweekly beginning at the end of July to minimize competition with the tree. Soil cores are being sampled each spring, summer and fall to a depth of 10 cm; cover crop and associated weed biomass were sampled prior to their first cutting; and apple leaf tissue samples will be analyzed in 2006. Apple leaf tissue samples will be analyzed to determine sufficient or excess plant N, as well as 12 other mineral elements.

Pooled soil cores collected from the WVC orchard floor management site are in the process of being collected and analyzed. Dried, ground and sieved soil are being analyzed for total C and N using an automated combustion analyzer (LECO). Nitrate and ammonium concentrations will be determined using a Lachet automated colorimetric analyzer (Lachet Instruments Inc. Milwaukee, WI). Net N mineralization potential will be calculated as the difference between inorganic N content at the end of a 7-day anaerobic incubation period and day 0. Short and long-term carbon pools will be determined by CO_2 release during an extended incubation period. The active soil organic matter fraction (POM) will be quantified and analyzed for C and N (LECO). Cover crop and associated weed biomass will be analyzed for total dry weight, total C and N, and mineralizable N. Apple leaf tissue samples will be analyzed to determine sufficient or excess plant N.

Data collected from this study will be combined with extensive knowledge collected from PNW orchardists and researchers to construct an extension booklet on organic orchard floor management alternatives. The booklet will include information on weed control, economics and soil quality issues.

Progress towards objectives: The small living cover mulch plots established in 2004 were not sampled as originally outlined, as this would have caused too much disturbance. However, information obtained from this initial study was used to identity suitable species for the new expanded trial. Due to limited space, the N supply and partitioning trial outlined in the original grant was integrated into a new trial being implemented by Granatstein et al. concerning understory management alternatives. This new experimental design allows both teams of researchers to pool resources and gain a

more holistic understanding of the processes and mechanisms behind organic orchard floor management. It will also allow us to make observations concerning N and C partitioning given alternative orchard floor management strategies side by side, rather than trying to make a comparison among several different study sites as originally proposed. This will allow us to make more informed management recommendations to producers.

Initial data seem to indicate that we have been able to bracket the ideal N fertility treatment for the Wonder Weeder and wood chip mulch understory treatments. This will allow us to make specific management recommendations to producers. However, the living cover mulches appear to be highly competitive with the trees for nutrients. As a result, we will increase the rate of N applied in all living cover mulch treatments. Soil analyses will allow us to determine N and C partitioning and cycling at the site and make better recommendations for the 2006 growing season.

We feel that progress toward the stated objectives is on track after the first growing season. Formal information gathering for the extension bulletin will begin in 2006.

Outputs: The graduate student employed on this project attended two national meetings to discuss the on-going progress of this trial and gain insight into additional methodology. These included the National Organic Tree Fruit Symposium in Lake Chelan, WA and the bi-annual meeting of the American Society of Ecological Economics in Tacoma, WA.

Impact: Data from the study will allow us to determine how N and C are being partitioned and cycled under alternative organic understory management strategies. This will allow us to make more site-specific recommendations for growers transitioning to or currently in organic apple production in Washington and throughout the Pacific Northwest.

Institution: Washington State University: Department of Crop and Soil Sciences and Tree Fruit Research and Education Center

State: Washington

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