Effects of Ground Cover Management Strategies on Yield and Nitrogen Supply in Organic Apple Production Systems

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Abstract

Ground cover management strategies had a significant impact on yield and nitrogen supply in a young organic apple orchard. Living mulches increased organic N supply but resulted in low apple yields. A wood chip mulch resulted in good apple yields, tree growth and N supply. Other treatments resulted in good yields but low organic N supply.

Objectives:

1. Determine the influence of understory management practices on nitrogen supply and yield of organically managed apple trees.

2. Determine how understory management practices influence N derived from compost amendments.

Methods

Picture 1. CLT treatment

Picture 2. LMNL treatment (left) and WC treatment (right)

- An organically managed orchard was established in 2005 in East Wenatchee, WA
- Each treatment (Table 1) was fertilized with approximately 100 kg available N as compost and split into 3 equal applications/year (in April, May and June).
- ^{15}N enriched compost was added to the LML, CLT and WC treatments in 2006 and 2007.
- ^{15}N enriched trees were excavated and destructively sampled in September 2007 to determine N derived from compost.

Code	Treatment	Cover
CON	Unfertilized Control	Undisturbed bare ground
CHE	Control	Undisturbed bare ground
BHE	Brassicaceae seed meal	Undisturbed bare ground
CLT	Clean cultivation	Tilled-bare ground
WC	Wood chip mulch	Wood chip mulch
LML	Living mulch legume in tree row	birdfoot trefoil + bentgrass
LMNL	Living mulch nonlegume in tree row	Bentgrass, alyssum, thyme

Table 1. Breakdown of treatments and ground cover management strategies.

Results and Discussion

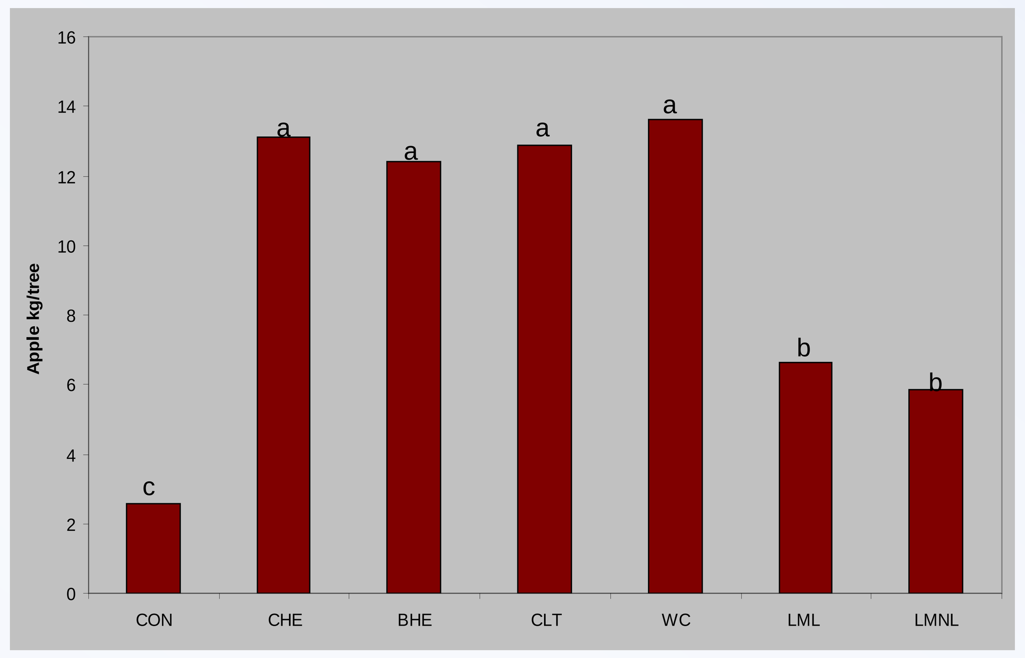

Figure 1. Kilograms of apples harvested/tree. September, 2007. ($p<0.05$)

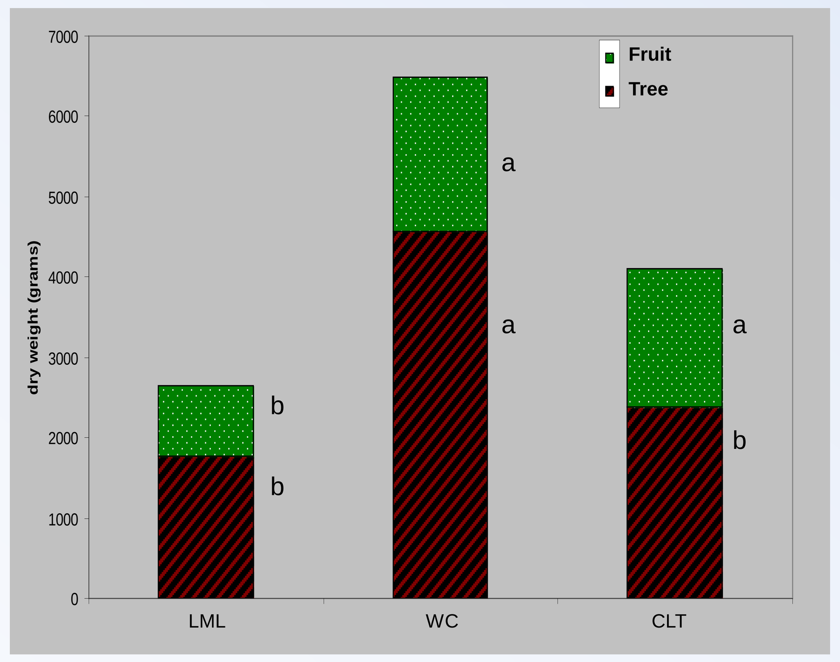

Figure 2. Total biomass (dry weights of tree and fruit dry weight) ($p<0.05$)

Treatment	Total Inorganic N (ppm)			Potentially Mineralizable N (ppm)		
	April	July	Sept.	April	July	Sept.
CON	5.6 abc	10.7 d	8.3 c	68.7 abc	22.7 a	27.7 bc
CHE	4.8 bc	48.3 bc	21.1 bc	51.2 c	-4.4 a	33.1 bc
BHE	8.1 ab	75.3 a	42.2 a	91.5 a	2.4 a	7.5 d
CLT	3.1 c	59.9 ab	31.6 ab	65.0 bc	-10.6 a	19.8 cd
WC	6.8 abc	28.3 cd	17.3 bc	70.8 abc	11.4 a	41.7 ab
LML	8.8 a	50.7 b	18.6 bc	85.7 ab	27.5 a	42.9 ab
LMNL	5.4 abc	18.7 d	11.4 c	89.3 ab	27.3 a	58.6 a

Table 2. Inorganic and potentially mineralizable nitrogen in soils. ($p<0.05$)

(-) Means that net immobilization of N occurred.

- Inorganic nitrogen was more prevalent in the BHE and CLT treatments, and less prevalent as PMN, along with CHE, indicating that N supply is less driven by microbial processes in these treatments and that N is more susceptible to leaching losses.
- WC, LML, and LMNL treatments had lower levels of inorganic N and higher supplies of PMN indicating that microbial processes and organic N are important sources of N supply for these treatments.

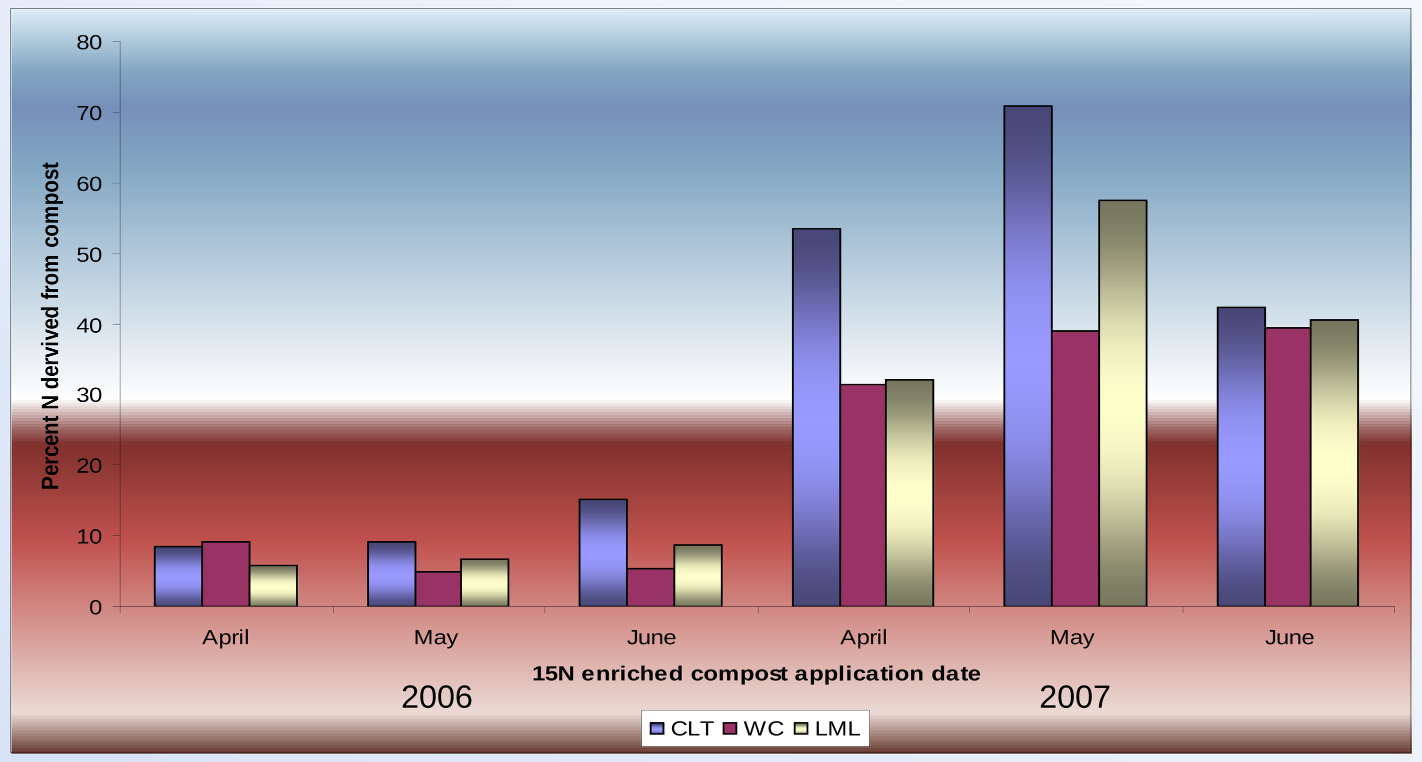

Figure 3. Percent of tree nitrogen derived from compost (NDFC) in trees at the time of destructive sampling (September 2007).

- The low NDFC values for all treatments in 2006 (Fig. 3) is most likely due to N lost in leaves at senescence.
- The NDFC is highest for CLT for all application dates, meaning that regardless of compost application date a higher percentage of tree N is derived from compost.
- Both LML and WC have lower NDFC indicating that more tree N comes from N sources other than compost.

Conclusions

- Living mulches had high N availability through biological processes (mineralizable N) (Table 2). However, this did not result in high yields (Fig.1) nor biomass production (Fig. 2).
  - This is most likely due to moisture competition between the living mulch and apple trees.
- Although inorganic N levels and yields (Fig. 1) were high under tillage, mineralizable N availability was low (Table 2). This coupled with a high percentage of NDFC (Fig. 3) indicates that very little N is supplied to the CLT by biological processes.
  - Tillage increased soil/compost contact likely resulting in aerating the soil, capturing NH_4, and causing rapid mineralization of available N.
- The wood chip mulch showed high levels of mineralizable N (Table 2), high yields (Fig 1) and biomass production (Fig. 2). NDFC (Fig. 3) is also low for WC. This data suggest that WC has the best balance of apple yield and N supplied through biological processes of any treatment.

Impact

Data generated in this study provides for a better understanding of the fate of compost derived N in organic apple production systems and how different ground cover management systems effect N supply to apple trees.

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