Apple-pomace Compost and Pre-plant Monoammonium Phosphate for Improving the Growth of Newly Planted Apple Trees

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In many orchards in the Northeast, early yield is limited by tree growth, and trees are typically not cropped until the third or fourth season because growth is not vigorous. Management practices that encourage rapid early tree growth and early fruit production result in economic advantages to growers by hastening a return on investment. Decreasing the time required for trees to fill their space would allow growers to increase early yields.

Increasing early tree growth can be accomplished by adding organic matter or phosphorus fertilizer to the planting hole. Adding compost as a source of organic matter to planting holes affected young apple tree growth in experiments in Massachusetts and Maine. Organic matter is often low in many existing orchard soils. Increasing soil organic matter improves its water and nutrient holding capacities, which enhances root regeneration and promotes overall tree vigor, but the effects of planting-hole treatments are most visible during the year of planting. As root growth extends beyond the volume of the planting hole, the effects of planting-hole treatments diminish. If organic matter amendments were broadcast throughout the orchard soil, perhaps the beneficial growth response could be sustained for a longer period. For pre-plant compost to be a feasible management practice, an economical, local source of compost must be available. University of Maine Cooperative Extension developed an apple-pomace composting project in cooperation with Chick Orchards in Monmouth, Maine. Apple pomace from the cider operation was mixed with leaf waste from the local waste transfer station, and chicken manure from a local egg farm at a 2:6:1 ratio by volume. Wood ash was used to adjust the pH to 5.8 prior to composting. Composting reduced the volume of apple-pomace waste by 50% and converted it into a soil amendment with highly desirable characteristics.

Newly transplanted trees have impaired root systems, so P fertilizer is often recommended for new plantings. Since P is very immobile in soil, this nutrient is more beneficial when it can be incorporated prior to planting. Research in British Columbia has shown that monoammonium phosphate (MAP 11-55-0) fertilizer, incorporated into the soil used to fill the planting hole, increased tree growth in the first 2years after planting and increased flower production and fruit set in the early years of the planting. The addition of MAP to the planting hole has become a common practice in B.C. orchards, especially when replant problems are anticipated. It has been suggested that root uptake or utilization of P may be more efficient in the presence of ammonium. Moreover, MAP could be influencing tree growth by providing N. This study was performed to determine if pre-plant-incorporated apple-pomace compost and MAP, either alone or in combination, would improve early apple tree growth and precocity.

Methods

This experiment was conducted at Highmoor Farm in Monmouth, Maine, on land which had been fallow for 6 years, but in continuous apple production for the previous 37 years. The soil was a fine sandy loam, with a pH of 6.8 and an organic matter content of 4.7% before the addition of fertilizer or compost. Macoun/B. 9 apple trees were planted using a tractor-mounted tree planter on May 1, 1998 into plots that had received one of the following combinations of pre-plant treatments: 1) urea fertilizer without compost; 2) MAP fertilizer without compost; 3) both compost and urea; and 4) both compost and MAP. Each plot consisted of three trees at a spacing of 6 feet between trees and 18 feet between rows. Cortland/B. 9 trees were planted as a buffer between plots. Prior to planting, MAP was applied to the plots at a rate of 332 lbs. per acre and urea at a rate of 79 lbs. per acre, so that each treatment received an equivalent amount of N (1.44 oz. per tree). Apple-pomace compost was spread over the planting strip and leveled to a uniform thickness of 4 inches. All plots were then roto-tilled to a depth of 6 inches. The trees were unfeathered whips, headed to a height of 28 inches at planting. The trees were attached to a galvanized conduit stake supported by a single wire at 7 feet. The trees were minimally pruned, and trained to the vertical axis system. Insecticides, fungicides, and herbicides were applied as needed.

Results

Tree growth was increased by compost, but not by MAP. Compost increased trunk diameter in the first two seasons, but by the third season, trunk diameter was similar in both plots (Figure 1). Annual shoot

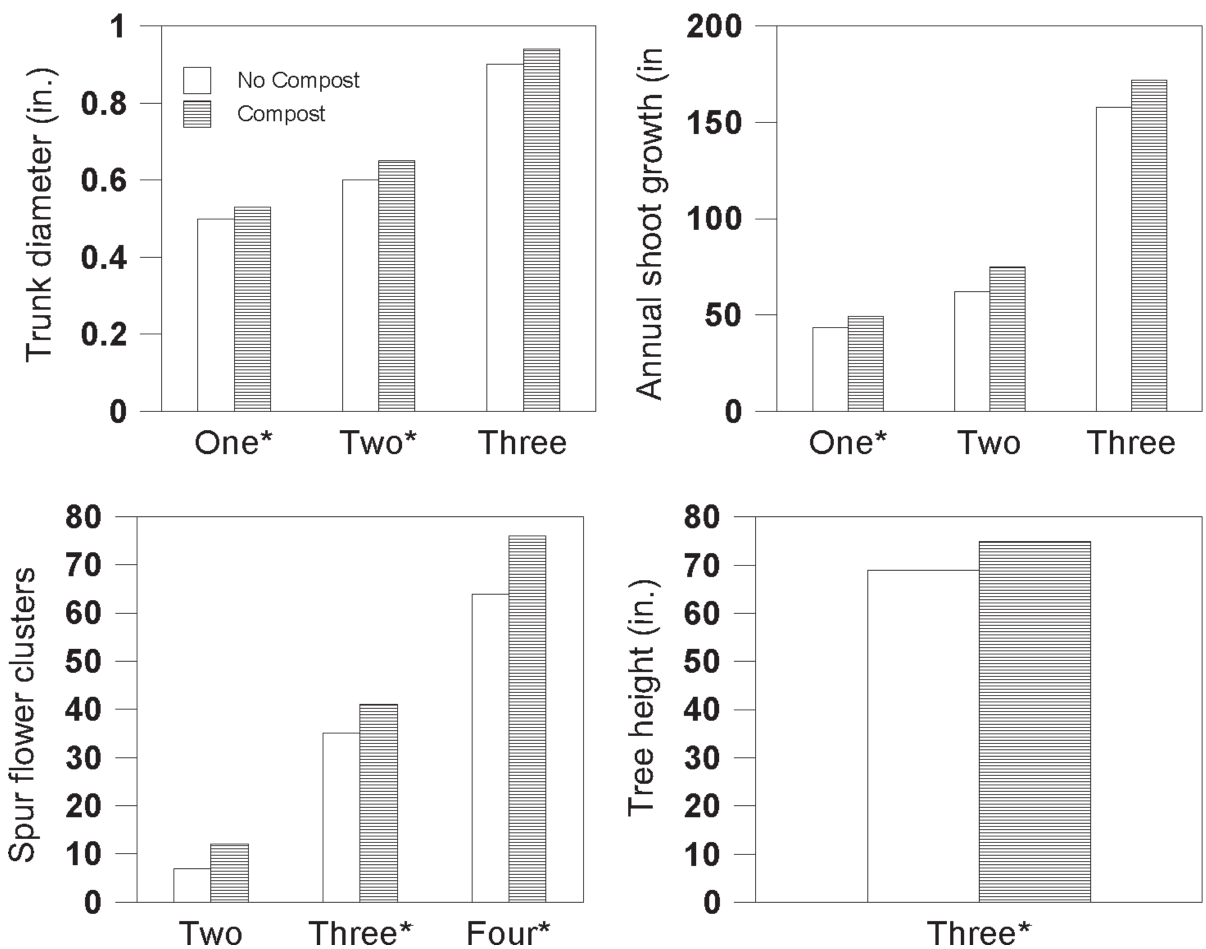

Figure 1. Tree growth characteristics with and without pre-plant-incorporated compost. * Indicates that compost had a significant effect in the indicated year after planting.

Table 1. Orchard soil properties following soil incorporation of phosphorous or apple pomace compost (year of planting).

Treatment	pH	Organic matter (%)	P (lbs / acre)	K (lbs / acre)	Mg (lbs / acre)	Ca (lbs / acre)
Urea	6.4	4.5	9.9	285	291	2144
MAP	6.4	4.4	13.0	272	301	2071
Compost-Urea	6.9*	5.3*	79.6*	679*	496*	3258*
Compost-MAP	6.8*	5.6*	86.8*	612*	457*	3093*

* Indicates a significant effect due to compost, at odds of 19 to 1.

growth was increased by compost in the first season, but not significantly in the second or third season. By the third season, tree height was greater with compost. Compost increased the amount of bloom. MAP had no effect on trunk growth, shoot growth, number of growing points, or tree height in any season of the study. We were unable to determine if the increases in tree size and flowering were large enough to increase early yield, because the trees did not attain sufficient size to permit cropping until after the third growing season. The trees in this study were on B.9 rootstock, which is less vigorous than M.9 EMLA, and may be insufficiently vigorous for spur-type varieties such as Macoun in northern New York and New England.

Tree growth was increased by pre-plant-incorporated apple-pomace compost, similar to results of other studies that showed organic matter added to the planting hole increased shoot growth and trunk girth. In those studies, the effect of planting hole treatments was no longer evident by the second or third season, and this result was attributed to roots growing beyond the planting hole. In our study, the effect of pre-plant organic matter on trunk diameter and shoot growth also diminished with time. The diminished effects observed in our study were possibly due to the depletion of soil K, Mg, and Ca (data not shown). Soil K in the compost plots was twice as great as in non-compost plots, but this difference was much smaller by the third season. Although trunk and shoot growth differences diminished with time,

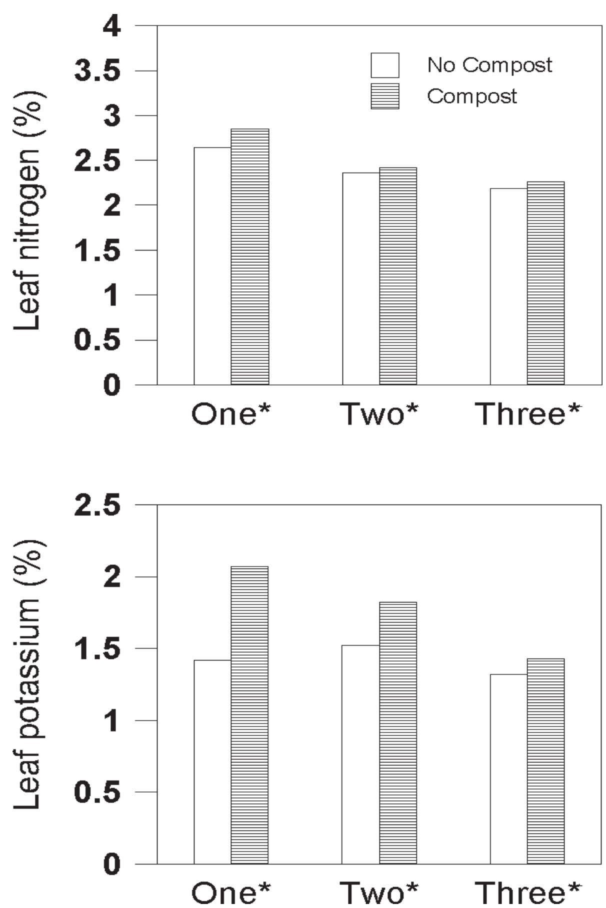

Figure 2. Leaf nitrogen and potassium with and without pre-plant-incorporated compost. *Indicates that compost had a significant effect in the indicated year after planting.

the greater tree height and bloom were evident in the third season indicating that the cumulative effect of compost on tree size was not short-lived.

Soil fertility was enhanced by the addition of compost, but little influenced by the addition of MAP, as shown for the year of planting in Table 1. The addition of compost resulted in higher soil pH and cation exchange capacity in each of the three seasons after planting, compared to the plots without compost (data not shown). Compost increased both soil organic matter and P, while MAP and urea had no effect. Compost also increased soil Mg, Ca, and K.

Compost increased tree growth and flowering by improving soil fertility and tree nutrient status, and most likely, by increasing soil water holding capacity and soil aeration. An increase in the water holding capacity of the soil would have been advantageous in 1998, when the newly planted trees were generating new roots to replace those lost in transplanting, and in 1999, a season in which little precipitation occurred before September. Foliar nutrient status was favorably affected by compost (Figure 2). Compost increased leaf N and K compared to trees in plots without compost in all three seasons after planting. Leaf P and Ca were not affected by compost. There was no difference between urea and MAP in their effect on leaf N or K, or leaf P, Ca, or Mg. Compost decreased leaf Mg in the first season after planting, but had no effect in the second or third season. The large increase in soil K following compost incorporation may have interfered with Ca and Mg uptake, so that even though soil Ca and Mg were greater, foliar levels were not. Leaf micronutrients were not affected by any of the pre-plant treatments.

Pre-plant incorporation of P fertilizer had no effect on tree growth or flowering in this study. In British Columbia, P fertilization previously has been shown to increase flowering when it results in greater leaf P. In our study the soil level of P was within the optimum range before treatment, and was increased to above optimum by compost. Although the level of P in the soil was increased with compost, there was no increase in foliar P. These results are consistent with most previous studies in showing no benefit from P fertilization for apple.

Conclusions

Pre-plant compost incorporation was more effective than P fertilization for increasing tree growth during the establishment years. The practice of adding P to the planting hole may not be appropriate for Northeastern sites, particularly those where the soil test indicates that P is adequate before planting. Soil incorporation of compost increased tree growth and flowering into the third year after planting. This was most likely due to improved N and K status of the trees, and through improved soil aeration and water-holding capacity. Our results suggest that trees planted in soil amended with apple-pomace compost would potentially fill their space more quickly and be able to support more fruit growth in the first years of cropping.

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