Testing Pre-plant MAP and Apple Compost for Improving the Growth of Newly Planted Apple Trees

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Management practices that foster rapid early tree growth and early fruit production result in economic advantages to growers by hastening a return on investment. In many orchards in the northeastern U.S., early yield is limited by tree growth, and trees are typically not cropped until the third or fourth season because tree growth is not vigorous enough. Decreasing the time required for trees to fill their space would allow growers to increase early yields. Two methods that have been used to increase early tree growth are the addition of organic matter or phosphorus fertilizer to the planting hole.

Organic matter is often low in many existing orchard soils. Increasing soil organic matter improves its water and nutrient holding capacity, which enhances root regeneration and promotes overall tree vigor. Adding compost as a source of organic matter to planting holes has been demonstrated to have beneficial effects on young apple tree growth in experiments in Massachusetts and Maine. 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, Monmouth, Maine.

Soil incorporation of compost increased tree growth and flowering into the third year after planting.

Apple pomace from Chick's 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 an organic soil amendment with highly desirable characteristics.

Well-rooted mature fruit trees are efficient at absorbing phosphorus (P) from the soil and seldom need P fertilizer. Newly transplanted trees have impaired root systems and P fertilizer is often recommended for new plantings (Stiles and Reid, 1991). Since P is very immobile in soil, this nutrient is more beneficial when it can be incorporated prior to planting. Research results in British Columbia have 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 2 years 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 (Neilsen, 1994). 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 compost or MAP, either alone or in combination, would improve early apple tree growth and precocity.

PRE-PLANT RESEARCH

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, and soil properties prior to planting are listed in Table 1.

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) no compost, urea fertilizer; 2) no compost, MAP; 3) compost + urea and 4) compost + 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 buffer trees between plots.

Prior to planting, MAP was applied to the plots at a rate of 332 lb/acre and urea at a rate of 79 lb/acre, so that each treatment received an equivalent amount of N (1.44 oz/tree). Apple pomace compost was spread over the planting strip and leveled to a uniform thickness of 4 inches. All plots were then rototilled 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 ft. The two buds directly below the new leader were rubbed off, as were all buds that sprouted below 15 inches. The trees were minimally pruned and trained to the vertical axis system. Insecticides, fungicides and herbicides were applied as needed.

RESULTS AND DISCUSSION

Tree growth was increased by compost but not by MAP. Compost increased trunk growth in the first two seasons but not in the third season (Fig. 1). Annual shoot growth was increased by compost in the first season but not significantly in the second or third season (Fig. 2). Compost increased the number of growing

TABLE 1

Orchard soil properties before and after pre-plant monoammonium phosphate (MAP) or apple compost.

Treatment	pH	OM (%)	P (kg/ha)	K (kg/ha)	Mg (kg/ha)	Ca (kg/ha)	CEC (me/100 g)
Pretreatment							
None	6.8	4.7	10.9	235	384	2664	7.6
Posttreatment							
Urea	6.4	4.5	11.1	235	342	2950	6.9
MAP	6.4	4.4	14.6	221	353	2861	6.8
Urea + compost	6.9	5.3	89.2	584	591	5579	11.1
MAP + compost	6.8	5.6	97.3	534	574	5489	10.4

FIGURE 1

Effect of pre-plant monoammonium phosphate (MAP) and apple compost on trunk growth of Macoun/B.9 apple trees in the first three seasons after planting.

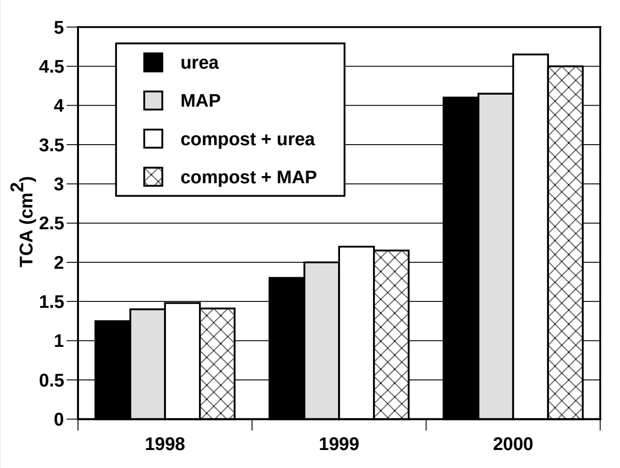


FIGURE 2

Effect of pre-plant monoammonium phosphate (MAP) and apple compost on shoot growth of Macoun/B.9 apple trees in the first three seasons after planting.

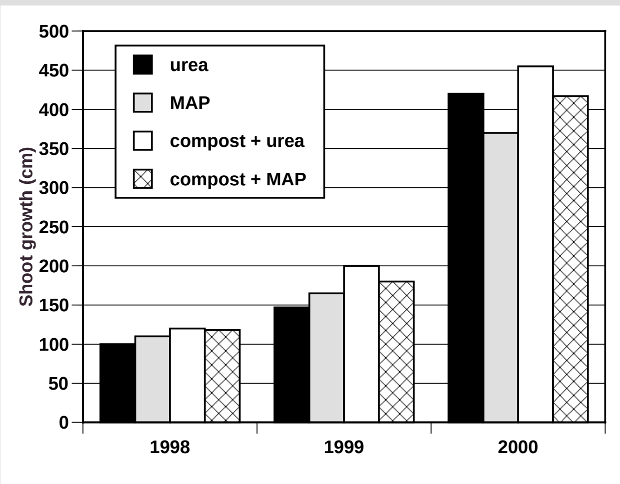


FIGURE 3

Effect of pre-plant monoammonium phosphate (MAP) and apple compost on number of growing points and tree height of Macoun/B.9 apple trees in the third season after planting.

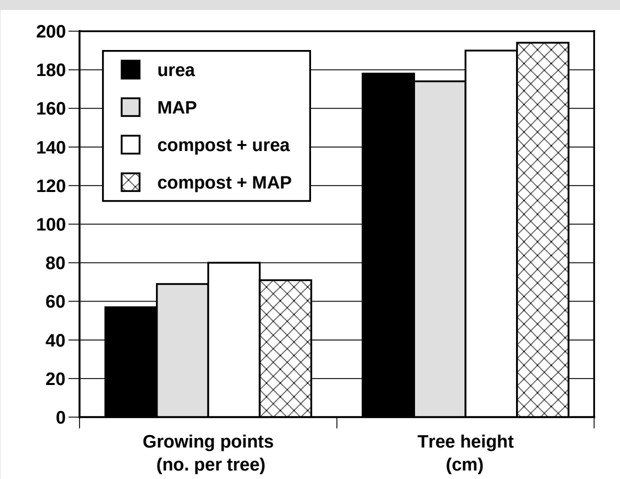


FIGURE 4

Effect of pre-plant monoammonium phosphate (MAP) and apple compost on number of flower clusters of Macoun/B.9 apple trees in the first three seasons after planting.

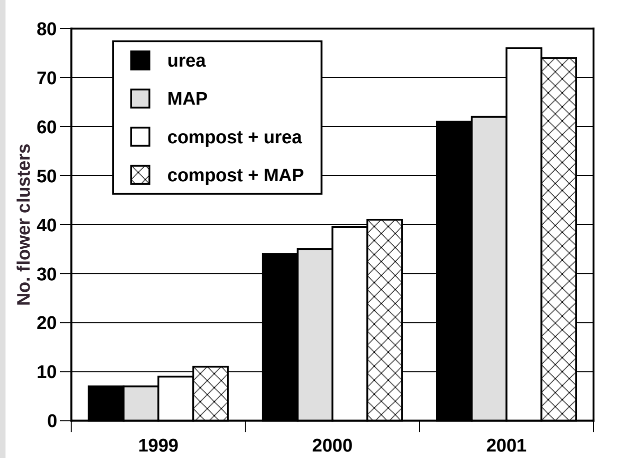


FIGURE 5

Effect of pre-plant monoammonium phosphate (MAP) and apple compost on leaf nitrogen of Macoun/B.9 apple trees in the first three seasons after planting.

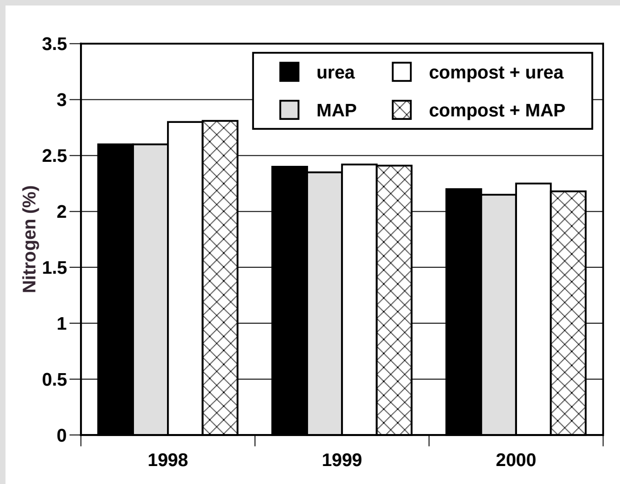
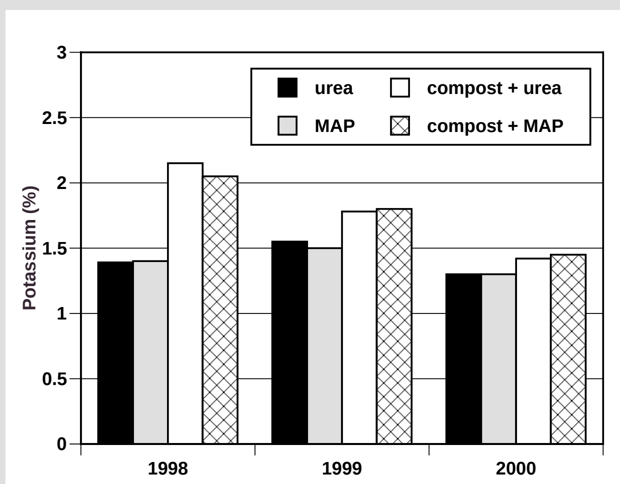


FIGURE 6

Effect of pre-plant monoammonium phosphate (MAP) and apple compost on leaf potassium of Macoun/B.9 apple trees in the first three seasons after planting.



points (the sum of spurs and shoots per tree) and tree height at the end of the third season (Fig. 3). MAP had no effect on trunk growth, shoot growth, number of growing points or tree height in any season of the study.

Tree growth was increased by pre-plant incorporated apple pomace compost, similar to 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 was attributed to roots growing beyond the planting hole. In our study, the effect of pre-plant organic matter on trunk circumference 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. 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, the increase in tree height and number of growing points was evident in the third season, indicating that the cumulative effect of compost on tree size was not short-lived.

The total number of flower clusters per tree in May 1999 was not affected by any of the treatments (Fig. 4). In May 2000 and 2001, the number of flower clusters was increased by compost but not affected by MAP. 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.

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. Compost increased both soil organic matter and P in the first season, while MAP and urea had no effect. Compost also increased soil Mg, Ca and K in each season of the study.

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. Foliar nutrient status was favorably affected by compost (Figs. 5 and 6). There was no difference between urea and MAP in their effect on leaf N or K (Figs. 5 and 6) or leaf P, Ca or Mg (data not shown). 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.

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. 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. Leaf micronutrients were not affected by any of the pre-plant treatments (data not shown).

Pre-plant incorporation of P fertilizer had no effect on tree growth or flowering in this study. P fertilization has been shown previously to increase flowering when it results in greater leaf P (Neilsen, 1994). 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 (Stiles, 1994).

SUMMARY

The results of this study indicate that preplant 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 U.S. 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. Greater tree growth with compost 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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