Dairy Manure/Compost N Release for Sugarbeets and Subsequent Wheat

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INTRODUCTION

There is frequently more manure generated than can be environmentally applied in a sound manner within the limited land resources of the growing number of Idaho dairies and feedlot operations. There is considerable incentive to export manure or compost from these operations to nearby farmer fields. Manure composting is currently used to reduce the volume of material hauled. But the slower release nature of organic N sources could be problematic for sugarbeets if the timing of N release interferes with late season sugarbeet growth and sugar content. A better understanding of the N release dynamics from manures and composts is needed to know how best to use these resources without causing excessive available N at the end of the season, the associated higher brei nitrate and conductivity, reduced sugar content and recoverability. Marketing of manures and composts to sugarbeet producers is limited by a lack of information regarding sugarbeet response to the applications.

Sugarbeet production in southwest Idaho involves fall application and shallow incorporation of broadcasted fertilizers prior to fall bedding. The bedding process essentially concentrates broadcasted fertilizers, composts or manures over the row to be planted the following spring. Precipitation can move soluble and mobile salts to the soil depth at which sugarbeet seed must germinate.

The objective of this study was to compare fall applied manure and compost N sources with conventional fertilization. Depth of organic N incorporation was also of interest.

METHODS

Sugarbeet (*Beta vulgaris L.*) field trials were conducted at Parma in 2003 and 2004 to evaluate N release dynamics from dairy heifer manure and dairy manure compost. The trials were conducted on a Greenleaf silt loam (fine silty, mixed, superactive, mesic Xeric Calciargid). Treatments both years consisted of an untreated control, and available N applied at 1x the optimum additional N required (UI fertilizer guide) or 180 lb N/A using conventional fertilizer urea N, dairy replacement heifer manure, or dairy compost, and 2x N rates using manure and compost. Manure and compost application rates were determined from their total N contents assuming a 1st year available N release of 40% for manure and 20% for compost. Total N content of manure N was 2.30% in 2002 and 2.21% in 2003. Compost total N was 1.90% in 2002 and 1.57% in 2004. Additional treatments included the 1x N rate of manure and compost incorporated at half the depth of the other treatments. Treatments were arranged in randomized complete blocks with four replications. Individual plot size was 22' x 50'.

Organic N treatments were applied by hand in the fall, prior to fall bedding, and rototilled to a depth of 4" except for the shallow incorporation treatments rototilled to 2". Following incorporation the field was bedded with 22" spacing and the beds left undisturbed until spring when the tops of the beds were removed just prior to planting sugarbeets in the bed center. The conventional N treatment was applied in split (broadcast and/or sidedressed) applications in the spring after the beets were established.

Weed control was accomplished using conventional pre-plant and/or post-emergent herbicides as well as mechanical cultivation and hand weeding. Powdery mildew was controlled in 2004 with labeled rates of liquid sulfur and Headline. Insects were controlled in 2003 with labeled rates of Asana and Lorsban. The beets were thinned by hand and furrow irrigated.

Residual N (nitrate and ammonium) was measured to depths of 12" and 24" prior to organic N treatment application, in early spring within four days of sugarbeet planting, and after the sugarbeet harvest. Over-winter N mineralization was measured from soils collected from 0 to 12", after organic N source incorporation and bedding, using buried polyethylene bags. The bags were removed in the spring prior to bed disturbance and the sugarbeet planting. Subsequent N mineralization during the sugarbeet growing season was measured using a new series of bags prepared from soils collected at planting and buried again to a depth of 12", which were destructively sampled during the sugarbeet season. Net mineralized N was taken as the difference in NO_3-N plus NH_4-N between the soil collected for the buried bags and soil in the removed bags. All removed buried bag nitrate values were examined for their relevance to previous sampling results. If nitrate values were appreciably lower than in previous samplings they were suspected as having been saturated, the nitrate denitrified, and were not used in the estimates of N mineralization.

Total dry biomass of sugarbeet tops (leaves) and roots were measured from 5' of a row at least once during the growing season and just prior to harvest in each trial. Beet yields were measured at the end of the season from four adjoining 40' rows. Beet subsamples were collected and submitted to the Amalgamated Sugar Company laboratory for tare and quality including brei nitrate, brei conductivity, and sugar percentage.

Winter wheat was planted over the trial area after the sugarbeet harvest. Whereas the sugarbeet harvest and subsequent wheat planting were timely in 2003, rain delayed the harvest in fall 2004 as well as the subsequent seedbed preparation and planting of wheat. Consequently all post-harvest soil sampling after the 2004 season was delayed until the following February when soils had thawed and adequately dried. There was no N applied for the wheat so that differences in wheat yield would primarily reflect residual and mineralized N from previous treatments. Buried bags were used to monitor the N release after planting from selected treatments during the wheat growing season. Buried bags were placed into soils 48 days after the sugarbeet harvest in 2003, and 84 days after the 2004 harvest. Wheat grain yield was determined using a small plot combine. Grain protein was subsequently determined and the grain N content was calculated from the yield and protein determinations.

RESULTS AND DISCUSSION

Soils collected (for the buried bags) after fall bedding tended to have higher NO_3-N and NH_4-N if they received a 2x available N rate rather than the 1x rate, but organic N sources did not differ appreciably in 2002 (Fig. 1). In contrast, soil NO_3-N and NH_4-N were higher in fall 2003 and compost treated soils had considerably more NH_4-N than manured soils (NH_4-N data not shown). The differences may be related to the time that N sources were stockpiled prior to application. Organic N sources were applied soon after delivery in 2002 but were piled, covered with black plastic, and essentially incubated for several days in 2003 until weather cleared and soils dried sufficient to apply and incorporate the treatments.

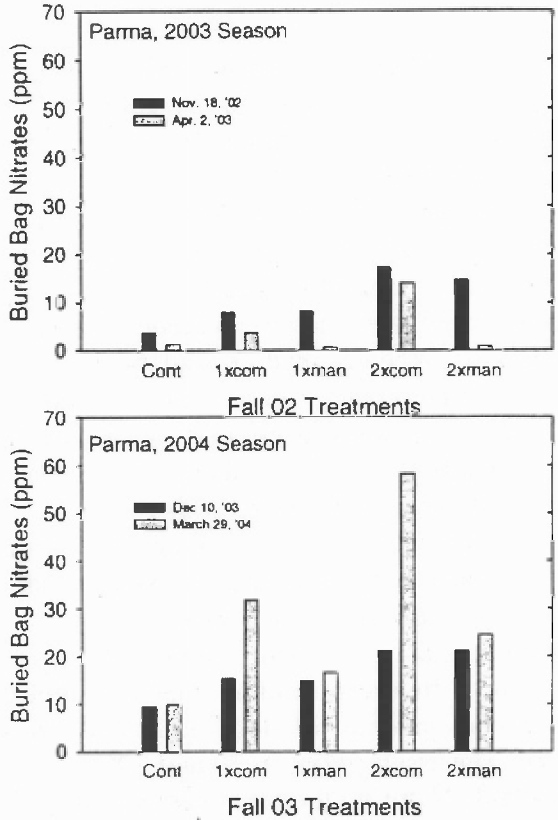

Figure 1. Over-winter N mineralization based on buried bag NO_3-N in the fall after organic N was incorporated and in early spring prior to sugarbeet planting.

Buried bag soil NO_3-N in early spring was appreciably higher in 2004 than in 2003 and NO_3-N in both years was consistently higher in compost than manure treated soils (Fig. 1). In the first year, buried bag NO_3-N was lower in early spring than it was in the fall, particularly in the manure treatment, which did not occur in the second year. The buried bag results suggest that N immobilization was greater in 2003 than 2004.

The pre-plant sampling of beds in April indicated that in both years some NO_3-N had moved from the first into the second foot, especially with the compost treatments. The NO_3-N in early April was generally distributed equally in the first and second foot depths. The NO_3-N at both depths was higher with compost than with manure treated soils. The results from fall and early spring sampling suggests there is appreciable readily available N from compost.

The results differ from common perceptions of compost N being more stable than manure N. In this study the initial readily available N was greater in compost than manure. This would be consistent if compost N were enriched with additional N or manure included bedding materials with greater potential for immobilizing N.

Mineralization during the season for the organic N treated soils were fitted to sigmoidal functions. Mineralization of N after early April from organic N treated soils exceeded that of the untreated soil (Fig. 2) and mineralization was greater from 2x than 1x N rates. Most of the N mineralized during the warmer temperatures of June through August, and the highest rates occurred during July through early August. Mineralization in untreated soils was roughly twice as high in 2003 as in 2004. In contrast, N mineralization

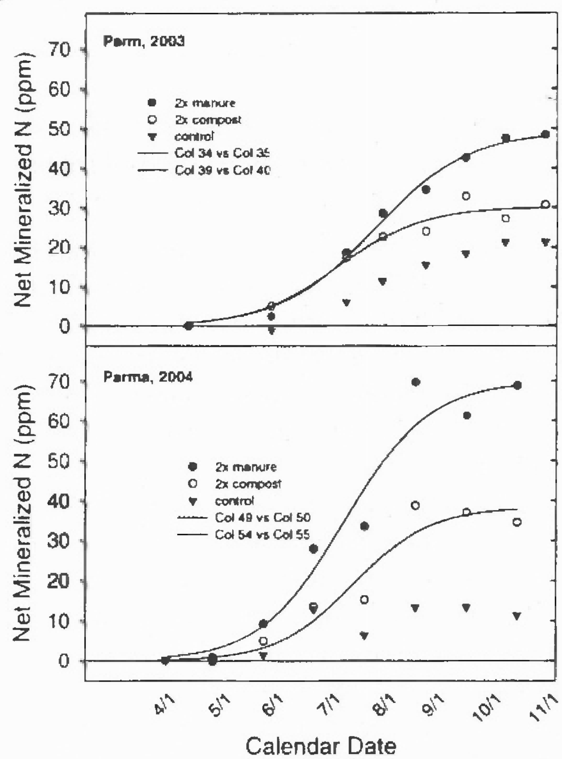

Figure 2. Net N mineralization as affected by untreated and 2x available N rates of manure and compost during the sugarbeet season.

in organic N treated soils was greater in 2004 than in 2003, especially for the manure treatment. Greater N mineralization in 2004 may have resulted from a later fall incorporation. Although initial buried bag NO_3-N in early April was greater for compost than manure treated soil, subsequent N mineralized from manure exceeded that from compost. Whereas readily available N was typically greater for compost, N provided during the season was greatest for manure.

Sugarbeet plant N uptake at harvest was generally greater in treated soils than the untreated control (Fig. 3). Uptake of N from soils treated with 1x N rates of manure and compost was less than from the 1x conventional N treatment. Uptake of N with organic N treatments did not match N uptake from conventional N unless the 2x rates were used. The assumptions of 40 and 20% available N during the first year from these N sources were apparently high. Uptake of N

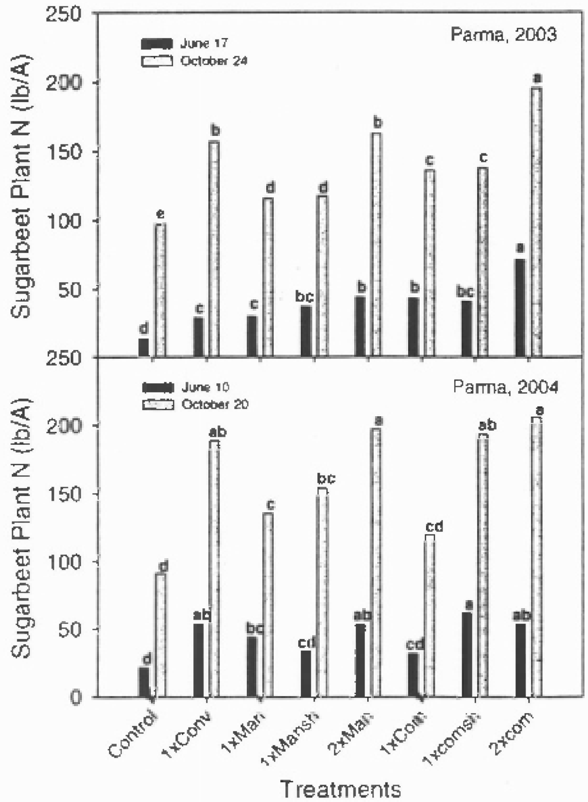

Figure 3. Early season and pre-harvest sugarbeet N uptake in leaves and roots.

with compost treatments was greater than from manure in 2003 but did not differ significantly in 2004. Depth of incorporation did not affect N uptake in 2003 but shallower incorporation increased N uptake in 2004. Uptake of N tended to be greater in 2004 than in 2003 for most treatments.

Yield of sugarbeets was higher in 2004 than 2003, especially when soils were treated with conventional or organic N sources (Fig. 4). Sugarbeet yields tended to be higher with organic N sources than in untreated soils although the treatments weren't always statistically different in 2003. Yields with organic N at the 1x rate typically were not as high as the conventional N treatment unless the 2x rate was used. Yields among organic N treatments did not differ in 2003 but in 2004 compost N yielded more than manure N at the 1x rate.

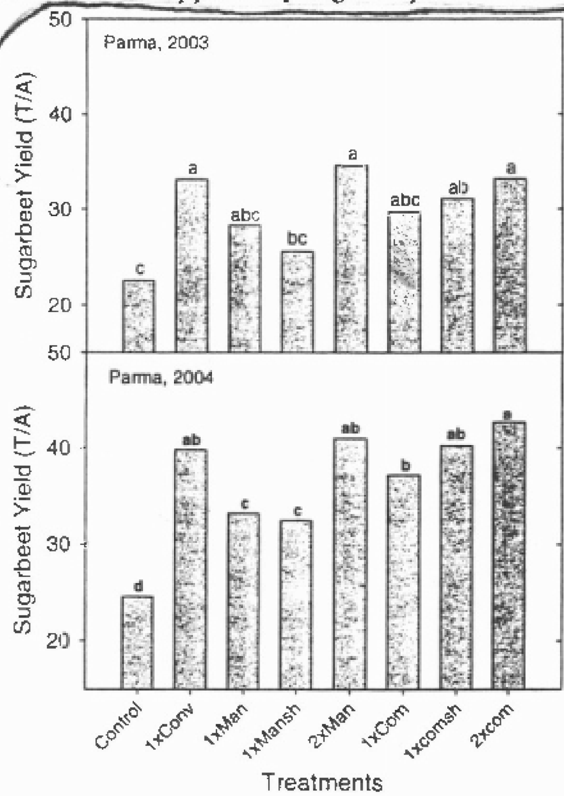

Figure 4. Sugarbeet yield in 2003 and 2004 as affected by N treatments.

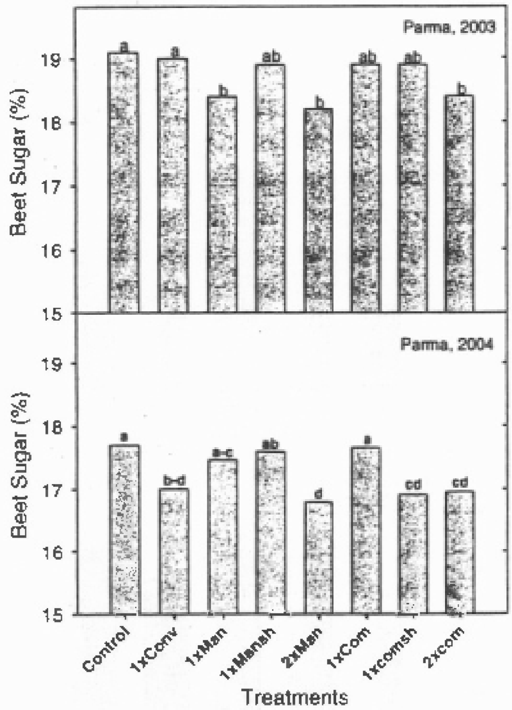

Figure 5. Sugarbeet percent sugar in 2003 and 2004 as affected by treatments.

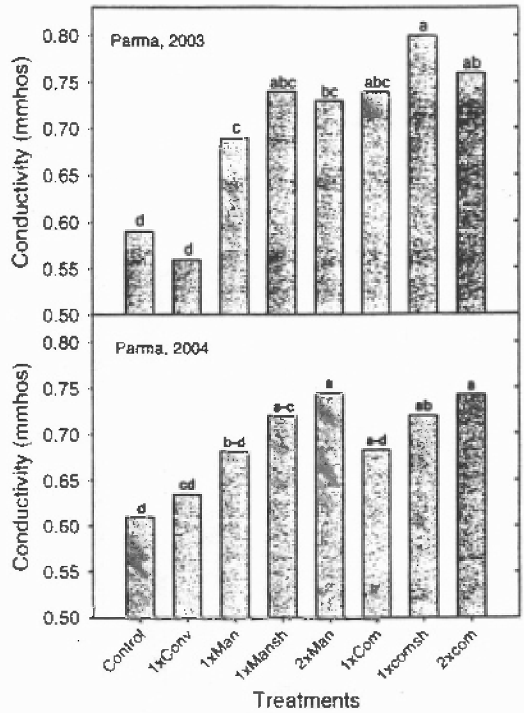

Figure 6. Sugarbeet brei conductivity in 2003 and 2004 as affected by treatments

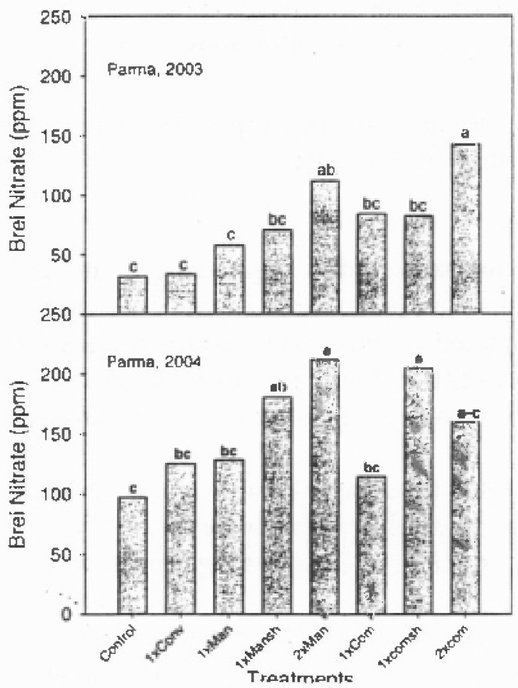

Figure 7. Sugarbeet brei nitrate in 2003 and 2004 as affected by treatments.

Percent sugar was particularly high in 2003 and higher in both years compared to the district average (Fig. 5). Percent sugar was consistently lower at the 2x rate of organic N than it was in the untreated soil, and in one of two years was lower than the conventionally fertilized sugarbeets. Brei NO_3-N was higher in 2004 than 2003 and generally higher with 2x rates of organic N than with 1x rates of N applied. Organic N sources did not differ in brei NO_3-N or conductivity. Conductivity was generally higher with organic N sources than with conventional fertilization (Fig. 6). Conductivity with conventional N fertilization did not differ from the conductivity in the untreated control.

Wheat yield after sugarbeets was higher in 2005 than 2004, was lowest in untreated soils, and generally highest with the 2x organic N rates, especially in 2005 (Fig. 8). Organic N sources did not differ in wheat yield, but were higher yielding than the conventional N treatment in 2004.

Buried bag NO_3-N after planting wheat was generally higher for manure than for compost but the amounts were low, particularly in December

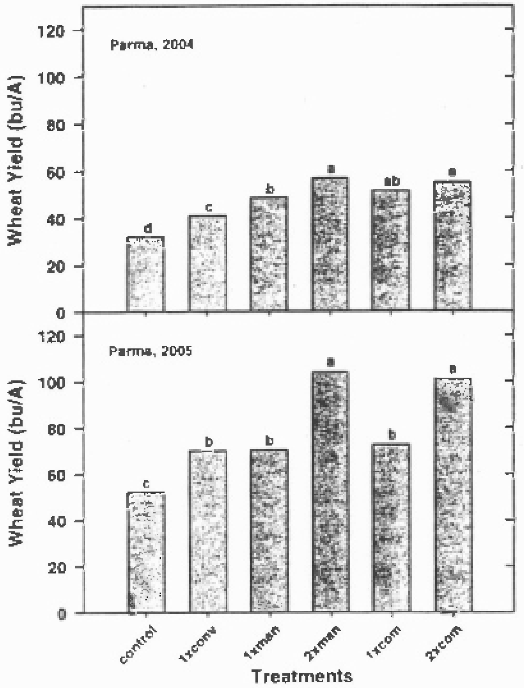

Figure 8. Grain yield in 2004 and 2005 as affected by treatments applied for sugarbeets the previous season

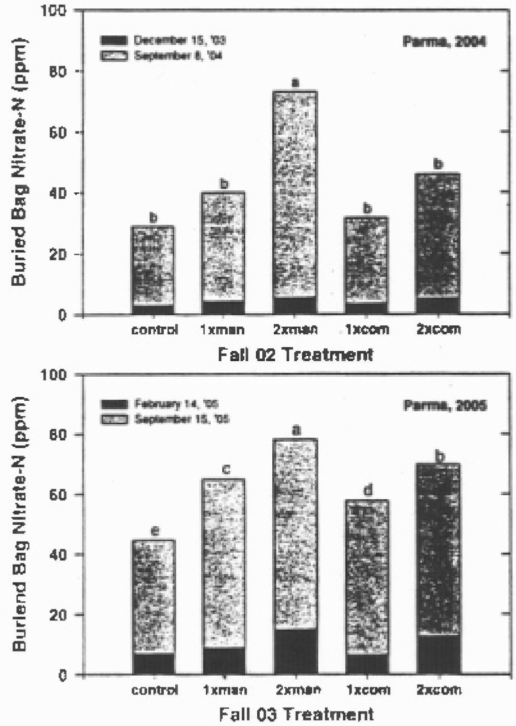

Figure 9. Buried bag NO_3-N following the planting of wheat as affected by organic N sources applied for the previous season sugarbeets.

2003 (Fig. 9). Mineralized N in buried bags from winter to the following September was generally higher at the 2x N rate and higher for manure than for compost.

SUMMARY

Compost had more readily available N than manure for early season sugarbeet growth but N mineralized after sugarbeet plantings was greater from manure, particularly during June through early August, and through the following season. Fall applied compost and manure N release for sugarbeets was less than from the spring split applied conventional urea treatment despite applying 5.0 and 2.5 times as much total N. Though manure and compost provided less available N, they increased sugarbeet brei conductivity.

The N release for subsequent wheat yield was unaffected by organic N source and wheat yield did not consistently differ for organic and conventional fertilization. However, mineralization beyond wheat maturity and through the remainder of the growing season was greater for manure than compost.

The rates of organic N source application in this study are several fold greater than are commercially used, assuming commercial rates are only 2 to 3 tons/A. Therefore the available N contributed from commonly used rates would not be sufficient to appreciably affect sugarbeet growth or quality unless rates were applied annually over extended periods.

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