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Are Currently Recommended Fertilizer Management Programs Sufficient?

Probably not, Nebraska researchers' observations suggest if maximum attainable yields are goal.

Summary: *To date, we have observed that attainable yield potential varied significantly in the two years of this study. It appears that only 75 to 85 percent of the yield potential (220 to 260 bu/A) is likely to be the most efficient and profitable yield target for high-yielding systems. However, intensification of management is essential to increased productivity. Currently recommended fertilizer management programs may not be sufficient to meet the nutrient demands of higher plant populations. We have observed that maximum attainable yields require higher plant densities as well as greater amounts of N (and especially K) per bushel of yield.*

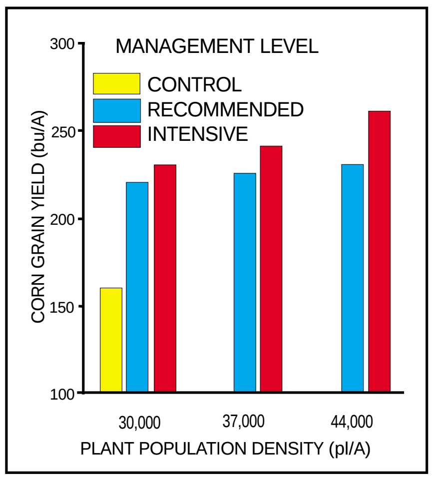

Figure 1. Population and management effects on corn grain yield, 1999.

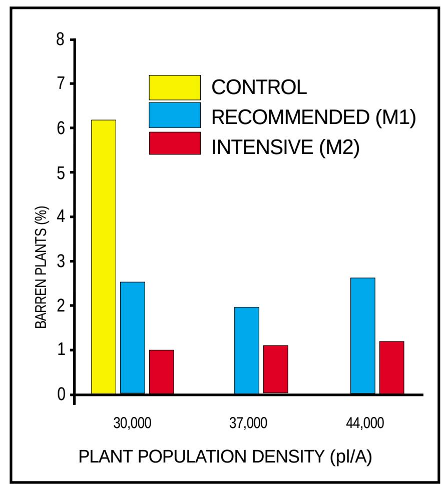

Figure 2. Population and management effects on percent of barren stalks, 1999.

Low commodity prices and environmental concerns about global climate change caused by carbon dioxide enrichment of the atmosphere provide strong justification for increasing both farm profits and the storage of carbon (C) in agricultural soils. The working hypothesis of this project is that achieving increased profit and C storage will require innovative new crop management practices that improve soil quality, increase yields and decrease production costs. To do so will require exploitation of the existing yield potential of modern hybrids and varieties. Although greater inputs will be required to achieve these goals, we hypothesize that nutrient-use efficiencies (and therefore profit) will be enhanced.

There is a need to develop scientific understanding of the relationship between soil productivity, crop yield potential, input use efficiency and C-sequestration in corn-based cropping systems. To address these issues requires an initial focus on quantifying crop growth rates and dry matter distribution among various plant organs, nutrient uptake rates, optimal

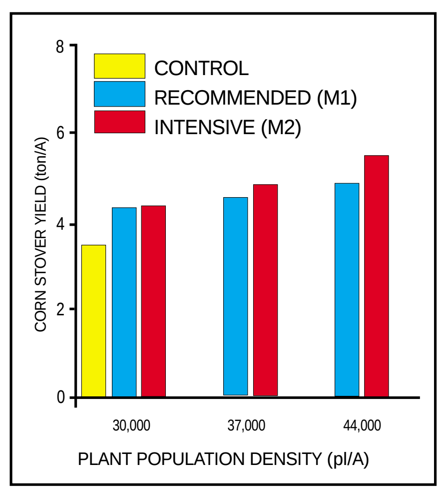

Figure 3. Population and management effects on stover yield, 1999.

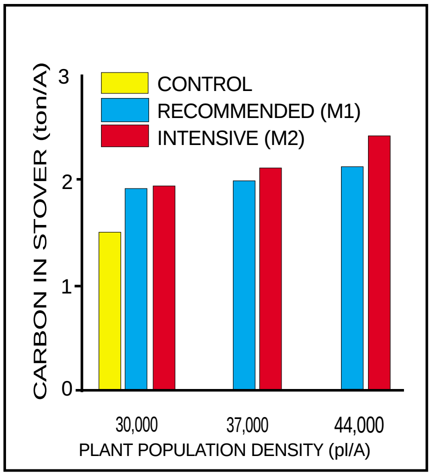

Figure 4. Population and management effects on Carbon returned to soil in crop residue, 1999.

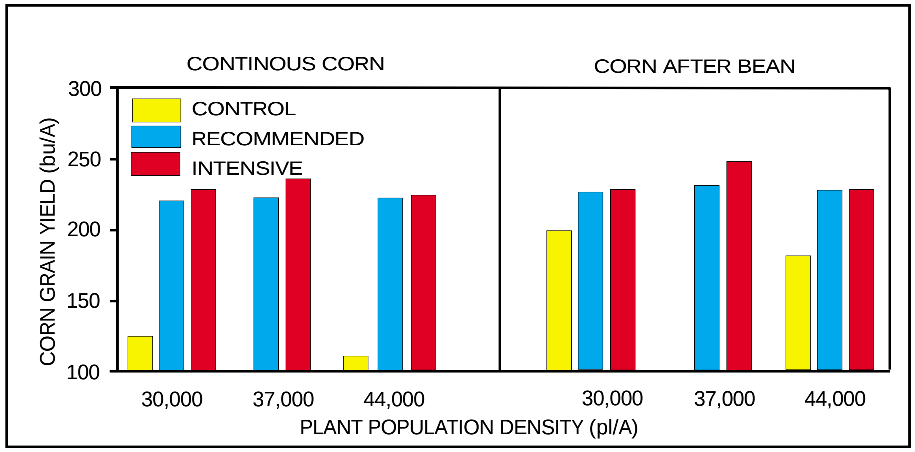

Figure 6. Population and management effects on corn grain yield, 2000,

plant populations, and fertilizer requirements needed to achieve yields that approach the crop's potential.

Primary objectives during the first two years of this research were to:

- Establish a long-term experiment in which several key factors governing optimal soil productivity and yield potential of corn and soybeans can be identified
- Quantify crop nutrient uptake requirements, crop growth rates, leaf area, and root development needed to achieve yield potential levels
- Determine the C sequestration potential of cropping systems that consistently produce yields near the yield potential levels, measure N, P, and S composition of the newly formed humus, and estimate the rate of organic matter turnover in these systems
- Validate appropriate crop simulation models that accurately predict the yield potential of corn and soybeans in different years and locations with different climatic regimes.

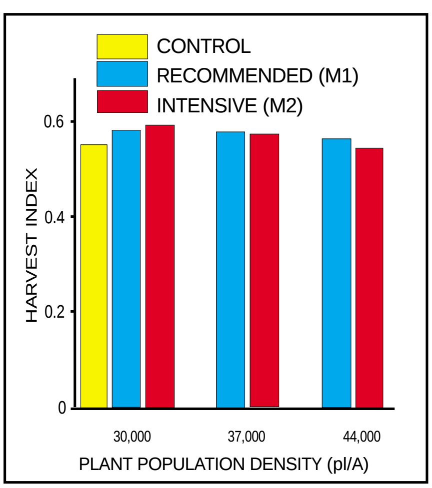

Figure 5. Population and management effects on corn harvest index, 1999.

Results reported are preliminary as many of the comprehensive soil and plant analyses performed are still in progress. These experiments began in 1999, following a soybean crop.

1999

As shown in Figure 1, grain yields ranged between a low of 162 bu/A for the unfertilized control (30,000 plants/A) and 258 bu/A for intensive management (M2) treatment at a high population (44,000 plants/A). The M2 treatment significantly increased yield at all population levels, resulting in an average grain yield increase of 25 bu/A over the recommended fertility regime (M1).

Grain yield also increased linearly with population. An average difference of 11 and 22 bu/A was observed by increasing population from 30,000 to 44,000 plants/A for the M1 and M2 fertility regimes, respectively. Fertility management had a significant effect in reducing the percentage of barren stalks, as shown in Figure 2.

Stover yield increased with both an increase in population and fertility management and ranged from 3.44 tons/A in the control to 5.5 tons/A under intensive management having a population density of 44,000 plants/A (Figure 3). This resulted in a significant increase in the amount of carbon added to the soil in corn residue under intensive management (Figure 4), which we hypothesize will result in improved soil quality and a greater capacity for this soil to sustain high yields under intensive management in future years.

Harvest index (grain yield/total biomass yield) of the 1999 corn crop was near the maximum published values observed for maize and averaged 0.55 across population and management treatments (Figure 5).

2000

We were able to compare the effects of crop rotation as an additional treatment. Corn grain yield in 2000 was not as we anticipated. We observed an average yield increase of 14 bu/A due to the previous soybean crop in the fertilized treatments (Figure 6). The M2 treatment resulted in a significant but smaller yield increase over the M1 treatment (8 bu/A) than observed in 1999. Averaged across population, grain yield was highest at 37,000 plants/A by approximately 8 bu/A.

We anticipated a much higher yield in 2000 than in 1999, based upon observed crop development. Vegetative (leaf and stalk) development averaged 12 percent higher in 2000, with the greatest

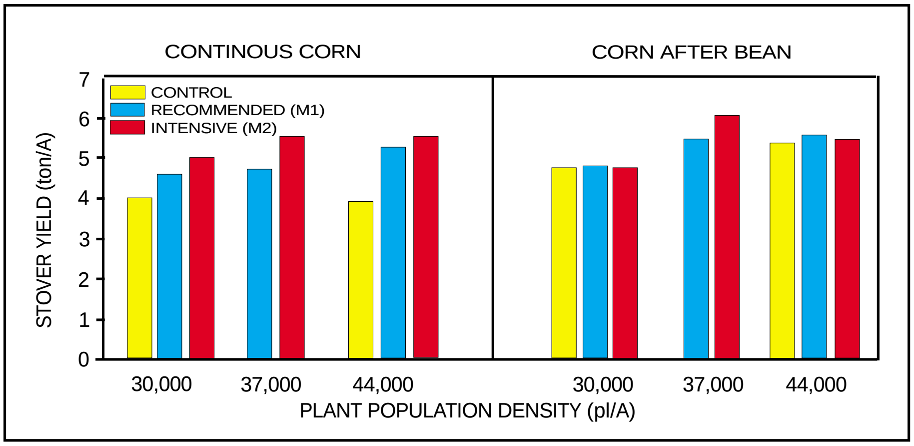

Figure 7. Population and management effects on stover yield, 2000.

treatment effects in continuous corn (Figure 7). However, the highest grain yield achieved in 2000 was treatment M2 following soybeans, producing 248 bu/A at 37,000 plants/A. The resulting harvest index was well below the 1999 level and averaged 0.50 for fertilized corn (Figure 8).

We believe the lack of a larger yield response, despite greater total dry matter production in 2000 compared to 1999, resulted from the unusually rapid grain filling rate due to high temperatures after silking in 2000. Total time from silking to black layer formation was 11 days shorter in 2000 compared to 1999, which provided a considerably shortened grain filling period. Simulation of crop growth using crop growth models gives credence to this hypothesis. With normal temperatures and a more typical length of grain filling, grain yields in 2000 should have surpassed the best yields obtained in 1999.

Methodology

Soil. The long-term experiment was established on a deep Kennebec silt loam (Cumulic Hapludoll). Soil test values to 8-inch depth were: pH 5.3, buffer pH 6.6, OM (%) 2.7, Bray ext. P (ppm) 67, and exch. K (ppm) 366.

Plots. Treatments were arranged in a split/split plot design. Crop rotations (continuous corn vs corn/soybeans) were main plots. Three plant populations planted in 30-inch rows were subplots. Level of fertilizer nutrient inputs was sub-subplots.

Fertilization. Initial applications of N, P, K, S, Fe, and Zn were applied preplant and incorporated prior to planting by disking. Subsequent N splits were surface broadcast and then irrigated into the soil. Table 1 shows N rates.

Lime was applied in fall of 1999 at 2 tons CCE/A.

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Table 1 Fertilizer rate and timing applied to corn.

Treatment		Growth stage	N (lbs/A) 1999	N (lbs/A) 2000
Corn/soybean,	M1	Preplant	58	92
		V6	58	31
	M2	Preplant	94	92
		V6	54	89
		V10	54	85
Corn	M1	Preplant		92
		V6		89
	M2	Preplant		92
		V6		116
		V10		116

M1: no additional nutrients applied.
M2: 44P-75K-20S-10Fe-5Zn applied preplant.

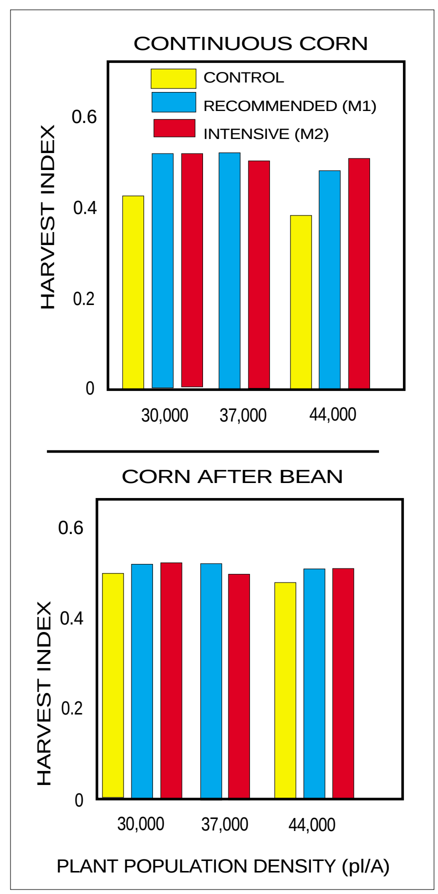

Figure 8. Population and management effects on corn harvest index, 2000.