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Starter Applications of APP Show Positive Response in Sugarbeet Trials

Surface banding APP (10-34-0) did not show increased sugar percent or yield; at one site it significantly reduced sugar yield.

Summary: *This project evaluated the effectiveness of ammonium polyphosphate (APP) starter fertilizer applied as either broadcast or banded at three different soil depths at three Idaho locations over two years. Banding APP six inches below the soil's surface resulted in increased sugar production at two sites due to a combined increase in sugar percent and total yield. A combination of relatively low yields, warm spring soil, late planting date, and early harvest date are most likely the reason the third location showed no response to starter fertilizer. The broadcast application did not increase yield at any location. The surface and the three-inch band showed a positive response for sugar production at one location, although the magnitude was not as great as that observed with the six-inch band. However, the surface band showed a yield decrease at one location. Although some discrepancies exist between locations, banding at the sixinch depth resulted in the highest total sugar production for two of the three site years of data.*

Studies in the North-Central U.S. have shown yield increases with the use of 12 to 20 lbs/A of P_2O_5 as APP starter in sugarbeets. Researchers have found that yields increase when a starter band is placed 1) in direct seed contact, 2) two inches below the seed, and 3) two inches below and two inches to the side of the seed. However, they also have found that the magnitude of the response is delayed and reduced as the distance between the seed and the starter fertilizer band increases. Others conclude that direct seed contact is the best option owing to rapid, vigorous response and because much of the soil in which sugarbeets are grown in that region is high in clay and susceptible to poor seed conditions due to implement-soil interface compaction. Unlike many other crops, these studies have found little advantage for placing the starter band two inches to the side of the seed. Still other research also supports the view that optimal placement of starter fertilizer for sugarbeets seems to be directly below the seed.

Sugarbeet growers in other regions have research-based starter fertilizer recommendations, but soil and management conditions in the Western U.S. are unique and those recommendations may not be applicable. There are no published scientific studies evaluating starter P fertilizer for sugarbeets in the western region and in particular, calcareous soils. Many western growers do not apply starter fertilizer with sugarbeets owing to previously observed problems with germination and emergence. However, these observations were primarily made at high rates of starter and with fertilizer having high potential for salt, ammonia, and biuret injury to seeds and seedlings in alkaline soils. Western soils tend to have relatively high pH, carbonates and salts, and low organic matter and clay content and, as a result, have increased likelihood of P deficiency, ammonia toxicity, salt injury, and surface crusting.

Although researchers have shown declining impact as P bands increase in distance from the seed, Idaho soils tend

to be very high in surface P and very low in subsurface P. This scenario works well for shallowrooted crops such as potato, but may be problematic for sugarbeets because of their dominant tap root system. It is probable that sugarbeet seedlings have adequate P at germination in soils with very high P levels, but there is concern that P availability is insufficient as the sugarbeet taproot explores relatively less of the surface soil and more of the subsurface soil during the first seven to nine weeks of growth. Banded P may enhance subsurface P uptake if placed relatively deep in the path of the sugarbeet taproot. This is especially the case as the availability and diffusion rates increase when P is applied in a band application. The purpose of this project is to determine if deep-banded P enhances sugarbeet P nutrition and if so, how this impacts fi nal yield and sugar content.

2002 results

Study involved broadcasting and banding 0, 20 and 220 lbs/A of P_2O_5 as phosphoric acid (PA) or APP. Banding placement depths were 0, 3, and 6 inches below the seed. Response showed significant increases in yield for the APP applications at both rates and at all three placement depths. Total sugar also increased for all three APP depths, but only the 6-inch depth was significant.

Surprisingly, none of the PA treatments showed increases in total or sugar yield, leaving the reason for the APP increases in doubt. Was the reason for the APP increase due to N or P or both? Did the PA suppress yield due to acid-induced P solubility reduction known to occur several weeks after application in high pH soils? In order to answer these questions and avoid further confusion, the study protocol for 2003 was changed to the format described below. The inclusion of the urea ammonium nitrate (UAN) treatments in 2003 served to separate the N contribution of the starter.

Treatments	% sugar	NO_3 ppm	Yield tons/A	Sugar lbs/A
UAN broadcast	16.4	193	31.6	10,394
APP broadcast	16.1	229	33.9	9,989
UAN--0 inches	16.8	303	33.9	10,360
APP--0 inches	16.5	193	31.7	9,546
UAN--3 inches	15.9	321	33.0	9,568
APP--3 inches	16.6	180	33.5	10,142
UAN--6 inches	15.5	422	36.4	10,283
APP--6 inches	16.2	241	32.1	9,515

Table 1. Effect of placement and soil depth on sugarbeet response to APP or UAN banding or broadcasting, Twin Falls, Idaho, 2003.

Treatments	% sugar	NO_3 ppm	Yield tons/A	Sugar lbs/A
UAN broadcast	16.7	252	37.2	12,376
APP broadcast	16.3	309	37.3	12,186
UAN--0 inches	16.3	312	37.6	12,284
APP--0 inches	16.1	370	33.9	10,891
UAN--3 inches	16.4	380	36.4	11,990
APP--3 inches	16.4	273	35.0	11,491
UAN--6 inches	16.6	324	35.4	11,774
APP--6 inches	17.1	251	40.2	13,757

Table 2. Effect of placement and soil depth on sugarbeet response to APP or UAN banding or broadcasting, Blackfoot, Idaho, 2003.

2003 results

Methodology for the two locations in the 2003 study was similar to the 2002 study with the exceptions of replacing PA with UAN and omitting the high starter rate. Results from the Twin Falls location showed no significant difference in total yield, sugar percentage, nitrate concentration, or total sugar production (Table 1). It is likely that a combination of relatively low yields, unusually warm spring soil, late planting date, and early harvest date resulted in increased P solubility/ reduced P need.

Results from the field near Blackfoot also showed no significant difference in sugar percentage and nitrate concentrations (Table 2). However, total yield and net sugar production (Figure 1) proved to have significant differences. The APP applied 6 inches below the soil surface was the only treatment significantly greater than the check. In contrast to the results from the Twin Falls site and previous year results, the surface-applied APP (0 inches) resulted in a significant decline in sugar production. No other treatments resulted in increases or decreases in yield.

Although the results from the three locations for the 2003 and 2002 studies were different, it is interesting to note

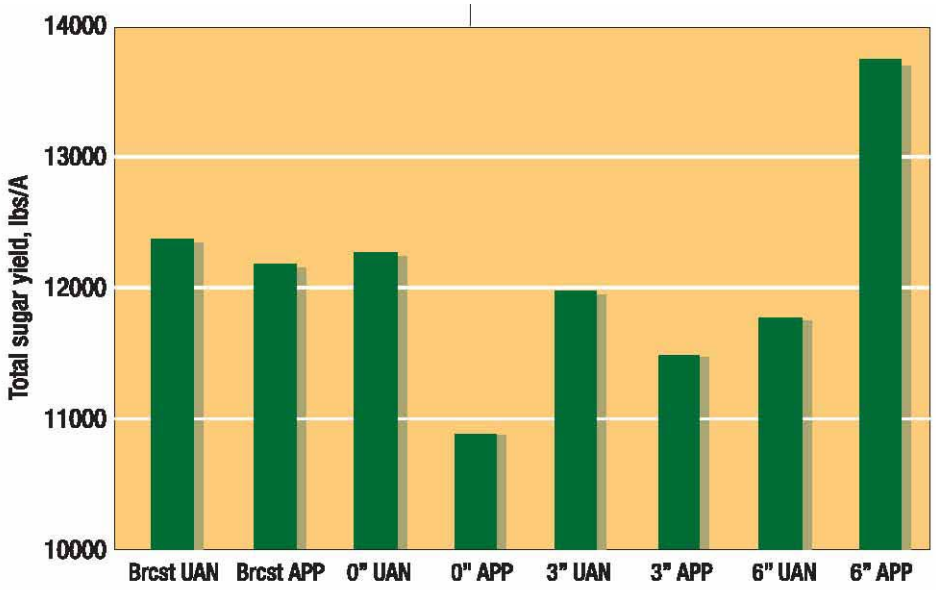

Figure 1. Sugar yield comparing banded and broadcast APP and UAN in sugarbeet field near Blackfoot, Idaho, 2003.

that the APP band 6 inches below the soil surface performed better than all other treatments for two of the three locations evaluated.

P uptake critical

The nutrient analysis shows substantial increases of N and P in the stems/leaves and roots when sampled early in the season (data not shown). These tissue concentration differences disappeared late in the season for the stems/leaves, but not so for the root P concentrations. The banded P treatments consistently exhibited higher root P concentrations than the broadcast or unfertilized check. The tissue nutrient concentration results from the 2002 study, combined with evidence from the results of the 2003 study, lead one to believe that all or much of the yield response observed with the deep-banded APP treatment is due to enhanced P uptake and use for both years of this study. No response was observed when N was added by itself, again indicating that the response was due to P or the synergistic effect of N and P applied together.

Going where roots are

During the early half of the season, sugarbeet roots are oriented dominantly downward as compared to a more diagonal orientation for most other plant species. The architecture of the sugarbeet root results in more exploration of the subsoil and less of the surface soil, especially in the first two months of growth. Subsurface P concentrations tend to be very low, especially in alkaline, calcareous soils common in the western states. This combination of sugarbeet roots not effectively exploring the surface soil and low subsoil P levels results in a potential problem for P availability early in the season, even in high P-testing soils. Deep banding APP seems to effectively correct this problem.

Methodology

Locations. Three trials were conducted in irrigated fields near Minidoka, Idaho, in 2002 and near Twin Falls and Blackfoot, Idaho, in 2003.

Soils were alkaline (pH 8.0 to 8.4), calcareous (5 to 12% $CaCO_3$), with medium-high soil test P (15 to 35 ppm bicarbonate P).

Treatments included four placements of two fertilizer sources (APP and PA in 2002 and APP and UAN in 2003).

Placement methods included: broadcast and banded fertilizer at 0, 3, and 6 inches below the surface (directly above/below the seed).

Fertilizers were applied either as APP (both years) with 6 lbs/A of N + 20 lbs/A of P_2O_5, as UAN (2003) with 6 lbs/A of N and 0 lbs/A of P_2O_5, or as PA (2002) with 20 lbs/A of P_2O_5. No additional fertilizer was needed, based on soil and petiole analyses, with the exception of broadcast N, which was applied to all plots uniformly at planting.

Plots were arranged in a randomized complete block design (RCBD) with six replications and were established as six 40-foot rows on 22-inch centers.

Timing. Broadcast applications were applied and tilled into the soil at final ground preparation. Subsurface bands were applied after hilling and prior to planting. Surface banding occurred immediately after planting by spraying fertilizer over the seed zone in a two-inch band.

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