Phosphorus Fertilizer Management for Sugarbeets in the Bighorn Basin of Wyoming

Nana Yaw Kusi[1], Abdel Mesbah[1,*], Bart Stevens[2], Andrew Kniss[1], Jay Norton[3], and Axel Garcia y Garcia[1,]**

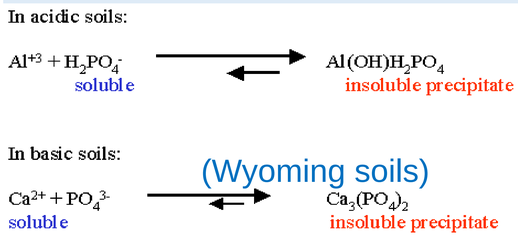
[1]Department of Plant Sciences, University of Wyoming, Laramie, WY ; [2]United States Department of Agriculture, Agricultural Research Services, Sidney, MT; [3]Department of Ecosystem Science and Management, University of Wyoming, Laramie, WY

*Currently at New Mexico State University Agricultural Science Center, Clovis, NM; **Currently at Department of Agronomy and Plant Genetics, University of Minnesota, St Paul, MN

Introduction

- Sugarbeet is a crop with high input use, fertilizer being one of the highest.
- Profitable sugarbeet production depends on high root yield, high sucrose content, and high sugar yield.
- Root elongation has a positive correlation to sugar yields in sugarbeets (Stevanato and Saccomani, 2004).
- Phosphorus (P) is known to increase root growth in crops as well as increase sugar and starch production
- P is best applied to soils through banding (Sims, 2010).

Figure 1: The reaction of P in acidic and alkaline soils



- It has been reported that banding P fertilizer results in more efficient uptake than broadcasting (Anderson and Peterson, 1978). When banding P fertilizers, it is often recommended that the P application rate should be reduced by 30 to 50 % (Sims, 2010).
- A major factor limiting P availability in Wyoming soils is Ca, which binds P, making it unavailable to plants.
- P enhancers are available that when added to fertilizers, are advertised to increase their use efficiency by inhibiting the soil reactions that tie P up.

Objectives

- Evaluate the effect of P application method (banding vs. broadcasting) and an availability enhancing product on sugarbeet response to P application rate.
- Evaluate sugarbeet seedling emergence response to a low salt liquid popup starter fertilizer.

Materials and methods

- Location: University of Wyoming Research and Extension Center - Powell, Wyoming.
- The experimental design was a randomized complete block design (RCBD) split plot with four replications.
- Main plot (105 m × 3.5 m) was fertilizer product and sub plot (15 m × 3.5 m) was fertilizer rates. Fertilizer products were liquid ammonium polyphosphate (**APP**) and dry monoammonium phosphate (**MAP**) with/without a P enhancer (**Avail**® - SFP, Belton, MS), and a popup starter fertilizer**; Helena Nucleus O - Phos**® (8-24-0).
- The five fertilizer products include **APP + Avail® + popup; APP + Avail®; APP; MAP + Avail®; MAP**.
- MAP (11-52-0) was broadcast on tilled plots at rates of **0, 34, 67, 135, 202, 269, and 336 kg ha^{-1}.**
- APP (11-37-0) was banded at a depth of 7 cm directly below, and 7 cm beside the seed row at the same rates prior to planting.
- For all treatments, amount of N applied with the P was deducted from sole N application so all plots received same N amount in a season.
- The starter fertilizer was applied at 14.42 kg ha^{-1} (in-furrow) at planting to one set of the banded P applications.
- Sugarbeet variety “Syngenta HM 9120” was planted in April and harvested in October for root yields and quality analysis.

Figure 2: The sugarbeet sampling process, from field to lab

Table 1: Effect of P source/placement and rates on the P and Zn concentrations in the sugarbeet plants in 2012 . Means with the same letters are not significantly different at P<0.05

Fertilizer product	Top P (%)	Root P (%)	Top Zn (mg kg^{-1})	Root Zn (mg kg^{-1})
APP (Banded)	0.309 b	0.257 ab	23.94 a	19.0 a
APP + Avail	0.319 a	0.260 a	24.91 a	18.47 a
MAP (Broadcast)	0.301 b	0.243 c	24.50 a	18.9 a
MAP + Avail	0.305 b	0.246 bc	25.17 a	18.5 a
APP + Avail + popup	0.303 b	0.248 b	24.90 a	18.47 a
Fertilizer rates (kg P_2O_5/ha)				
0	0.296 d	0.238 de	27.67 a	19.18 a
34	0.289 d	0.237 e	26.74 ab	18.70 ab
67	0.297 d	0.243 de	25.44 bc	19.03 ab
135	0.299 cd	0.249 bc	24.94 c	19.19 a
202	0.313 bc	0.254 ab	23.33 d	18.13 b
269	0.322 ab	0.260 ab	22.72 d	18.22 ab
336	0.331 a	0.265 a	23.21 d	18.09 b

Table 2: Effect of P source/placement and rates on the P and Zn concentrations in the sugarbeet plants in 2013. Means with the same letters are not significantly different at P<0.05

Fertilizer product	Top P (%)	Root P (%)	Top Zn (mg kg^{-1})	Root Zn (mg kg^{-1})
APP (Banded)	0.404 a	0.331 a	56.88 a	26.08 a
APP + Avail	0.394 a	0.332 a	57.04 a	25.00 a
MAP (Broadcast)	0.404 a	0.340 a	56.81 a	25.96 a
MAP + Avail	0.391 a	0.334 a	56.71 a	24.99 a
APP + Avail + pop	0.389 a	0.319 b	59.15 a	25.26 a
Fertilizer rates (kg P_2O_5/ha)				
0	0.380 b	0.308 c	59.03 a	26.11 ab
34	0.382 b	0.320 bc	56.84 ab	25.74 ab
67	0.379 b	0.319 bc	58.41 a	25.12 b
135	0.385 b	0.331 ab	57.21 ab	25.35 ab
202	0.403 a	0.339 ab	56.34 ab	27.05 a
269	0.417 a	0.351 a	57.11 ab	24.69 b
336	0.420 a	0.345 a	55.21 b	25.09 b

Results summary

- Initial soil test results of P (10 mg kg^{-1} in 2012, and 14 mg kg^{-1} in 2013) suggested that there should be a good probability (50 - 60 %) of a yield response to added P fertilizer.
- There were no significant differences among root yields by fertilizer products, which ranged between 86 and 87 t ha^{-1} in 2012 (Fig. 3), and 59 and 60 t ha^{-1} in 2013 (Fig. 4).
- Sugar yields for fertilizer products was between 14.14 and 14.80 t ha^{-1} in 2012, and 7.33 and 7.38 t ha^{-1} in 2013.
- Root yield among rates in 2012 were between 83 and 88 t ha^{-1} (Table 3), whereas sugar yields were between 14.06 and 14.85 t ha^{-1} (Table 3).

Figure 3: Root yield and sugar yield response to fertilizer products in the 2012 growing season. Within the same color bar, means with the same letters are not significantly different at P<0.05.

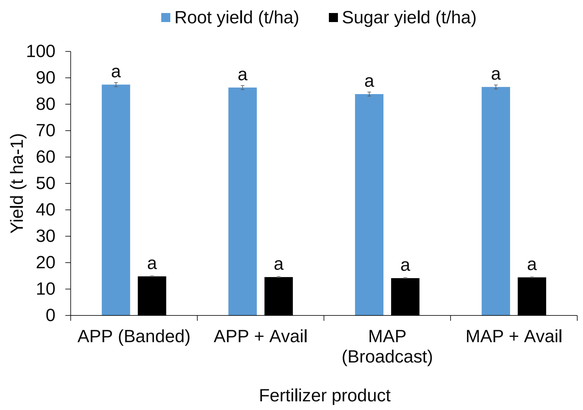


Figure 4: Root yield and sugar yield response to fertilizer products in the 2013 growing season. Within the same color bar, means with the same letters are not significantly different at P<0.05.

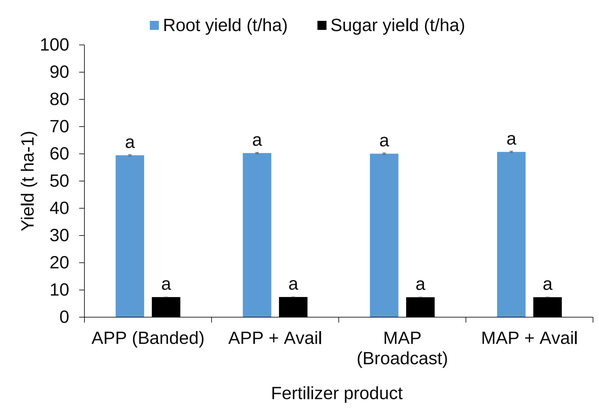


Table 3: Root and sugar yields response to P fertilizer rates in the 2012 growing season

P rates (Kg P_2O_5 ha^{-1})	Root yield (t ha^{-1})	Sugar yield (t ha^{-1})
0	83.84 a	14.06 a
34	86.53 a	14.46 a
67	86.08 a	14.60 a
135	85.86 a	14.50 a
202	85.86 a	14.44 a
269	85.86 a	14.41 a
336	88.32 a	14.85 a

***Means with the same letters within a column are not significantly different at P<0.05.**

Table 4: Root and sugar yields response to P fertilizer rates in the 2013 growing season

P rates (Kg P_2O_5 ha^{-1})	Root yield (t ha^{-1})	Sugar yield (t ha^{-1})
0	58.15 a	7.08 b
34	58.35 a	7.08 b
67	58.71 a	7.15 ab
135	60.01 a	7.36 ab
202	61.15 a	7.44 ab
269	60.37 a	7.44 ab
336	62.07 a	7.69 a

***Means with the same letters within a column are not significantly different at P<0.05.**

Table 5: Sugarbeet seedling emergence (standcount), root yield, and sugar yield response to popup liquid starter fertilizer in 2012 and 2013

	2012				2013			
Fertilizer product	Standcount Plants/3m	Plants/hectare	Root yield (t ha^{-1})	Sugar yield (t ha^{-1})	Standcount Plants/3m	Plants/hectare	Root yield (t ha^{-1})	Sugar yield (t ha^{-1})
APP + Avail	15.1 a	90,294 a	86.31 a	14.53 a	7 b	41,176 b	59.8 b	7.36 b
APP + Avail + Popup	14.8 a	88,394 a	86.31 a	14.47 a	12 a	70,588 a	75.17 a	9.24 a

Results summary … *continuation*

- Root yields among rates in 2013 were between 58 and 62 t ha^{-1} (Table 4). Sugar yields among rates were between 7.08 and 7.69 t ha^{-1} (Table 4). There were no significant differences among root yields but there were significant differences among sugar yields.
- The popup starter fertilizer and the non-popup treatment equally produced root yields of 86 t ha^{-1} and sugar yields of 14 t ha^{-1} in 2012 (Table 5). In 2013, the popup treatment produced a root yield of 75.17 t ha^{-1} and sugar yield of 9.24 t ha^{-1}, whereas the non-popup treatment had root yield of 59.8 t ha^{-1} and sugar yield of 7.36 t ha^{-1} (Table 5).
- Sugarbeet standcount in 2012 was 88,394 plants/ha for the popup treatment (Table 5) and 90,294 plants/ha for the non-popup treatment. In 2013, the standcount was 70,588 plants/ha in the popup treatment and 41,176 plants/ha in the non-popup.

Conclusion

- Higher P_2O_5 rates corresponded to slightly higher root and sugar yields.
- The P enhancer was seen to have minimal to no effect on P availability based on the early season sampling analysis.
- Applying popup starter fertilizer may increase sugarbeet seedling emergence and yield.
- Banding P fertilizers increases early season plant weight in some cases.

References

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Contact: nkusi@uwyo.edu

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