Phosphorus Reduction Demo Trial 2013

Introduction

Potatoes require a large amount of nutrients for sufficient tuber production, because they are inefficient nutrient users in comparison to many other crops. This is due in part to a very shallow root system, thereby reducing the exposure the root system has to nutrients prior to leaching or becoming tied up with other ions within the soil solution.

Over application of nutrients beyond the crop requirements often occurs to ensure that the crop has sufficient nutrients available to produce acceptable crop yields. This is particularly the case for phosphorus (P) fertilization. Since available P ions ($H_2PO_4^-$, HPO_4^{2-}) are relatively immobile within the soil solution, it is difficult for P to travel within the soil solution to areas intercepted by the plant's roots. This immobility is beneficial since they are rarely leached out of the system, but is invaluable if fertilizers are applied via broadcast or away from the root zone. P availability is also greatly reduced within PEI soils since P ions are made largely unavailable as they become tied up with aluminum and iron ions, forming fixed compounds. Even when soil P levels appear high, soil P can be largely unavailable.

Accumulation of P within agricultural soils was one of the main observations found within the PEI Soil Quality Monitoring Study (2012). Highest soil P levels were often found within potato crop rotations, with increased values in soil P occurring with increased frequency of potato years within the crop rotation (PEI Soil Quality Monitoring Report 2012). Given the reduced P uptake efficiency of the potato accompanied with the excess amounts of applied P at planting, the potential for PEI soils to reach P saturation is possible. Excess P nutrients within the soil can cause many environmental issues, including P movement following precipitation events from runoff into surface waters causing eutrophication and algal blooms, as well as potential P precipitation into the groundwater (within P saturated soils).

In order to continue cropping potatoes sustainably, nutrient management practices that reduce potential P loss from the soil system, but also maintaining original crop yields, is essential. A reduction in P inputs in this system may be beneficial to the environment, as well as economically to producers, through reduced application rates.

Methods

A demo trial was conducted within the spring of 2013 to determine the impact of reducing additional soil P to potatoes (cv. Shepody), and to identify potential yield and soil P availability differences over the growing season. The trial was conducted on a field under a 3 year grain (forage under seeded) - hay- potato rotation, within the potato year, in the Kensington area. This field was chosen based on grower cooperation and P levels testing within the High range. Using data from a grid sampling soil analysis in the previous fall, average soil P levels within the field were 294 $\pm$ 45 ppm.

Potatoes (cv. Shepody) were planted on May 31, 2013. All plants were under rain-fed production. The field was divided into two treatments: grower standard practice (GSP) and reduced P (RP) practice. Both treatments were managed identically with exception to the amount of P fertilizer applied at planting. Although both trials received approximately 150 lbs/acre of N and 200 lbs/acre of K_2O, the GSP plot received 150 lbs of P_2O_5 /acre, whereas the RP plot received approximately 100 lbs of P_2O_5 /acre.

Soil samples were taken 5 times throughout the season following planting, approximately every 3-4 weeks. Six soil samples were taken at three depths (0-15 cm, 15-30 cm, and 30-45 cm), to produce a composite soil sample for all depths for both treatments. Petiole samples were taken from each treatment twice during the season. Prior to commercial harvest, three yield strips of 10 m lengths, were harvested and graded by size, and total yields were estimated.

Results and Discussion

There was no effect of treatment for any of the measured soil characteristics including plant available P (P_2O_5), plant available K (K_2O), pH, or organic matter, throughout the season. Soil samples taken across the season showed no significant changes in plant available P levels for either treatment or for any of the three soil depths (Figure 1a). Soil P levels within the RP treatment in comparison to the GSP treatment within the shallow root zone (0-15 cm) were relatively stable across the season, whereas both deeper soil depths showed no obvious soil P use pattern. Greatest soil P levels would have been expected within the shallow depths due to fertilizer banding at planting and the relative immobility of P. The greater soil P levels observed in early July were consistent with the highest P petiole levels observed all season, sampled on the same date (Table 1).

Average payable tuber yields based on sampled test strips (tubers greater than 2”) for the RP and GSP treatments were 184 $\pm$ 34 cwt/acre and 178 $\pm$ 40 cwt/acre, respectively. There was no significant difference in total yields or total pay yields for either treatment found within this study (Figure 2). This may suggest that in this field, for this growing season and this cultivar, enough soil P was available within the soil to meet conventional P inputs even at a reduction of 50 lbs/acre of P added. It is important to note however, that predicted yields from the 10 m strips within both treatments were estimated to be 50-60 cwt/acre lower than predicted yields from grower harvest, which may have been partially impacted by an early harvest of yields strips in comparison to the timing of grower yields.

Plant available K levels (K_2O) showed an obvious decline for all soil depths following planting and hilling (Figure 1). During this time, plant K uptake greatly increases throughout the season as increased plant growth and plant biomass is produced. This increased plant K uptake is estimated to continue into tuber initiation and bulking, with less K use near the end of the season during tuber maturation due to plant senescence (Stark *et al*. 2004).

Soil pH within the root zone decreased following planting within both treatments possibly due to the addition of ammonium fertilizers, which can lead to acidifying conditions through the process of nitrification. Organic matter levels were inconsistent throughout the season, and unexpectedly showed lower levels within the top layers of the soil profile within the RP treatment (Figure 1). This reduction in soil organic matter is not easily explained, but the fluctuation of reduced organic matter within August could have been caused by organic matter displacement by soil erosion or runoff due to the sloping topography of some areas of the field during the few, but significant rainfall events during July (Agweather Atlantic 2014).

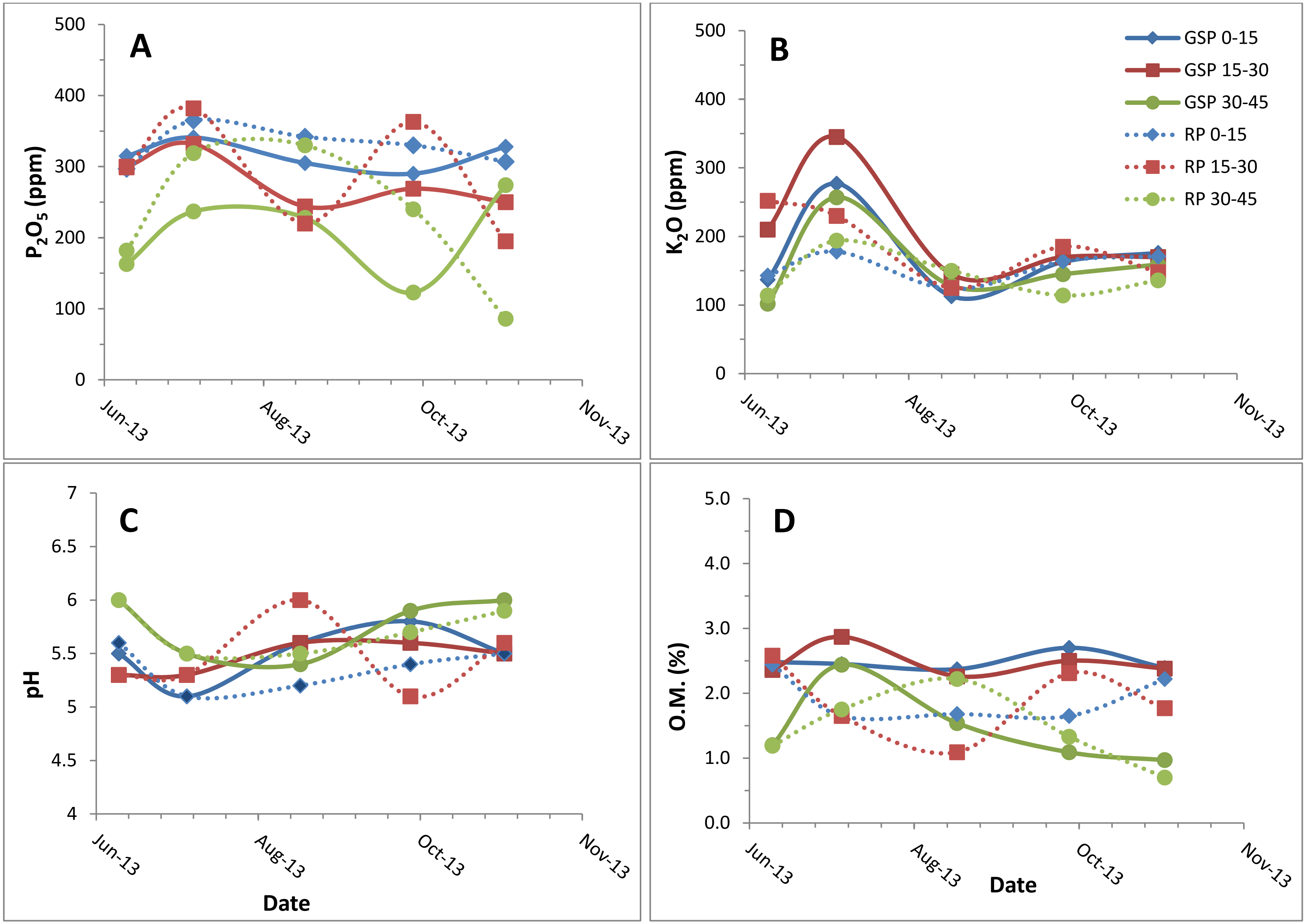

Figure 1. Plant available P (A), plant available K (B), pH (C) and organic matter levels (D) in both fertility treatments at all three depths (0-15 cm, 15-30 cm, and 30-45 cm) across the growing season.

Table 1. Petiole sample results for both fertility treatments taken across the growing season.

Treatment	Sample Date	NO_3	P	K	Ca	Mg	S	B	Cu	Zn
		%						ppm		
GSP	7/2/2013	2.28	0.46	8.64	0.66	0.2	-	22.8	11.29	49.7
RP		2.8	0.5	9.8	0.65	0.24	-	23.3	11.29	63.1
GSP	7/23/2013	3.48	0.29	8.51	0.75	0.22	0.15	23.5	3.6	29.7
RP		3.26	0.31	8.54	0.64	0.2	0.14	22.7	3.86	31.2
GSP	8/23/2013	2.49	0.2	9.9	1.06	0.46	0.13	30.6	3.02	41.9
RP		3.07	0.21	9.39	1.09	0.44	0.11	30.6	3.97	38.2

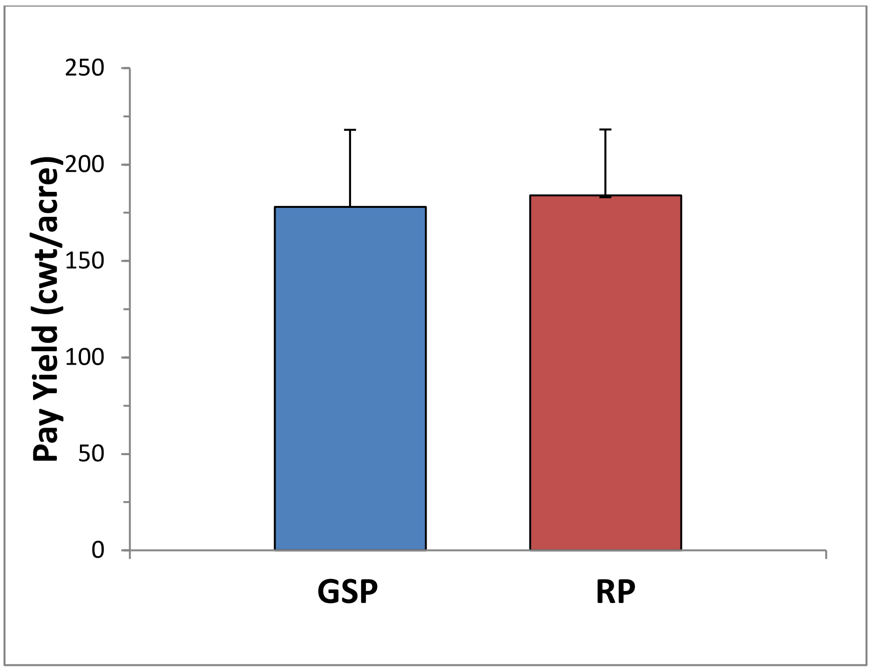

Figure 2. Total yields (above 2” tuber size) for both fertility treatments.

Conclusions

Preliminary data indicates that there was not a significant difference in total pay yields within both the GSP and RP trials, although there was a significant reduction in soil P within the RP treatment. This may advocate that where there are high levels of soil P, a reduction in P application rates may prove to be beneficial to the producer through better cost of return, as high P application rates may not be necessary to maintain yields. Reduction in soil P would also show positive returns environmentally, as this would reduce potential P loss from fields through soil erosion and runoff. We recommend that this trial be repeated over future growing seasons to test applied P reductions in fields that vary in soil P levels under varying seasonal conditions. It is also advisable that in future studies, harvested tubers from all treatments be sent to a grading facility for assessment of marketable yield and tuber quality.

References

- Agweather Atlantic Monthly Report. 2014. Monthly summary report for Kensington Weather Station, available online at: http://atl.agrometeo.org/indices/mcd/cyqm. Retrieved online on January 29, 2014.
- PEI Soil Quality Monitoring Report. 2012. Soil nutrient status over the last 15 years in Prince Edward Island. PEI Department of Agriculture and Forestry. 48 pps. Retrieved online on January 20, 2014. Available at: http://www.gov.pe.ca/photos/original/af_sw_soilq2012.pdf.
- Stark, J.D., Westermann, D., and B. Hopkins. 2004. Nutrient Management Guidelines for Russet Burbank Potatoes. University of Idaho College of Agricultural and Life Sciences Extension (Bulletin 840). Published October 2004.

Contact Information:

Kyra Stiles
Nutrient Management
PEI Department of Agriculture and Forestry
Tel: 316-1600