

# LIQUID PHOSPHORUS POTATO FERTILITY TRIALS

## Final Report

January 2016

### Introduction

The PEI Department of Agriculture and Fisheries (PEIDAF) and Genesis Crop Systems Inc (GCS) were engaged to collaborate on a two year project evaluating the performance of several liquid phosphorus based starter fertilizer products during the growing season of 2014 and 2015. Parameters assessed included yield, tuber quality, soil nutrient attributes and overall economic benefit on several potato varieties grown for the commercial potato industry in Prince Edward Island.

Generally, Island potato producers might consider adoption of liquid starter fertilizer products for the following reasons:

- Lower salt index than most traditional dry fertilizer components
- Less fertilizer dust during application and /or planting
- Increased application efficiency in the presence of daily fluctuating humidity levels
- Capacity to add various secondary micronutrients when required

Agronomic performance, cost, storage logistics and product availability were also other important factors that were considered in this trial, as they should be considered for adoption of this type of system.

Prior to the spring of 2014, GCS initiated contact with representatives of the following companies that had expressed interest in having their products evaluated under PEI conditions: Alpine Plant Food, Agro-Culture Liquid and N-XT. A description of each company and specific application for each program is described below.

## **Methodology**

Potential grower collaborators were identified and fields with current soil test reports selected for the evaluation process. Liquid fertilizer strategies were developed for each grower and site based on: current soil test report data, credits for use of any additional organic amendments or green manures, the potato variety, crop end use and/or specific market, and recommendations from the appropriate liquid fertilizer supplier.

Trial procedures varied based on each field trial as it was dependent on grower's current standard practices. Implementation of liquid fertilizer into the potato year was based widely on how it would best fit into their current nutrient application practices on farm and individual crop management preferences.

At time of planting, growers split each trial field into two or more sections. One section consisted of one or more of the liquid application rates under investigation; the second consisted of a fertilizer program based on that individual farm's current grower standard practice (GSP) for the variety being planted. All subsequent field management activities were provided with growers using industry accepted best management practices for potato production in PEI.

Petiole samples were collected from each treatment in each field at time of full row closure and again two weeks later. Petioles were submitted to the PEI Analytical Laboratories for analysis of plant nutrient content.

Prior to commercial harvest, six 15' strips from each treatment within each field were hand harvested and placed at GCS storage for tuber evaluation. Care was taken to ensure the same number of plants was harvested from each treatment within each respective field.

Soil samples were collected at 0-6", 6-12" and 12-18" depths directly within the row approximately 10-20 days after row closure and post-harvest in 2014. Soil samples in 2015 were taken at the same depths as

2014, but only at post-harvest. Soil samples were also submitted for analysis to the PEI Analytical Laboratories for soil nutrient content.

All tuber samples were initially sized, and weighed at GCS and later delivered to Cavendish Farms Central Grading Facility (CFCG) to simulate evaluation of a commercial delivery of potatoes. Tubers from several fields where the varieties are not commonly used for French fry production were excluded from this step and evaluated in conjunction with the participating grower.

## **Products**

- **G24<sup>®</sup>** is produced by Alpine Plant Food based in New Hamburg, ON. According to the company, each US gallon provides 2.5-3 lbs/acre P<sub>2</sub>O<sub>5</sub> (Note: all liquid fertilizer application rates discussed within this report are reported in US gallons per acre, gpa). Rates tested in trials ranged 10-40 gpa/acre in furrow at planting, mixed with a 0.5 gpa mixture of Boron and Zinc. In all cases but one, all additional nutrients (N, K<sub>2</sub>O, Mg, etc.) were applied via broadcast and incorporated prior to planting and/or prior to final hilling.
- **Pro-Germinator<sup>®</sup>** is produced by Agro-Culture Liquid in St Johns MI, USA. According to the company, each US gallon provides 10-12 lbs P<sub>2</sub>O<sub>5</sub>/acre. All Pro-Germinator was applied at 10 gpa + 0.5 gpa micronutrient mix applied in furrow at planting. All additional nutrients (N, K<sub>2</sub>O, Mg, etc.) were applied via broadcast and incorporated prior to planting and/or prior to final hilling.
- **N-XT<sup>®</sup>** is a liquid fertilizer company based in Emmen, The Netherlands. The NXT program involved several applications of various liquid products as follows: *in furrow at planting* (40 gpa 18-14-0 + B Zn), *immediately prior to hilling* (22 gpa 9-0-0+ Ca B), and *starting at tuber initiation and at 10 day intervals* afterward initiation

throughout the season (2-4 gpa of 18-0-0 + Ca Mg Mn). All K<sub>2</sub>O and additional Mg applied were broadcast and incorporated prior to planting.

## **RESULTS**

Various visual foliar and subsoil effects were observed during both growing seasons. Generally, visual observations showed that within some fields, liquid programs produced foliage that had paler green color than foliage produced from the comparative GSP section in the same field. In some cases, the liquid treated sections appeared to emerge and senesce quicker than the GSP section (Figure 1). This may be due to the differences between N applications between both treatments. Within some treatments, N was applied at lower rates within the liquid program as compared to much higher initial N application in the planter mix at all grower GSP sites (>2 sites). Total lbs/acre N applied in most liquid treatments was relatively similar to the GSP treated sections. However, applied phosphorus from the liquid products may also have played a role in this process, given it had greater availability to the emerging root complex earlier in the season and subsequent effects on plant growth, in comparison to the granular GSP applied P.



**Figure 1. Prospect potatoes at full row closure from GSP and ProGerminator based fertilizer systems - July 22<sup>nd</sup> 2014 at Site A.**

Root “window” boxes constructed at one site in 2014 revealed quite different plant root growth from the liquid treated area as compared to the GSP, where the liquid treated program saw much greater fibrous root growth than that of the GSP program at the end of the season (Figure 2). However, fresh weights of roots collected during mid-season plant collection showed no significant difference between both treatments in terms of total root weight (data not shown). This may be caused by the fact that the data collected was slightly biased toward collection of large roots, since roots were harvested by pulling whole plants from the ground. This would have caused detachment of smaller, fibrous roots from the plant and left within the soil. Greater root development would have been assumed within the liquid program given the role that P traditionally plays in encouraging root development.

Total yield, tuber specific gravity and net crop value data are presented in Tables 1, 2 and 3 for Alpine G24, Pro-Germinator and NXT trials, respectively. Treatments varied within several fields so all programs are presented by supplier and year on a site by site basis below.

## **Alpine G24**

Sites A and B featured the product, G24 applied at 40 gpa compared to the farms' traditional grower standard practice (GSP) program (Table 1). Slight numerical differences were evident in yield and crop value at harvest but no consistent trends were observed.

G24 treated plants displayed somewhat lighter foliage color and slightly less overall vine growth than those from the GSP plants. As mentioned previously, this may likely be a result of the nature of the nitrogen application (several smaller doses as compared to the GSP where the majority of N was banded at planting).

Sites C and H featured G24 applied at 10 gpa *in addition* to the traditional dry planter fertilizer or broadcast mix and compared with the traditional dry planter fertilizer mix alone (GSP), which resulted in increased numerical yield, specific gravity and crop value at Site C only (Table 1). Limited samples from Site H prevented any statistical analysis.

Sites D, E, F and G featured G24 applied at 10 or 20 gpa, as well as the GSP treatment. Although tuber yields were similar at Sites D and E, a severe mid-late season weed flush in both G24 treated sections may have been responsible for a reduction in crop value. Tuber specific gravity values (one composite per treatment) were trending higher in the G24 samples, but not statistically different.

Yields of Monticello at Sites F and G were up slightly in both the 10 gpa and 20 gpa treatments, but were not statistically different (Table 1). Potential differences could be due to changes in overall field performance as opposed to effect of fertility treatment given that the distance between treatments was approximately 200 yards away.



Figure 2: Prospect potato root systems from GSP (left) and Pro-Germinator (right) fertility systems from a window root box - 2014 PEI Liquid Fertilizer Trials.

## **Pro-Germinator**

Pro-Germinator was featured at four sites in 2014 and at six sites in 2015 (Table 2). Plot harvest logistics prevented sample collection prior to commercial harvest at site T in 2014. The grower, however, did collect and evaluate several samples from the GSP and Pro-Germinator strips and reported a yield increase of 20 cwt/acre in the Pro-Germinator treated plots. Application issues arose at site S in 2015 that prevented attaining the target rate. Material left after planting was broadcast sprayed on the target area in the field and immediately incorporated at time of final hilling.

**Table 1: Comparison of Alpine G24 and GSP fertility programs on yield, specific gravity and net crop value of PEI potatoes – PEI Liquid Fertilizer Trials 2014-15**

Site / Year	Variety	Treatment	Rate (us gpa)	Total Yield	Specific Gravity	Net Crop Value (\$/acre)
A14	R Burbank	GSP		327	1.081	2462
		G24	40.5	322	1.083	2277
B14	R Burbank	GSP		310	1.092	2534
		G24	40.5	323	1.087	2732
C14	R Burbank	GSP		339	1.083	2981
		GSP + G24	10.5	375	1.087	3387
H15	FL2137	GSP		287	N/A	2670
		GSP + G24	10.5	307	N/A	3201
D15	GoldRush	GSP		305	1.074	5282
		G24	10.5	304	1.078	4297
E15	GoldRush	GSP		305	1.074	5282
		G24	20.5	307	1.077	4683
F15	Monticello	GSP		295	N/A	3080
		GSP + G24	10.5	270	N/A	2736
G15	Monticello	GSP		295	N/A	3080
		GSP + G24	20.5	305	N/A	3116

\* At a 95% confidence interval.

Pro-Germinator yields and crop values were similar to those from GSP samples in Prospects at Sites I and J (Table 2). Specific gravity values were higher in the Pro-Germinator samples at Site J, though not statistically different. In 2014, Russet Burbank Pro-Germinator yields were similar to GSP at two of three sites (Table 2). Numerically, Site K had higher specific gravity values in the Pro-Germinator samples while Site M had lower values than the GSP treatment. No significant differences were recorded with regards to overall crop value at any of these three sites.



**Table 2: Comparison of Pro-Germinator and GSP fertility programs on yield, specific gravity and net crop value of PEI potatoes- PEI Liquid Fertilizer Trials 2014-2015**

Site / Year	Variety	Treatment	Total Yield	Specific Gravity	Net Crop Value (\$/acre)
I14	Prospect	GSP	301	1.091	2677
		ProGerm	295	1.089	2762
J14	Prospect	GSP	397	1.075	3042
		ProGerm	396	1.081	3185
K14	R Burbank	GSP	271	1.082	2196
		ProGerm	270	1.087	2244
L14	R Burbank	GSP	304	1.087	2622
		ProGerm	320	1.088	2698
M14	R Burbank	GSP	304*	1.093*	2414
		ProGerm	280	1.089	2201
N15	Monticello	GSP	295	1.089	3080
		ProGerm	292	1.088	2988
O15	Ranger Russet	GSP	223*	N/A	2192*
		ProGerm	211	N/A	1825
P15	R Burbank	GSP	423	1.087	3689
		ProGerm	424	1.086	3713
Q15	R Burbank	GSP	313	1.078	2608
		ProGerm	358	1.085	2490
R15	R Burbank	GSP	288	1.08	2542
		ProGerm	294	1.088	2995
S15	R Burbank	GSP	391*	1.084	3939
		ProGerm	338	1.086	3232

\* At a 95% confidence interval.

In 2015, Pro-Germinator samples showed high variation for all treatments for yields, specific gravity and crop values. Tuber specific gravity values were higher within the Pro-Germinator sections at Sites Q and R, numerically but not statistically (Table 2).

## N-XT

The N-XT program was evaluated three times in the 2014 and 2015 seasons (Table 3). Results obtained from the 2014 data suggested the N-XT program may have provided inadequate N fertilization to the crop. Following discussions with company officials, 2015 fertility rates were adjusted upwards 10-20% to alleviate this concern.

**Table 3: Comparison of N-XT and GSP fertility programs on yield, specific gravity and net crop value of PEI potatoes – PEI Liquid Fertilizer Trials 2014-15**

Site / Year	Variety	Treatment	Total Yield	Specific Gravity	Net Crop Value (\$/acre)
T14	R Burbank	GSP	327	1.081	2462
		NXT	278	1.087	2095
U14	R Burbank	GSP	310	1.092	2534*
		NXT	310	1.089	2121
V15	GoldRush	GSP	279	1.072	4635
		NXT	263	1.075	3676

\* At a 95% confidence interval.

Tuber yield from NXT treated plants was equal or lower than that from GSP treated plants (Table 3). Throughout most of the growing season, foliage of NXT plants was much paler than those of GSP plants. Canopy growth was noticeably reduced as well. Adjustments made to fertility recommendations in 2015 did not appear to accommodate the plants' N requirements given that no major improvements were observed in overall plant appearance or performance in comparison to the 2014 season. Crop values from NXT treated sections were reduced at each site each of the two years, but only statistically in one case in 2014.

## Nutrient Analysis

In a nutrient removal budget based on tuber yields, greater amounts of N and  $K_2O$  were removed from the soil from the Liquid treatments in 6 of 10 cases, and for  $P_2O_5$  in 2 of 10 cases (Appendix 1). It is difficult to know with certainty why less P was found within tubers within the Liquid program. Petiole samples within 2014 did not show consistently greater P levels at the mid-season sampling, and it is possible that some P was diffused within the soil within the liquid program and was not available to the tubers or roots at this time. However, all petiole samples at both mid-season sampling times (with exception to one site) in 2015 showed higher P concentrations within the GSP than the Liquid programs.

Soil analysis results in 2014 at the 0-6" soil depth demonstrated that all liquid programs showed a decrease in soil  $P_2O_5$  levels from mid-season to post-season, whereas only 4 of the GSP treatments showed a reduction in soil P levels from mid-season to post-season. In 2015, all P levels post-harvest were lower within the liquid P treatment in comparison to the GSP treatments, with exception to three sites.

A slight trend of lower soluble salt levels within the first twelve inches was visible for most liquid programs in 2014, with exception to the G24 liquid program at Site E.

In 2014, whole plant samples were collected. Total plant weights showed lower total above-ground plant biomass within the Liquid programs at all sites except Sites B14 and I14 (Appendix 1), which would help support the theory that greater emphasis was put towards root growth rather than shoot growth within the liquid trials, as was discussed within the beginning of the results section. Whole plant samples also showed higher moisture levels within all liquid programs with the exception of two sites, Site A14 and Site E14 (N-XT treatment; Table 6). Greater moisture levels within these whole plant samples may also add to the advantage of greater root development and the appearance of greater fibrous roots within the liquid program at the root boxes, since greater area covered by the roots may lead to greater scavenging of water under dry conditions as

those observed both seasons. Whole plant samples were not collected in the 2015 season.

## **Conclusions**

Results collectively from this Liquid Fertilizer Trial within both years were generally quite variable. In all trials where no external confounding factors could be identified, the use of liquid fertilizer proved to be both beneficial and disadvantageous in comparison to GSP. Several of the sites had confounding issues with weeds, unanticipated distances between sample collection sites, and issues with appropriate application rates at planting time in comparison to the rates that were anticipated. Data collected from identified sites that were impacted by these factors should be interpreted with caution.

When comparing all liquid products separately, there was a positive response to use of the product G24 when it was added to a program in conjunction with some dry fertilizer products. Results with Pro-Germinator were overall too variable, and the cost of using this product to replace all of the  $P_2O_5$  may be cost prohibitive for most growers. The NXT trial results were disappointing from all sites tested in both seasons. Trans Atlantic shipping of product from Western Europe would also not be feasible for the long term, given the results received using this product.

Given the positive results with the G24 product, further study would be recommended to evaluate the effects of using G24 in combination with reduced rates of standard dry P products on a larger scale.

The benefit of liquid starter P fertilizers in decreasing total P application within potato production (and therefore P concentrations within the soil over time), is still possible given the soil results seen in both seasons. Some benefit was also seen in increasing specific gravity within tubers of some sites, however this may also be impacted by the results of split N applications, not only liquid P products.

Slight incompatibility issues (with in furrow fungicide products) arose at two sites and anyone wanting to use these products should consider installation of separate application equipment to ensure proper product placement.