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Use of EndoMaxx mycorrhizal seed treatment to improve potato production in Maine

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Introduction

With the increasing cost of fertilizer and the ever-decreasing supply of apatite worldwide, improving phosphorus (P) uptake should be a goal for all producers. Due to our high levels of iron and aluminum oxides in Maine soils, P efficiency is very poor. As a result, potato farmers tend to over apply P to ensure that their crop will have adequate P. Over time, this has led to increasing plant available soil test P levels. I recently requested the Maine Soil Test Lab director for potato soil tests over the past ten years. The percentage of soils testing above 40 lbs/ac has grown steadily over the past 10 years (Figure 1). Mycorrhizal fungi have long been used as a means to effectively improve P absorption of perennial plants. Less work has been done evaluating these for annual crops. With funding from the Valent corporation, we were able to evaluate one such mycorrhizal fungi product, EndoMaxx, to see if it might improve P uptake, yield and quality of potatoes.

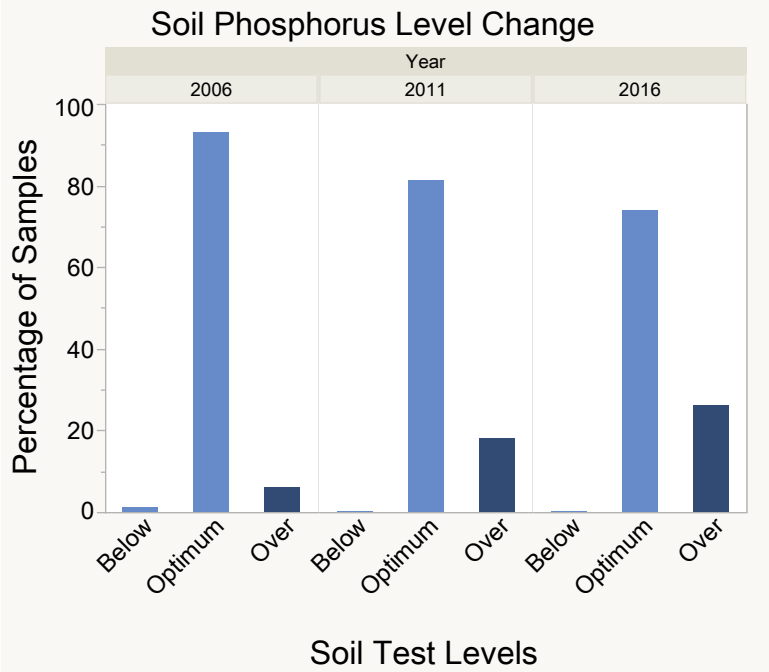

Figure 1. Change over time of the number of fields testing above optimum for phosphorus

Methods

Snowden was the variety selected to evaluate the EndoMaxx product in Central Maine. The experiment was set up as a split plot design with three rates of phosphorus (0 – 75 and 150 lbs P2O5/ac) with and without EndoMaxx and replicated six times. Field information is provided in Table 1. Phosphorus was broadcast applied and incorporated

with one pass of a Perfecta II harrow. Following plot reestablishment, potato rows were marked and N and K fertilizer was band applied at 160 lbs N and K2O/ac. Seed pieces were hand planted at 9 in spacing. Red potatoes were planted between the study treatments to allow machine harvest. The Endomaxx product was then applied at a rate of 0.23 g/ha using a hand held spray Asolo sprayer directly to seed in the row. The potatoes were then covered using the planter. Weeds were controlled using 1 lb/ac of metribuzin and 2 pints of metolachlor/ac applied after one-pass hilling on 7 June 2016. This was the first time this implement had been used by our farm manager, and there was a learning curve; at the end of the season we had to discard three plots due to hiller damage. Insects were controlled with spinosid and imidichloprid applied post emergence. Fungal organisms were controlled with weekly applications of fungicides including Tanos, Curzate and Revus rotated through the season. We identified one row per plot to use for yield, and we sampled the first and fourth rows in the plot for potato leaf sampling and for identification of infection by the mycorrhizae. To sample leaf P concentrations, we sampled 25 leaves from the 4th potato leaflet from the top of the plant in early July at flowering. These were placed in paper bags and sent away for analysis. On August 26, root samples were collected to assess mycorrhizal infection. Four plants were sampled per plot and combined over replicates to provide the lab with six samples to analyze. On 2 September potatoes were top-killed with diquat. One 20-foot plot was harvested for yield. Potatoes were dug using a one-row harvester on 22 September. Potatoes were stored at 42 degrees F in a controlled temperature and humidity storage locker at the University of Maine. We processed the potatoes over a course of several weeks. Potatoes were washed and graded into the following size catagories: <114 g, 115 – 227g, and 227 - 342 g, and > 342. Additionally, 10 potatoes were graded for skin quality and internal defect. There was very little internal defect noted. Skin surface disease symptoms were also virtually non-existant. Data were analyzed using JMP 11 statistical software. Treatment differences were determined using pre-planned orthogonal contrasts and significance was set at alpha of 0.05.

Table 1. Trial information for EndoMaxx Trial – 2016

Site Information	**Values**
Soil Test Results	
pH	6.2
Organic matter	3.4
P (lbs/ac)	7.9
K (% sat)	8.1
Ca (% sat)	78.7
Mg (% sat)	13.2
S (ppm)	12
CEC	5.5 meg/100g
Previous Crop	Small grains
Tillage	Moldboard plowed – disked twice prior to planting
Potato Variety	Snowden
At planting insecticide	Imidichloprid – labeled rate
Herbicide: metribuzin and metolachlor	0.5 lbs/ac and 2 pints/ac

P fertilization date	20 May
N fertilization rate	160 lbs/ac
K fertilization rate	160 lbs K2O/ac
Planting Date	23 May
Rate of Endomaxx	4 g/ac
Leaf sampling	9 July
Root ball sampling	26 August
Desiccant applied	1 September
Potato Harvest	22 September

Results

Limited accumulated rainfall affected potato production and likely the effectiveness of Endomaxx in 2016. The lack of rainfall could have reduced the effectiveness of the mycorrhizal fungi to grow following root infection. Accumulated rainfall is presented in Figure 2.

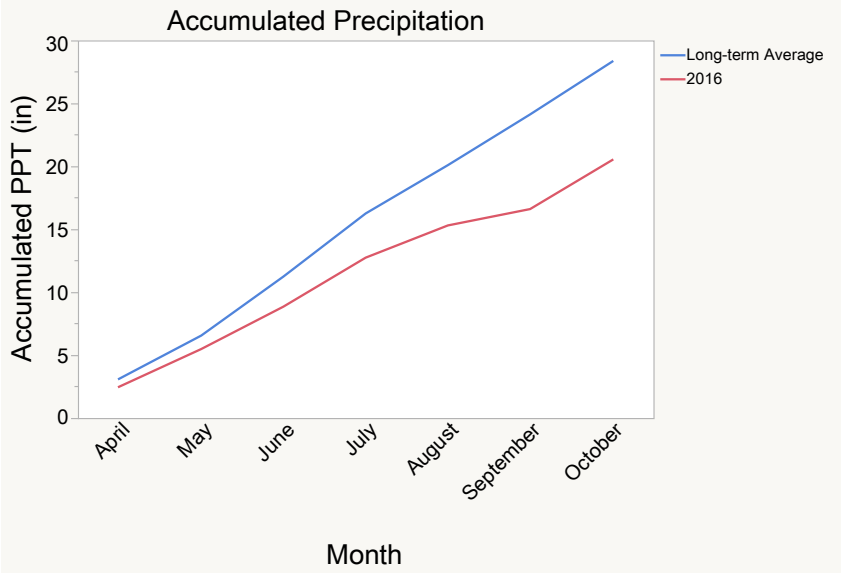

Figure 2. Accumulated precipitation over the 2016 growing season

Efficiency of fertilizer applied to field

To address the efficiency of fertilizer P, we sampled each plot in the study area approximately a month after broadcast application of P fertilizer and incorporation; we were unable to detect treatment differences. Despite applying up to 150 lbs P_2O_5/ac, no treatment differences were found (Figure 3). This documents the extent that this silt-loam soil has excellent capacity to fix P.

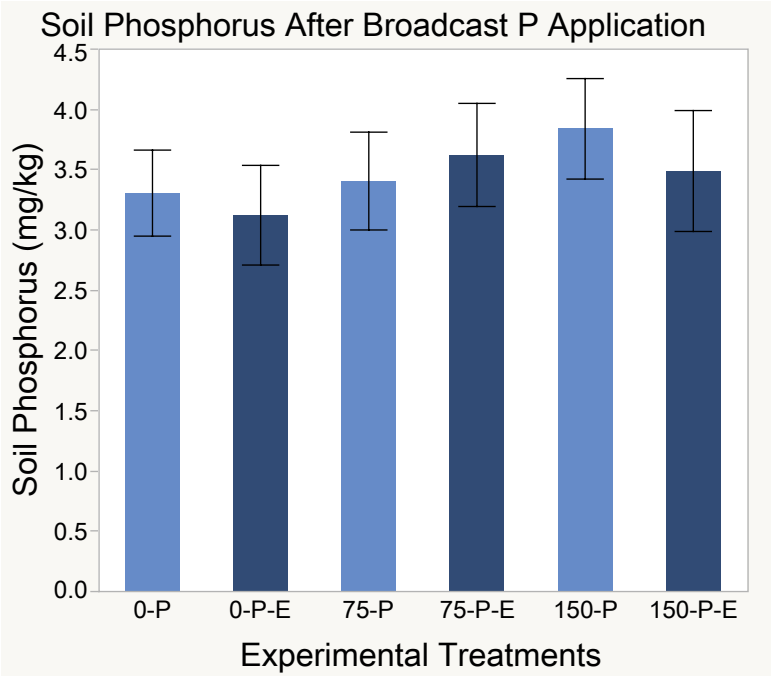

Figure 3. Evidence of soil phosphorus fixation

Root Colonization

We found evidence of root colonization of mycorrhizal fungi in the treated plots and little evidence in the untreated plots. We found an average of 20.4% of the roots showing sign of infection where we treated. One of the untreated plots showed evidence of 5% infection in one of three untreated treatments. This could have been from application error or there might have been some natural mycorrhizal fungi present in a section of the field? The field was not fumigated prior to initiating the trial. Aside from the one detection, there was not much evidence of mycorrhizal fungi in the background soil.

Canopy closure and Drought Assessments

As shown in Figure 2, the area did not receive the usual rainfall for our area. In early August, we assessed both canopy closure and drought by plot to see if we could see treatment differences. Due to the lack of rainfall, potatoes never reached canopy closure. Therefore, the ratings presented in Figure 4, don't mean a great deal. I have included a picture of the study below in exhibit 1 that both shows the degree of canopy closure reached in the study as well as some of the cultivation damage caused by the one-pass hiller.

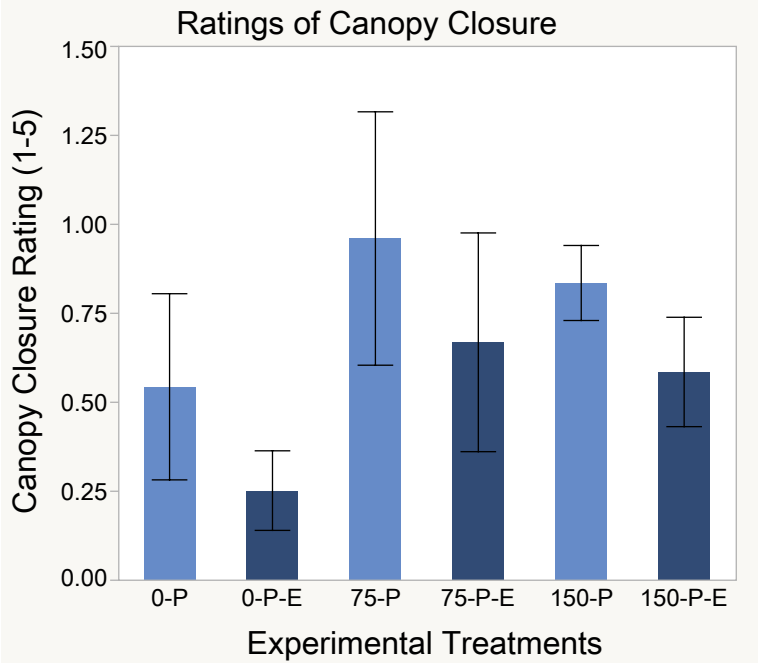

Figure 4. Ratings of canopy closure in EndoMaxx study.


Exhibit 1. Potatoes at maximum growth – August 18, 2016

Leaf P Concentration

We also did not see treatment differences in leaf P concentrations. All the leaf P samples ranged between 0.31 and 0.32 percent.

Yield

We harvested one 20-foot row from each plot for our yield estimates. Three plots were designated as a loss (not to harvest) prior to harvest and two plots were harvested together, and the data from those plots had to be thrown out. Each plot was from a different treatment, and so I randomly threw out a replicate from the other treatment, and I analyzed the study as a five replication study for yield and quality analyses.

The overall analysis of variance for all treatments was not significant for total or marketable potato number or for total or marketable potato yield. Yield variance can be higher with potatoes compared to other crops (corn, soybeans, etc), and in a year with low rainfall variability can be expected to be high. With additional unprotected contrasts, we found that marketable potato number was significantly higher across P rates with potatoes treated with EndoMaxx (Figure 5). But, total potato number was more variable and not different at the 0.05% level.

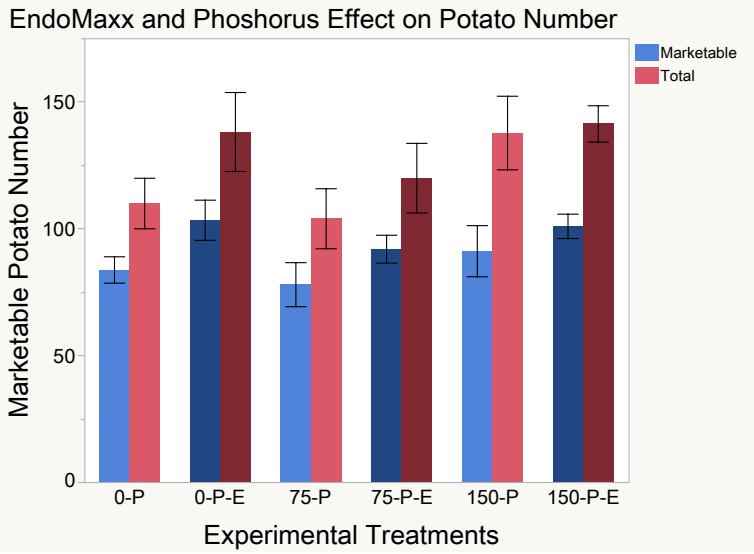

Figure 5. EndoMaxx significantly increased marketable potato number

Again, overall analysis of variance was not significantly different for P or EndoMaxx, but when we did contrast analysis for EndoMaxx, we found significant differences at the 0.1% level for potato marketable yield (Figure 6). Differences appear to be greater at the 0 and 75 lb/ac P rate than compared to the highest P rate.

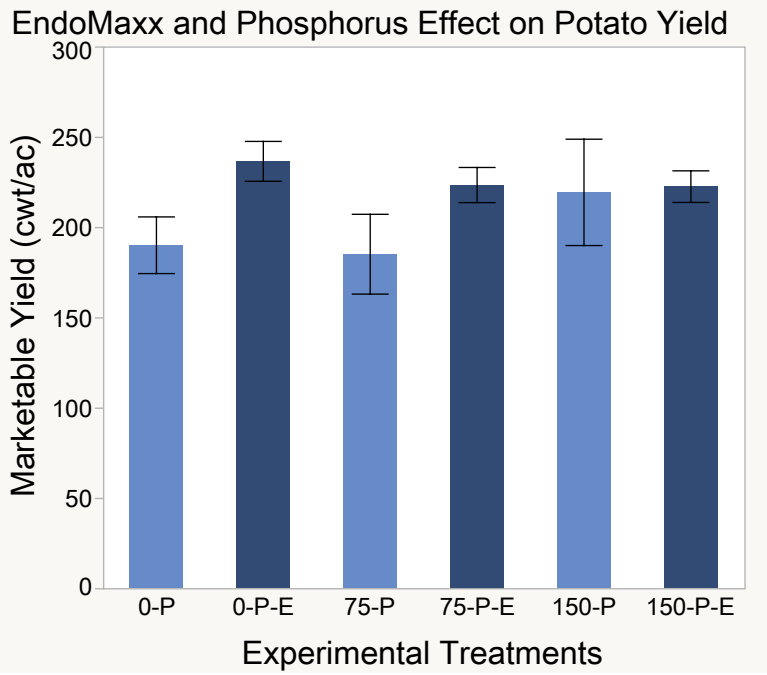

Figure 6. Endomaxx influence on marketable yield

Conclusions

With a single year of work, in a low P testing field, we were not able to show dramatic differences with added P or EndoMaxx. That said, there were indications that this could be useful to potato growers. We were able to document that in a non-fumigated field, the amount of background mycorrhizal fungi is either low (assuming slight error in application) or non-existent. While we were not able to show more rapid emergence or faster growth to canopy closure, higher levels of P in the plant mid-season, we did find some indication that at the lower rates, the mycorrhizal fungi might be helping with potato yield. More work should be done to further elucidate these findings.