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Predicting Phosphorus Needs in Snap Beans

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Summary

Unreplicated Phosphorus (P) trial

- On average total P205 uptake in 6 grower fields using grower standard practices was 35 lb P205/A (range 11-22). **Of the total P uptake, approximately 1/3rd was removed in the harvested product (pods) while 2/3rd remained in the field.** The residue remaining in the field after harvest had a high N content (avg of 3.0%) and will break down rapidly, releasing N and P back into the soil.
- The average grower fertilizer P205 application was 75 lb/A (range 30-158).
- For 5 out of 6 sites, soil test P (STP) levels were very high (>120 ppm), but due to methodology problems we were unable to assess the impact of eliminating P fertilizer on yield (see Appendix A for more information). Despite high STP levels, some growers applied >130 lb P/A; a rate at which an increase in yield would be highly unlikely. **Due to a continuing trend of increasing STP levels in the Willamette Valley, we recommend shifting away from low N, high P analysis fertilizers (i.e. 10-34-0) to higher N, lower P products.**
- Root rot severity was low to moderate for all sites, likely due to long rotations between bean crops.
- On average total N uptake in 6 grower fields using grower standard practices was 153 lb N/A (range 110-214). **Of the total N uptake, an average of 27% was removed in the harvested product (pods) while 73% remained in the field.** Due to a high N content of the foliage (avg of 3.0%) and warm soil temperatures, a large fraction of the residue will rapidly mineralize (estimate of 15-30%) and be converted to nitrate. This nitrate will be subject to leaching with fall and winter rains.
- Nitrogen fertilizer applications averaged 55 lb N/A (range 29-87). Based on the large difference between total N uptake and N fertilizer applications, **biological N fixation and soil N mineralization supplied a large fraction of total plant N uptake.**
- On average total K uptake in 6 grower fields using grower standard practices was 126 lb K/A (range 62-198) (to convert to K2O multiply by 1.12). **Of the total K uptake, approximately 29% was removed in the harvested product (pods) while 71% remained in the field.** Because K is relatively immobile in soil, this residue K will contribute to the soil K pool.
- Four out of six sites had high K levels (>200 ppm). At this level, the OSU bean fertility guide (FG28) recommends eliminating K fertilizer. One site had extremely high K levels (657 ppm) likely due to irrigating with cannery process water, which is high in K.

Fumigation trial

Although we encountered many challenges with the fumigation trial this year, the results are very promising, and the experience we gained will guide us next year in overcoming some of the issues we faced. These challenges included the following factors: 1) only three replicates; this reduces the statistical power of the analysis, 2) loss of a plot, which further reduced the statistical power of the analysis, 3) changes in soil texture across the experimental area; this may have resulted in variable fumigation effects (i.e. more effective in heavier textured soil vs. less effective in sandier soil), 4) multiple cultivations of the field; the grower cultivated the field 3x after fumigation to eliminate germinating seeds from a previous seed crop, which may have reduced the fumigant's effectiveness as well as mixing unfumigated soil with the fumigated soil, and 5) use of urea fertilizer. We found in a side experiment that urea banded at planting reduced plant growth, which isproblematic because each treatment received a different urea amount (all plots received the same total N application from MAP and Urea, but in differing quantities). These factors may have masked true effects and must be considered when interpreting the following results.

- **Fumigation significantly reduced root rot severity compared to unfumigated plots and had a positive effect on plant growth and pod yield**. The 3 highest pod yields observed in the trial (even higher than the grower standard practice) were all in fumigated plots, indicating a positive effect of fumigation (i.e. root health) on yield. Although there was not a statistically significant relationship between fumigation and gross pod yield and foliage biomass, there was a positive trend.
- **Fumigation resulted in lower tissue P concentrations in pods and foliage compared to the unfumigated plots, but P uptake in pods and foliage were unaffected by fumigation.** Fumigated plots tended to have larger plants, which may have diluted the tissue P, or the fumigant may have had an adverse effect on mycorrhizal populations (beneficial association between fungus and root that can increase the uptake of P). To eliminate this variable, next year we plan to add a mycorrhizal inoculant.
- **There was a significant yield response to P fertilizer for both pods and foliage.** There was an apparent yield response with fertilizer P applications up to 30 lb P2O5/A regardless of fumigation treatment. The soil test P (STP) at this site was 44 ppm Bray-1 P, which may have been low enough for us to have seen a P fertilizer response at this site.

Background

Although Oregon is the #2 snap bean producer in the US, yield of snap beans per acre is greater in Oregon than any other state (USDA NASS 2012). Despite the scale and importance of snap bean production in Oregon, almost no research has been done on phosphorus (P) utilization over the past 30 yrs in the Willamette Valley (personal communication with John Hart, Emeritus professor, OSU Crop and Soils). As a result, P fertilization recommendations (OSU's Bush Beans: Western Oregon—West of Cascades Fertilizer Guide publication #FG 28) have not changed in decades even though much has changed during this period. We now have a better understanding of the factors that influence P availability. Also, during this period, soil P levels have steadily increased due to P fertilization in excess of what is removed in the harvested product. If soil P levels are already at the critical value for optimum growth, any addition of P beyond crop needs represents a potential economic loss as well as an increased risk for negative environmental losses.

To maximize fertilizer P utilization of snap beans will require a two pronged approach: 1) determining P sufficiency levels based on soil tests, environmental conditions, and root diseases of the plant; and 2) understanding the nutrient uptake characteristics of snap beans as a step toward creating a P budget. Determination of P sufficiency based on soil test P (STP) levels alone is difficult, since the ability of snap beans to obtain P from the soil is influenced by pH, soil temperature, biological activity, and root diseases. In spring plantings a banded P application may be necessary to overcome the effect of low soil temperatures even when STP levels may be considered adequate for optimum growth. Phosphorus moves only a short distance from where it is placed in the soil, so it is commonly banded near the seed where seedling roots proliferate. Root growth is governed by temperature and can be minimal early in the season, limiting crop P uptake. Low soil temperature also reduces the rate at which organic P is converted to soluble plant-available P. Research from California showed a 40 percent reduction in available P with a 20°F decrease in soil temperature. In western Oregon, the minimum soil temperature at the 4-inch depth increases approximately 20°F between mid-April and early July. Thus, soil P is less available at early planting dates and higher fertilizer P rates may be required.

Another important factor influencing the ability of snap beans to utilize soil P is the presence of root diseases. Root rot caused by several soilborne pathogens which include species of *Fusarium, Rhizoctonia, Thielaviopsis,* and *Pythium*. These diseases reduce bean yields when conditions are favorable for disease, especially when beans are rotated too frequently in the same ground. With a less extensive root system, diseased plants may be unable to access nutrients even though there may be sufficient nutrients for a plant with healthy roots to achieve maximum growth. The severity of root diseases must be considered when developing P fertilizer recommendations.

To create better recommendations for P fertilization requires a better understanding of plant uptake, removal in the harvested product, and how much is cycled back into the soil with incorporated residues. Knowing this is a step towards creating a P nutrient budget. This project aims to increase the P utilization efficiency of snap beans by developing P fertilizer recommendations that take into account the P status of the soil and the factors that control P availability.

Research Objectives

1. **Quantify P uptake, P removal in the harvested pods, and residue P remaining in the field at harvest.** Outcome: This is a step towards developing a P nutrient budget for snap bean production fields.
2. **Determine the effect of bean root rot diseases on P uptake, and yield.** Outcome: If bean root diseases limit P uptake even when soil test P values are high, P fertilizer recommendations may need to be adjusted when a high level of root rot is expected (i.e. a field with a history of root rot or when rotations are too short to significantly reduce disease severity). Also, fertilizer recommendations may need to be adjusted when soil temperatures are low, such as are found in early spring.

Methods

Unreplicated plots

On six commercial farms, growers excluded P applications from an area of their field (seeder width by ~30-40'). To match grower N and K application in the No P plots, urea and K-Mag were banded approximately 3" from the seedline and 2" deep using a Planet Junior fertilizer applicator. Site information for the 6 sites are given in Table 1. At harvest, three 5'sections of row were harvested in the No P plot as well as outside the plot (Grower standard practice). Pods were stripped by hand. Stand, pod yield, and foliage weight were recorded. The beans were graded and then dried at 60C. The foliage was shredded using a 5 hp shredder (MTD model 242-645-000), from which a subsample was collected and dried in an oven at 60C. The dried foliage and pods were then ground using a Willey grinder and sent to Brookside Laboratories, Inc for nutrient analysis.

Table 1. Site information for unreplicated P plot trials. Site 4 was also used for the fumigation trial.

						Grower fert. application	
Site	Location	Seeded	Variety	Previous crop	Last bean planting	N	P
					yrs	lb/acre	
1	Brooks	29-Apr	OSU 5630	Pasture	Unknown	29	43
2	Independence	8-May	91G	Fescue	~7	87	47
3	Brooks	20-May	OSU 5630	Sweet corn	~7	78	44
4	Albany	5-Jun	OSU 5630	Buckwheat seed	2	50	30
5	Dever-Conner	14-Jun	Crockett	Corn	~4	39	131
6	Scio	14-Jun	Crockett	Perennial rye	~10	47	158
					avg	55	76

Fumigation trial:

This trial was conducted on a commercial farm in the North Albany area on a soil mapped as a Newburg fine sandy loam soil. This field had a history of bean root rot problems and beans were last planted in this field in 2010. The experimental area was 5 seedlines wide (26" spacing) by 720'. The experimental design was split plot with the main plot being fumigation/no fumigation and the subplots being the fertilizer treatments in a randomized complete block design. The plots were replicated 3 times and each subplot was 30' in length.

The soil fumigant Vapam (metam sodium) was surface applied with a backpack sprayer on May 9, 2013 at a rate of 75 gal/A. The fumigant was rototilled and rolled with a smooth roller within 30 seconds of application. In between the time of application of the Vapam and planting (27 days), the field was cultivated 3x to eliminate unwanted volunteers from the previous buckwheat seed crop. On June 5 the cultivar OSU 5630 was planted and the P fertilizer treatments of 0, 15, 30, and 60 lb P_2O_5/A were applied by banding approximately 3" from the seedline and 2" deep using a Planet Junior. See Table 2 for treatments and fertilizer rates. The P_2O_5 was supplied by monoammonium phosphate (MAP). Each plot received 50 lbs/A of nitrogen (as a mixture of urea and MAP) and 25 lb/A of potassium (K_2O).

The harvest occurred on August 2 (58 days after planting). The harvest area in each plot was 2 m by the middle two seedlines. Stand, pod weight, and foliage weight were recorded. The beans were graded and then dried at 60C. The foliage was shredded in the field using a 5 hp shredder (MTD model 242-645-000), from which a subsample was collected and dried in an oven at 60C. The dried foliage and pods were then ground using a Willey grinder and sent to Brookside Laboratories, Inc for phosphorus (P) tissue analysis.

Table 2. Treatment fertilizer rates and fumigation.

Trt	P Fertilizer rate	Fumigated	N supplied by MAP[1]	N supplied by MAP
	lb P2O5/A		----------- lb N/A	------------
1	0	No	0	50
2	15	No	3	47
3	30	No	6	44
4	60	No	13	37
5	0	Yes	0	50
6	15	Yes	3	47
7	30	Yes	6	44
8	60	Yes	13	37

1- Monoammonium phosphate

For root rot severity evaluation, 20 plants were collected and the roots washed in the field. These plants were then evaluated using a rating scale that relied on a visual rating scale developed by Jim Myers (OSU Dept of Hort) as well as cutting into the roots and evaluating degree of internal rot. The scale is as follows: 0- no symptoms, roots firm; 1- superficial discoloration and firm roots; 2- superficial discoloration with some internal hypocotyl discoloration; 3-darkly discolored hypocotyl and roots, and tap root collapse under pressure but not as easily as in 4; extensive root pruning. 4-very darkly discolored hypocotyl and roots, hypocotyl completely collapsing easily under pressure, severe root pruning; and 5- tap root dead with few lateral roots, plant is dead or dying.

<u>Both trials</u>

Soil samples were collected at planting and sent to Brookside Laboratories, Inc for (New Bremen, OH) chemical analysis. Results are given in Table. 3. Soil characteristics for the fumigation trial are under site 4 (N. Albany).

Table 3. Soil characteristics for the P trial sites. Site 4 was also used for the fumigation trial.

Site	Location	Soil mapping	Est CEC meq/100g	pH	Total N[1] %	OM[2] %	Bray I P	K[3]	Ca[3]	Mg[3]	S[3]
							--------------	mg/kg soil		-------------	
1	Brooks	Willamette sil	16	6.1	0.26	4.4	181	657	1726	324	13
2	Independence	Cloquato sil	20	5.7	0.11	2.1	158	263	2043	353	10
3	Brooks	Wapato sicl	24	6.2	0.19	3.3	121	164	3041	498	12
4	N. Albany	Newburg fsl	23	5.8	0.10	1.8	44	89	2201	577	8
5	Dever-Conner	Newberg fsl	35	5.2	0.14	2.7	159	414	2711	494	24
6	Scio	Conser sicl	38	6.3	0.29	5.6	189	423	5555	386	25

1-by combustion ; 2-estimated by 1.7 x total C (assumes soil OM contains 58% C); 3- Mehlich III extractable nutrients

P supply to roots under actual field conditions was measured using Plant-Root Simulator (PRS) probes The PRS measurements assessed P supply as affected by prevailing soil moisture, temperature, physical and biological conditions at each site. At the field sites, P flux (estimate of amount of P supplied to root surfaces) was measured quantitatively using these PRS probes (Western Ag Innovations, Inc., Saskatoon, SK, Canada). Each PRS probe consists of an anion exchange membrane mounted on a flat plastic stake. The PRS probes were allowed to adsorb P from soil solution on the zero P plots to get a measure of the cumulative effects of temperature, moisture, and soil test P on phosphorus solubility. PRS probes were buried in soil for two 2-week intervals (2-wk exposure time for each burial) starting at planting to determine changes in P supply in response to soil temperature and other environmental factors. Each 2-wk PRS probe burial generated a measurement of P supply. Preplant soil samples (0-12 inches) from each site were analyzed via routine procedures to measure soil test nutrients as per OSU recommended protocols (Table 3).

Results and Discussion:

Unreplicated plots

Soil test phosphorus (STP) levels were very high for all sites except for Site 4 (Table 3). A University of Idaho Extension publication (CIS 1189) published in 2012 recommends that no P fertilizer should be applied when Bray 1 P is ≥30 ppm, but these recommendations are for dry beans which may have slightly different P requirement than snap beans. At such high STP levels we would not expect to see a fertilizer response to added P. However, we did observe differences in yield, grade, and P uptake (Tables 4 and 5), which was unexpected. **We believe that the yield response observed was due to our method of banding urea fertilizer and not to an actual yield response to P fertilizer.**

To test our theory that our banding method impacted snap bean yield, we band applied different rates of N fertilizers (urea vs ammonium sulfate) next to snap bean seeds rows at planting in a separate experiment later in the season. A description of the experiment and results are given in Appendix A. We found overall, thatbanding (regardless of rate or fertilizer material) slowed snap bean emergence by 2-4 days relative to plots that were not banded. This was due to the fertilizer applicator throwing soil over the seedline, which resulted in delayed emergence. Also, we found that urea applied at a rate of 60 lb N/A further reduced growth. Peck et al. (1989) also observed that banded urea reduced plant growth and pod yield, especially as the N rate increased (Fig. 2 Appendix A). This suggests that snap bean plants are sensitive to ammonia, which is produced as the urea hydrolyzes. **Therefore, the difference in yield we observed between the No P plots and the Grower treatment was likely due to a yield depression as the result of banding urea fertilizer and was not due to an actual yield response to P fertilizer.**

The following results and discussion are for the Grower treatment only. Total P uptake in 6 grower fields using grower standard practices was 15 lb P/A (range 11-22; Table 6). Of the total P uptake, an average of approximately 35% (range 16-52) was removed in the harvested product (pods) while 65% remained in the field. The residue remaining in the field after harvest had a high N content (Table. 6) and will break down rapidly, releasing P back into the soil. **This residue P will contribute to the soil phosphorus pool that will be available to future crops.** The tissue P in the pods was 0.42%, which was 61% more than the tissue P in the foliage (Table 6).

On average total N uptake in 6 grower fields using grower standard practices was 153 lb N/A (range 110-214) (Table 7). **Of the total N uptake, an average of 27% was removed in the harvested product (pods) while 73% remained in the field.** Due to a high N content of the foliage (avg of 3.0%) and warm summer/early fall soil temperatures, a large fraction of the residue will rapidly mineralize (estimate of 15-30% based on OSU's Cover Crop Calculator) and be converted to nitrate. This nitrate will be subject to leaching with fall and winter rains unless a N scavenging cover crop is planted. Nitrogen fertilizer applications averaged 55 lb N/A (range 29-87). Based on the large difference between total N uptake (153 lb N/A) and N fertilizer applications (55 lb/A), **biological N fixation and soil N mineralization supplied a large fraction of total plant N uptake.**

On average total K uptake in 6 grower fields using grower standard practices was 126 lb N/A (range 62-198; Table 8). **Of the total K uptake, an average of 29% was removed in the harvested product (pods) while 71% remained in the field.** Because K is relatively immobile in soil, this residue K will contribute to the long term soil K pool. Four out of six sites had high K levels (>200 ppm). At this level, the OSU bean fertility guide (FG28) recommends eliminating K fertilizer. One site had extremely high K levels (657 ppm) due to irrigating with cannery process water, which is high in K (Table 3).

Table 4. Gross pod yield and grade for grower standard practice (Grower) and no phosphorus fertilizer plots (No P). Due to scheduling conflicts, the plants at site 6 were sampled early, which resulted in a high proportion of pods with no value. The values in parenthesis next at site 6 are the harvest results given to us by the grower. Care should be taken when interpreting the data as **difference in yield between the No P plots and the Grower treatment was likely due to a yield depression as the result of banding urea fertilizer and was not due to an actual yield response to P fertilizer.**

Site	Location	Days to harvest	Trt	Gross fresh pod yield	Grade		
					No value	#1	#2
				ton/A	--------------	% of total	-------------
1	Brooks	72	Grower	7.5	12	87	1
			No P	7.0	13	86	1
2	Independence	70	Grower	10.8	5	34	61
			No P	6.7	4	52	44
3	Brooks	66	Grower	6.8	6	59	35
			No P	5.2	12	60	29
4	Albany	58	Grower	8.7	10	86	4
			No P	7.8	8	85	7
5	Dever-Conner	61	Grower	7.9	15	85	0
			No P	7.2	16	84	0
6	Scio	60	Grower	4.9 (6.4)	56 (21)	44 (74)	0 (5)
			No P	4.2	61	39	0
		Average	Grower	7.8	17	66	17
			No P	6.4	19	68	13

Table 5. P205 uptake in foliage and pods. Care should be taken when interpreting the data as **difference in yield between the No P plots and the Grower treatment was likely due to a yield depression as the result of banding urea fertilizer and was not due to an actual yield response to P fertilizer.**

		Foliage		Pods		Total		P removed with pods	
		Grower	No P	Grower	No P	Grower	No P	Grower	No P
Site	Location	--	lb/A	---				% of total	
1	Brooks	27	25	14	13	41	37	35	34
2	Independence	16	11	18	10	34	21	52	50
3	Brooks	17	19	11	8	28	27	39	30
4	N. Albany	14	11	11	12	25	23	44	50
5	Dever-Conner	21	17	12	10	33	27	35	37
6	Scio	43	31	8	7	51	39	16	19
	Average	23	19	12	10	35	29	37	37

Table 6. Tissue P and N content in foliage and pods for the **Grower only.**

		Foliage	Pods	Foliage	Pods
Site	Location	% P		% N	
1	Brooks	0.30	0.50	2.5	3.1
2	Independence	0.23	0.36	3.3	2.8
3	Brooks	0.25	0.45	3.3	3.5
4	N. Albany	0.20	0.34	2.3	2.8
5	Dever-Conner	0.28	0.41	3.6	3.0
6	Scio	0.30	0.47	3.0	3.6
	Average	0.26	0.42	3.0	3.1

Table 7. Nitrogen uptake for **Grower only** treatment.

		Foliage	Pods	Total
Site	Location	------------	lb N/A	-----------
1	Brooks	98	39	137
2	Independence	102	60	162
3	Brooks	98	36	134
4	N. Albany	72	39	111
5	Dever-Conner	120	37	157
6	Scio	188	27	214
	Average	113	40	153

Table 8. Potassium uptake for **Grower only** treatment (to convert K to K2O multiply by 1.12)

Site	Location	Foliage ------------	Pods lb K/A	Total -----------
1	Brooks	135	37	172
2	Independence	71	44	115
3	Brooks	68	27	95
4	N. Albany	35	27	62
5	Dever-Conner	79	34	113
6	Scio	174	24	198
	Average	93	32	126

Fumigation trial

Pod and Foliage Yield

There was a trend that showed increased gross pod yield or foliage biomass for the fumigation treatments (Table 9) as well as a P fertilizer response on gross pod yield (Figure 1) and foliage biomass. However, we found that urea had a negative impact on plant growth (see Appendix A for more information) and we cannot be certain that the yield response observed is due to P fertilizer and not to different amounts of urea fertilizer, which decreased with increasing P rate (this was due to adjusting urea rates to account for the N that was supplied by the monoammonium phosphate). In future trials, we can overcome this problem by using ammonium sulfate as the N source and using triple-super phosphate as the P source. This would eliminate any N fertilizer effect on the results. Also, by increasing the number of replicates, we will be able to better evaluate the influence of P rates and fumigation on plant growth, P uptake, and root health.

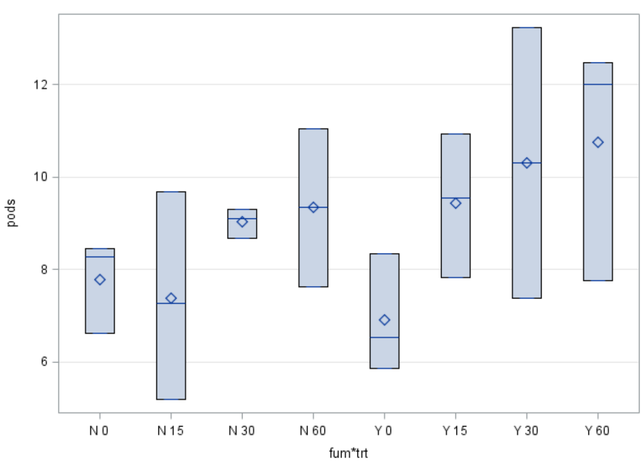

Figure 1. Gross pod yield (ton/A). Box plot of fumigation*treatment interaction on pod yield (ton/A) and (Y=Fumigated; N= Not Fumigated; 0, 15, 30, and 60 lb P2O5/A)

Table 9. Pod and foliage yield, tissue P, P uptake, and root rot rating. Highlighted cells indicate statistically significant difference (p<0.10). Treatment 9 (Grower standard practice) was not included in the statistical analysis and include here only for comparison.

Trt	P2O5 rate lb/A	Fumigation	Pods (gross) ----- ton/A	Foliage (fresh) ------	P in foliage %	P in pods %	P in foliage lbs/A	P in pods lbs/A	Root rot rating
1	0	No	7.79	6.03	0.22	0.41	4.99	5.06	2.7
2	15	No	7.38	6.04	0.21	0.39	4.84	4.76	2.3
3	30	No	9.03	7.48	0.22	0.42	6.12	5.99	2.3
4	60	No	9.34	8.87	0.22	0.39	7.06	5.74	2.4
5	0	Yes	6.91	5.46	0.23	0.42	4.46	4.48	1.9
6	15	Yes	9.44	7.40	0.19	0.35	5.14	4.94	1.7
7	30	Yes	10.31	9.04	0.17	0.33	5.60	5.15	1.6
8	60	Yes	10.75	9.41	0.19	0.34	6.38	5.49	1.5
9	30	No	8.70	8.56	0.20	0.34	6.11	4.78	NA
	Pr>F	blk	0.123	0.049	0.055	0.081	0.127	0.096	0.800
		fum	0.184	0.383	0.005	0.002	0.424	0.418	0.002
		blk*fum	0.457	0.966	0.187	0.284	0.721	0.128	0.066
		trt	0.082	0.028	0.013	0.021	0.048	0.173	0.427
		fum*trt	0.515	0.758	0.015	0.021	0.861	0.851	0.928

Phosphorus Uptake

In general, pod and foliage tissue P was significantly lower in the fumigated treatment compared to the unfumigated treatment (Table 9). Because there was not a difference in pod and foliage yield due to fumigation, the lower tissue P content likely cannot be attributed to a dilution effect (i.e. more plant tissue resulting in a lower P content). Possibly this is due to the fumigant reducing mycorrhizal fungal populations which reduced the P availability. But, total P uptake was not measurably influenced by fumigation making interpretation of this data difficult (Table 9).

Root Health

Fumigated plots had healthier roots than unfumigated plots (Figure 2), though the effect on root health was less pronounced in block 1. There was not a strong relationship between root rot rating and yield (Figure 3). But P rate also influenced yield and a 2-D graph may not fully capture the relationship. However, analyzing the data to include P rate did not significantly increase the relationship between yield, P rate, and root rot rating. It is interesting to note that the 3 highest yields were in the fumigated plots, indicating that fumigation may have had a positive impact on yield even though statistically it did not. Increasing the number of replicates would help to overcome this problem.

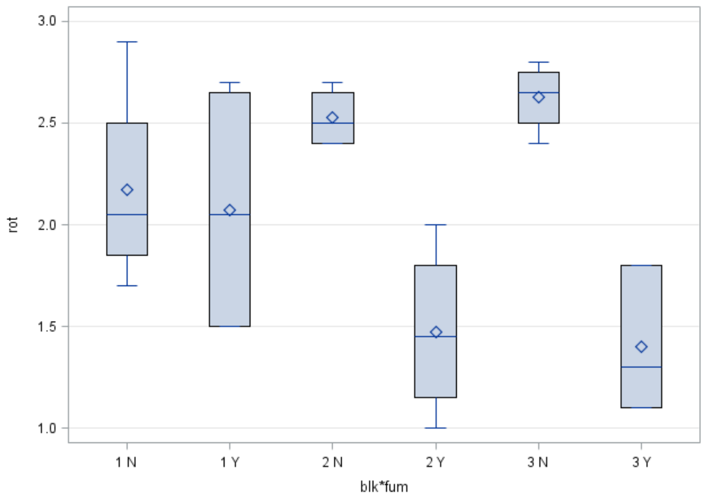

Figure 2. Box and whisker plot of block and fumigation effect on root rot rating (Y=Fumigated; N= Not Fumigated).

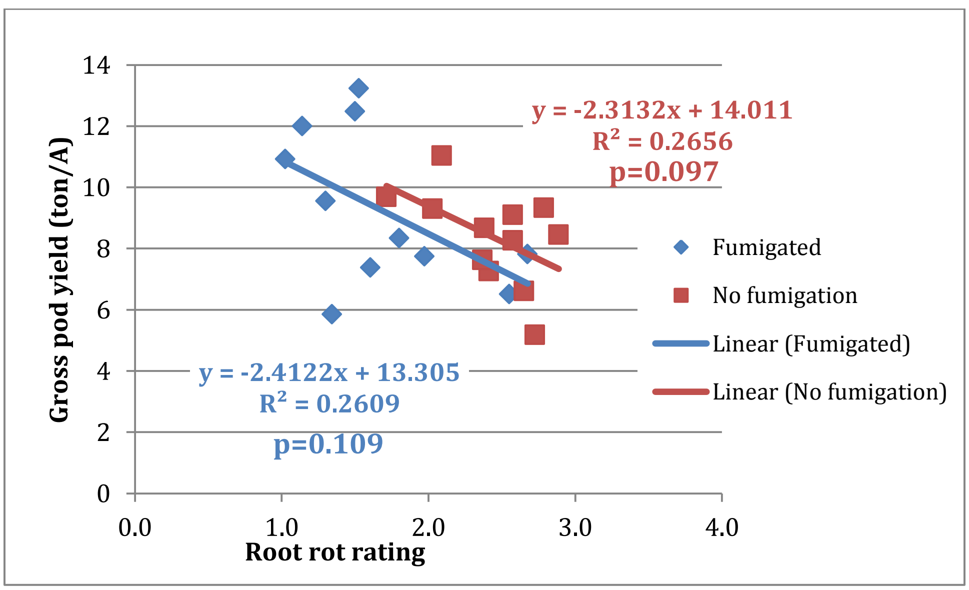

Figure 3. Relationship between root rot rating and gross pod yield for fumigated and unfumigated plots.

Appendix A.

Banding and N source on stand and biomass of snap bean

Summary

In general, banding fertilizer reduced plant stand 19% for the high rate urea application rate (60 lb N/A) compared to the no fertilizer treatment (p=0.10). Stand was not affected for the other treatments. Biomass at the third trifoliate was highest in the no fertilizer treatment and lowest in the high rate urea application rate (60 lb N/A). The influence of banding and the high rate urea application (60U) reduced biomass by approximately 49% relative to the No N treatment. Compared to the low rate urea application (30U), 60U reduced biomass by 34%. Both banding and high rates of urea significantly reduce biomass.

Objectives

Determine how banding using a Planet Junior push spreader and N fertilizer source and rate effect snap bean emergence and growth.

Method

The bean variety OSU 5630 was planted at OSU's vegetable research farm on 8/23 at a rate of ~10 seeds/ft with 30" spacing between seedlines. Fertilizer treatments were banded on 8/24 using a Planet Junior applicator. The treatments were No N, 30 lb N/A of urea (30U), 30 lb N/A of ammonium sulfate (30AS), 60 lb N/A of urea (60U), and 60 lb N/A of ammonium sulfate (60AS) and were applied in a randomized complete block design with 3 replications. The No N plots were not banded. Experimental plots were 4 seedlines wide by 25' long. On 9/27,whole plants were harvested from two 8ft sections the middle two rows at the third trifoliate.

Results and Discussion

Banding resulted in delayed germination likely due to soil that was thrown into the seedline, resulting in the seed being buried deeper than in the No N plots. This delayed germination by several days and resulted in non-uniform emergence. Also, the high rate urea (60U) resulted in a decreased stand and yield relative to the No N and low rate urea treatment (30U; Table 1A and Figure 1). Peck et al. (1989) also observed that banded urea reduced plant growth and pod yield, especially as the N rate increased (Fig. 2). This suggests that snap bean plants are sensitive to ammonia, which is produced as the urea hydrolyzes.

Table 1A. Results from biomass.

Treatments	Stand/8'		wt/8' row		wt/plant	
			g		g	
No N	59.5	a	486	a	8.2	a
30AS	54.7	ab	343	bc	6.2	bc
30U	55.5	ab	382	ab	6.9	ab
60AS	55.5	ab	346	bc	6.2	bc
60U	48.3	b	250	c	5.2	c
Pr>F treat	0.100		0.005		0.005	
Pr>F block	0.081		0.206		0.005	
LSD 0.05	7.9		110		1.4	

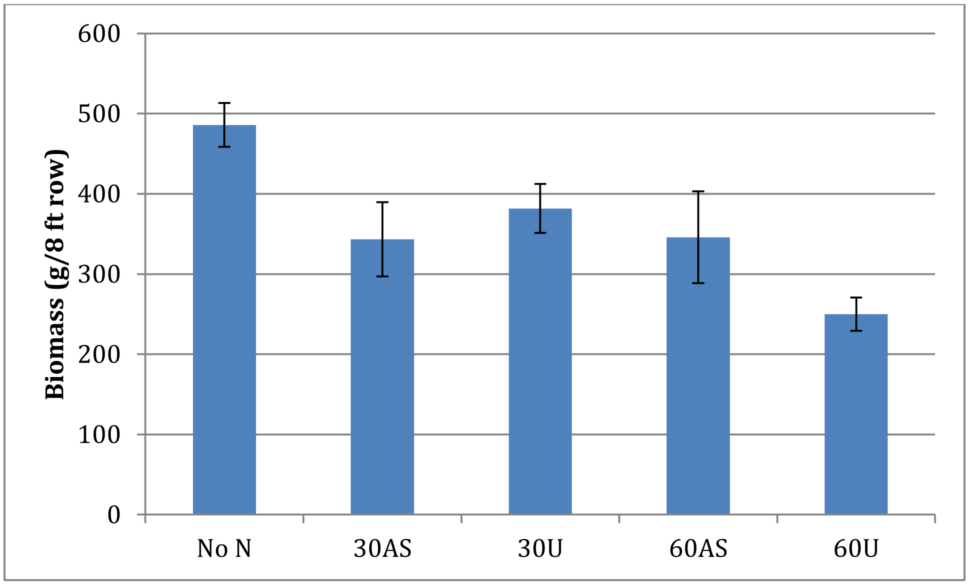

Figure 1. Biomass of snap beans harvested on 9/27. Error bars represent the SEM (n=6)
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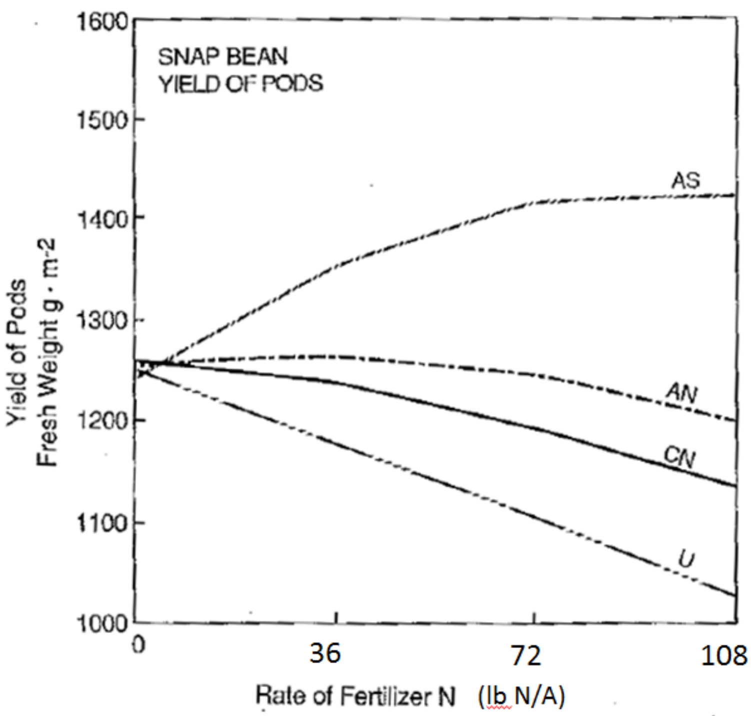

Figure 2. Pod yield for 4 fertilizers x 4 N rates on the fresh pod wt of snap beans. AS= ammonium sulfate; AN= ammonium nitrate; CN= calcium nitrate; and U= urea. Fertilizer was band applied 2” to the side and 2”below the seed. Graph adapted from Peck et al. (1989).

References

Peck, N.H., G.E MacDonald, and A.V. Gardner. 1989. Snap bean plant response to sources and rates of nitrogen and potassium fertilizers. HortSci. 24(4):619-623