NUTRIENT USE IN HIGH-YIELDING SNAP BEAN

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Introduction

Previous research (Wang et al., 2015) on snap bean response to N provided interesting results, but it is unclear if the results are applicable to all fields. This previous research was conducted in Plover, WI with high yielding DelMonte varieties. Results suggested that 100 lb-N/ac was the optimal N rate (20 lb-N/ac in starter and 80 lb-N/ac in-season) when yields are greater than 9 ton/ac. However, typical yields for snap bean are in the 4-5 ton/ac range (personal communication with processing crop agronomists), which may not require 100 lb-N/ac (current UW recommendations are 60 lb-N/ac for yields up to 6.5 ton/ac). In addition, the previous research also indicated that for non-nodulating varieties (i.e. varieties that do not allow root infection of rhizobium, and thus do not directly obtain N fixed from the atmosphere), had an N utilization efficiency of 68% when 100 lb-N/ac was applied. For nodulating varieties (in this case the high-yielding Del Monte varieties) additional analysis using ^{15}N stable isotope concentrations was necessary to determine the true removal efficiency as it is unknown how the addition of N fertilizer will inhibit the amount of N that is fixed. Preliminary analyses of these results indicate that the 100 lb-N/ac rate completely inhibits N fixation in snap beans. Now, it may seem counter-intuitive, but this is actually beneficial for water quality. It means that the applied N is replacing the N fixed by the atmosphere and is actually well-utilized in the system. If applying N fertilizer did not completely inhibit N fixation, then much of the N that was applied would not be used and thus leached to groundwater. However, 100% inhibition of N fixation occurred at the 100 lb-N/ac rate, with lower N rates inhibiting a small percentage of N fixation. Now, if more commonly used varieties require less N inputs (in the 50 to 80 lb-N/ac range) it is important to know what the true N use efficiency is as less N on lower yielding varieties may be less efficient than more N on higher yielding varieties. With all of the issues concerning nitrate concentrations in the Central Sands, we know little about the actual fate of N (or at least the utilization of applied N) in snap bean production systems.

The other big issue in snap bean production is a lack of modern measurements on removal rates of all nutrients. There are recommendations in the A2809, but it is not clear how these recommendations were developed – it's possible that they were estimated from other similar plants or from research in other states. The goal of this project is to develop N recommendations to snap beans that are variety specific and are considerate of water quality. The objectives of this study are to: (1) determine agronomically and economically optimum N rates for nodulating and non-nodulating varieties based on linear or quadratic-plateau regression and (2) determine the N

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removal and N uptake efficiencies at agronomic and economic optimum N rates to assess the potential impact on groundwater nitrate. A secondary objective is to quantify the P, K, S, Ca, Mg, B, Zn, Mn, and Cu removal rates from the production system with snap bean harvest.

Materials and Methods

The research was conducted at the Hancock Agricultural Research Station in 2016 and 2017. The experimental design was a randomized complete block, split plot study with four in-field replications. The study will also be replicated twice per growing season, comparing two different planting dates to evaluate the effect of planting date, as well as to obtain additional site years within a 2-year study. The whole plot factor will be snap bean variety, which will include publically available varieties of Huntington and Pismo (non-nodulating) and two non-nodulating varieties. The split plot factor will be N rate and include rates of 20, 50, 80, 110, 140, and 170 lb-N/ac. Since starter fertilizer is a common management practices (with a rate of 20 lb-N/ac), there was not a true zero N rate in the study.

Results

Results from 2016 show again the difference between non-nodulating (Fig. 1) and nodulating varieties (Fig. 2). Non-nodulating varieties do not fix their own nitrogen and the economic response to N is quite clear. Nodulating varieties do fix their own nitrogen, but there is still an economic incentive to apply N. Interestingly yields with 20 lb-N/ac as starter fertilizer were quite good at the Hancock Agricultural Research Station, indicating there is quite a bit of nitrogen available through mineralization of plant residues or through irrigation water.

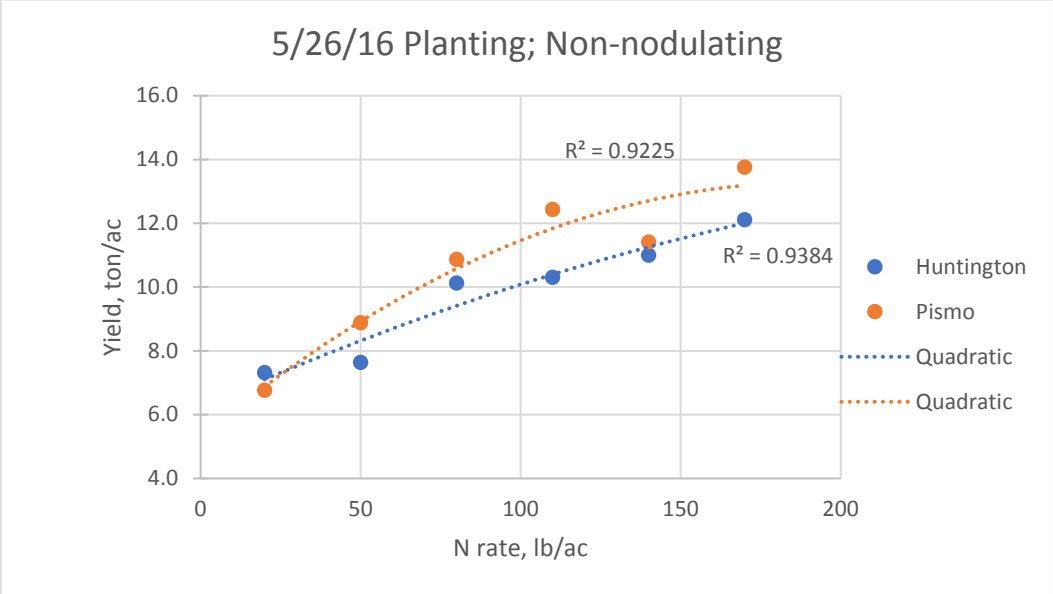

Figure 1. Snap bean yield (fresh weight) response to nitrogen fertilizer in 2016 for non-nodulating varieties.

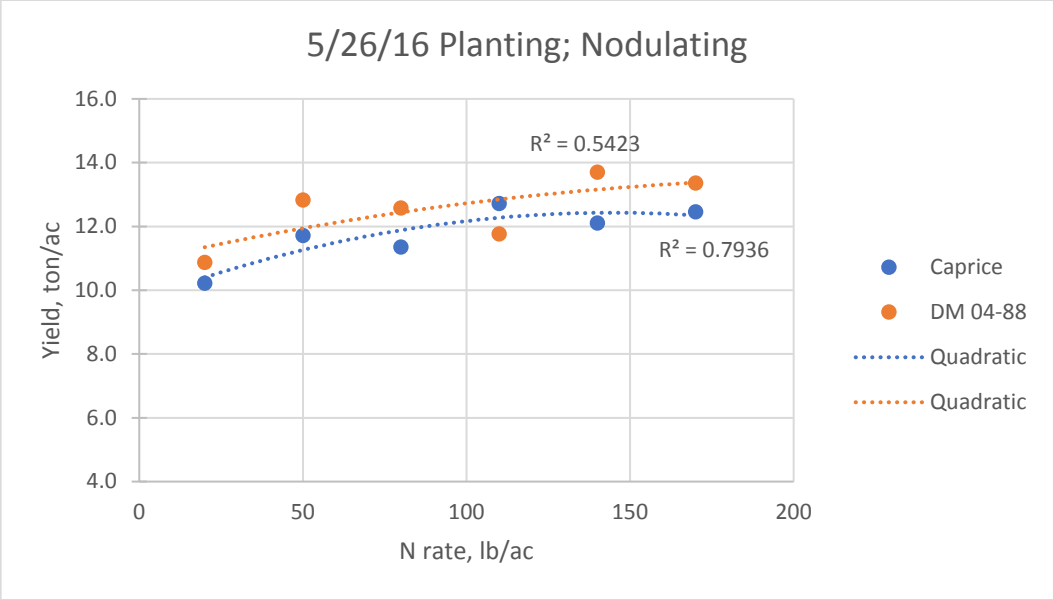

Figure 2. Snap bean yield (fresh weight) response to nitrogen fertilizer in 2016 for nodulating varieties.

Table 1. P, K, and S removal rates (lb/ac) from four varieties in 2016.

	P		K		S	
Variety	Avg.	St Dev	Avg.	St Dev	Avg.	St Dev
	---------- lb/ac ----------					
Non-nodulating #1	9.1	1.7	51	7.7	4.1	0.9
Non-nodulating #2	9.3	0.7	55	5.3	4.3	0.6
Nodulating #1	9.2	1.6	53	7.5	3.9	0.4
Nodulating #2	11.5	1.1	56	4.1	5.3	0.7

Removal rates for P, K, and S were similar for across all varieties, not varying by more than 2 to 5 lb/ac for any nutrient. Thus, the actual removal of nutrients is relatively low compared to other crops, but may not reflect actual nutrient need of plant. Snap bean is typically grow in rotation with potato, so soil test P and K are often high and sufficient to supply most of the nutrient demand.

Summary and Future Work

Research was completed in 2017 and yield results are currently being analyzed. These results can be used to provide variety specific or planting date specific N fertilizer recommendations if appropriate.