NITROGEN USE EFFICIENCY IN MODERN SNAP BEAN PRODUCTION SYSTEMS

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Introduction

Current University of Wisconsin-Extension guidelines recommend 60 lb-N/ac for snap bean grown on soils less than 2% organic matter, which are most soils in the Central Sands of Wisconsin. However, the typical rate that snap bean growers apply is much greater than this rate. In addition, it is possible that rates lower than 60 lb-N/ac may be economically optimal for some varieties. Snap beans are a legume and some, but not all, varieties nodulate, meaning they have the ability to fix nitrogen (N) from the atmosphere. This will result in different N response curves and perhaps different N recommendations for different snap bean varieties. It is often assumed that when we fertilize legumes with N, the added N replaces the amount of fixed N in a one-to-one manner – but this is rarely true. In fact, we know little about the tradeoffs between N application and nodulation in snap beans. The objectives of this paper are to review the state of knowledge of snap bean response to N fertilizer and evaluate the different ways nitrogen use efficiency can be determined.

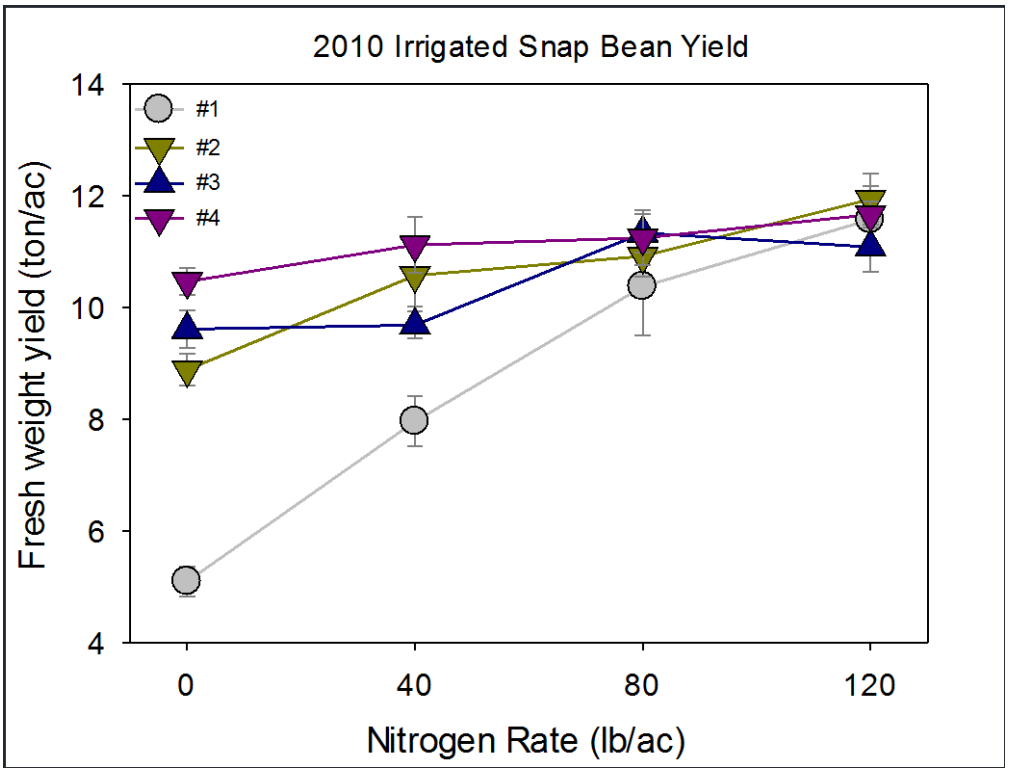

Figure 1. An example of the difference in snap bean yield response to N fertilizer by variety. Variety #1 was non-nodulating and varieties #2, #3, and #4 were nodulating.

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Previous Research and Results

Previous research (2010-2012) was conducted in Plover, WI to assess snap bean variety response to N fertilizer as well as N uptake and use efficiency. Four varieties were tested, one of which (#1) was a non-nodulating variety. In Figure 1, it can be clearly seen that this variety had a much larger response to N fertilizer compared to the nodulating varieties, which had quite a bit of N supply when no N was added. However, the nodulating varieties did have an economically valuable yield increase when N fertilizer was applied indicating that nodulation was not enough to provide agronomically optimal amounts of N. Although up to 40 lb-N/ac could be added before it significantly affected the N balance of the production system (Fig. 2).

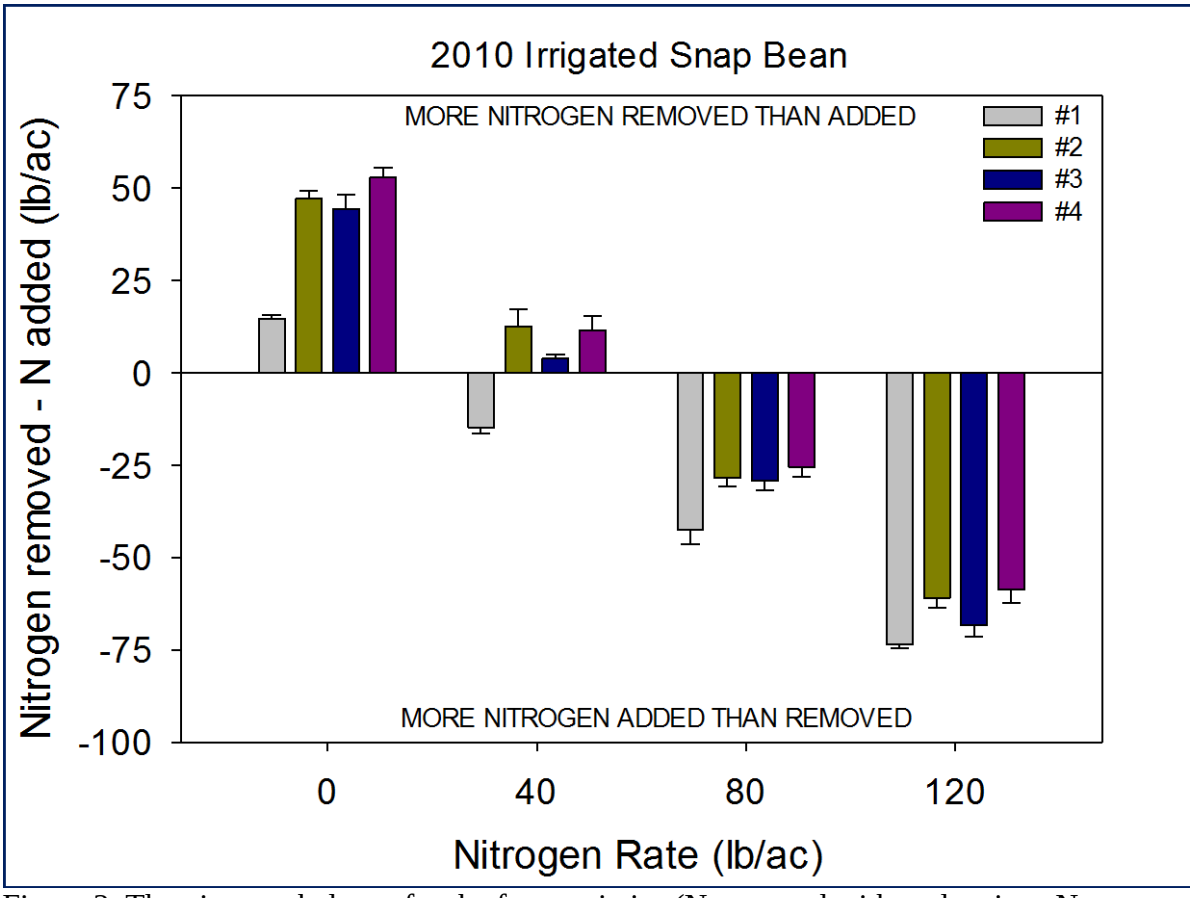

Figure 2. The nitrogen balance for the four varieties (N removed with pods minus N applied with fertilizer) across different N rates.

The N taken up by nodulating varieties of snap bean can come from three sources: the soil, fertilizer, and from biological N fixation (BNF) (i.e. the N produced by N fixing bacteria). The N derived from BNF will have a different isotopic signature (15N) compared to other sources of N and we can use this measurement to calculate how much suppression of N fixation occurs when N fertilizer is applied. Preliminary data (Fig. 3) indicates three things: (1) Whole plant N uptake increases with additional N applied, (2) N

derived some soil says consistent across N application rates, and (3) the addition of N fertilizer clearly suppressed N fixation, but not completely. For example, when 40 lb-N/ac was applied, BNF was reduced by 31 lb-N/ac. When 80 lb-N/ac was applied, BNF was reduced by 49 lb-N/ac. At the N rate of 120 lb/ac, BNF was suppressed completely. This is interesting information for growers as it would indicate that N fertilizer additions clearly suppresses BNF and that the N use efficiency of the applied fertilizer remains high. This study is being continued to address this effect across different yield potential scenarios. The previous work has all been conducted under extremely high yielding conditions, well above the average yield for the state of Wisconsin.

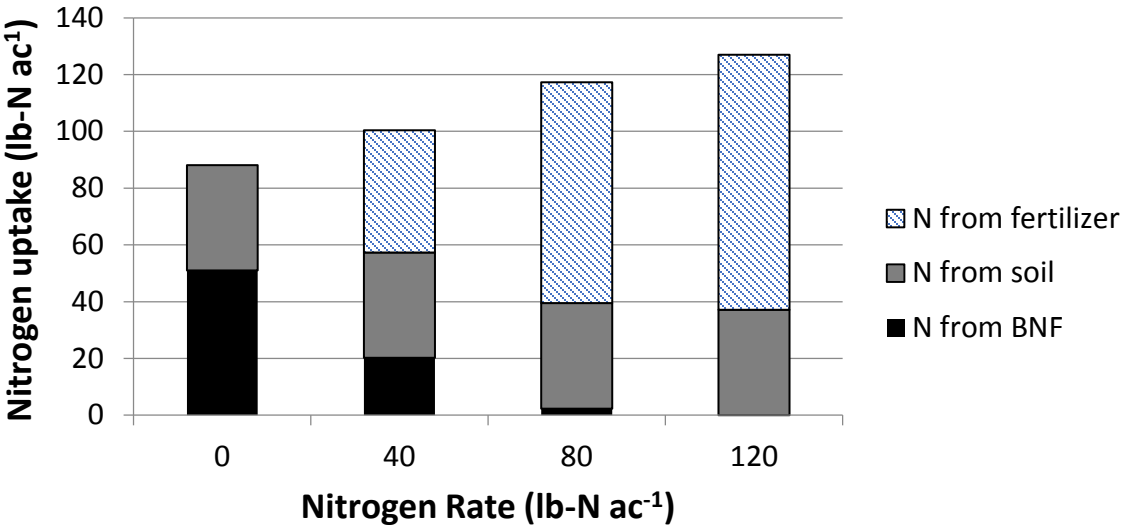

Figure 3. Nitrogen uptake of one nodulating variety of snap bean in 2011 as determined by 15N analysis.