Using Controlled Release Fertilizer to Increase N Use Efficiency in Commercial Snap Bean Production Applying Center Pivot Irrigation in North Florida

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Controlled release fertilizer (CRF) is a class of insoluble and granulated fertilizer that releases nutrients such as nitrogen (N) gradually; CRF may reduce nutrient loss through leaching; and hence, CRF may increase crop yield and N use efficiency (NUE). This study was conducted at the University of Florida, IFAS, Suwannee Valley Agricultural Extension Center, Live Oak, FL in Fall 2012. ‘Bronco’ bush snap beans (Phaseolus vulgaris L.) were fertilized with seven N treatments of 0, 40, 80, or 120 lb/acre supplied as either ammonium nitrate (AN) or CRF alone or as combinations of AN plus CRF, arranged in a randomized complete-block design with four replications. The resulting snap bean marketable yields (lb/acre) were: 1) 4697 for 40 AN, 2) 6572 for 8 AN + 32 CRF, 3) 6846 for 80 AN, 4) 7230 for 16 AN + 64 CRF, 5) 8091 for 80 CRF, 6) 7263 for 120 AN, and 7) 8746 for 20 AN + 100 CRF, plus 983 for the 0 N control. The NUE values of the seven N treatments were: 93, 140, 73, 78, 52, and 65 (lb/lb), respectively. The NUE values were significantly greater when the 40 lb/acre and 120 lb/acre N treatments included 80% of the N as CRF. Therefore, use of CRF showed potential to significantly increase snap bean yields and NUE in north Florida.

Florida’s snap bean (Phaseolus vulgaris L.) production ranks first in the nation and constitutes 44% of the nation’s total production and 51% of the market value (Elwakil and Mossler, 2012). Adequate nitrogen (N) management is critical to optimize the yield and N use efficiency (NUE) of snap beans (Phaseolus vulgaris L.). Nitrogen may be lost via ammonia volatilization, nitrification and nitrate leaching and/or denitrification, particularly in sandy soils. Most commercial snap bean production in north Florida is on sandy soils. Controlled release fertilizers (CRF) are designed to deliver bioavailable N to the crop to meet plant growth demand and to reduce the risk of N losses. The objectives of this study were to 1) determine the N rate for optimizing snap bean production using center pivot irrigation; 2) compare the difference between soluble and CRF fertilizers; and 3) quantify the N use efficiency of the fertilizers.

Materials and Methods

This study was conducted on a Blanton-Foxworth-Alpin complex sandy soil at the UF/IFAS Suwannee Valley Agricultural Extension Center Live Oak, FL between 12 Sept. and 14 Nov. 2012. ‘Bronco’ bush snap beans were fertilized with three N rates of 40, 80, or 120 lb/acre (45, 90, or 134 kg/ha) with either ammonium nitrate (AN) and/or controlled release fertilizer (CRF), 39–0–0, 60-day polymer coated urea (Everris NA, Inc. Dublin, OH). The treatments (lb/acre of N) were: (1) 40 AN; (2) 8 AN + 32 CRF; (3) 80 AN; (4) 16 AN + 64CRF; (5) 80 CRF; (6) 120 AN; (7) 20 AN + 100 CRF, plus a control without N fertilization; four replicates each. All of the N treatments with CRF were applied before planting, while those for the treatments with AN alone were applied with three applications: at planting (20%), at first trifoliate leaf (40%), and at first flower bud (40%). Plots consisted of eight, 30-ft (9.2-m) rows, with marketable beans harvested in the central 20 ft of the two middle rows. Nitrogen use efficiency (NUE) was defined as bean marketable yield (lb) produced per pound of applied N. Data were analyzed by one-way ANOVA (SAS Institute, Cary, NC). The critical ranges (LSD0.05) of Duncan’s Multiple Range Test were used to identify significantly differences among the means of either bean yield or NUE (Hubbard, 2001).

Results and Discussion

The bean yields were: 4697, 6572, 6846, 7230, 8091, 7263, and 8746 lb/acre for treatments 1, 2, 3, 4, 5, 6, and 7, respectively, and the control produced a bean yield of 983 lb/acre (Fig. 1). Florida’s average snap bean marketable yield is approximately 8000 lb/acre (Hochmuth and Hanlon, 2010). Our data indicate that 80 lb N as CRF can produce slightly greater bean yield. Treatments 2, 4, 5, and 7 that included CRF had 50.5%, 6.5%, 21.2%, and 23.6% greater bean yields than their corresponding treatments 1, 3, and 6 with the same N rates supplied from AN. Due to the
variation, only treatments 1 and 2 showed a significant difference in bean yield at the same N rate (Fig. 1). There was no significant difference in marketable bean yield among treatments 2 through 6 even though there was a 3-fold difference in N rates (Fig. 2).

The NUE values of the seven N treatments were: 93, 140, 73, 78, 89, 52, and 65 (lb/lb), respectively. At the same N rate of 40 lb/acre, the NUE value of AN was 93 (lb/lb), but that of the CRF was 164 (lb/lb). Similarly tendencies in the NUE were also found for the other N rates of 80 and 120 lb/acre (Fig. 2). CRF fertilizer significantly increased snap bean yields and N use efficiency in this study. IFAS recommendation for regular N fertilizers on snap beans is 100 lb/acre (Hochmuth and Hanlon, 2010; Olson et al., 2012), which has been shown to be applicable to overhead-irrigated snap beans (Simonne et al., 2012). Our data indicate that 40 lb/acre N including 32 lb N as CRF and 80 lb N as AN had similar marketable yield and greater NUE compared with 120 lb N as AN (Figs. 1 and 2).

In summary, in this particularly study, there were no significant differences in snap bean marketable yields among the N rates: 40 lb N including 20% AN + 80% CRF; 80 lb N as 100% AN; or 120 lb 100% AN. Treatments with CRF always had greater bean yields than those with only AN. Treatments 3, 5, 6, and 8 with CRF were always greater in NUE than those with the corresponding N rate without CRF (treatments 2, 4, and 7): 71.5; 9.6~31.2; or 37.1 lb more beans per lb of N for the first, second, and third 40 lb N increase, respectively.

Fig. 1. Marketable bean yield responses to N programs. Control: 0 lb N; treatment 1, 40 lb N, 100% ammonium nitrate (AN); treatment 2, 40 lb N, 8 lb N as AN plus 32 lb N as CRF; treatment 3, 80 lb N, 100% AN; treatment 4, 80 lb N, 16 lb as AN plus 64 lb as CRF; treatment 5, 80 lb N, 100% CRF; treatment 6, 120 lb N, 100% AN; treatment 7, 120 lb N, 20 lb as AN plus 100 lb as CRF.

Fig. 2. Nitrogen use efficiency (NUE) for different N rates and NUE increment per 40 lb/acre of N. Control: 0 lb N; treatment 1, 40 lb N, 100% ammonium nitrate (AN); treatment 2, 40 lb N, 8 lb as AN plus 32 lb as CRF; treatment 3, 80 lb N, 100% AN; treatment 4, 80 lb N, 16 lb as AN plus 64 lb as CRF; treatment 5, 80 lb N, 100% CRF; treatment 6, 120 lb N, 100% AN; treatment 7, 120 lb N, 20 lb as AN plus 100 lb as CRF.
Literature Cited


