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RESPONSE OF SNAPBEAN TO NITROGEN FERTILIZATION ON A SANDY SOIL

George Hochmuth[1]
Bob Hochmuth[2]
Ed Hanlon[3]

INTRODUCTION

Snapbean (Phaseolus vulgaris) is a widely grown vegetable crop in Florida with 21,000 harvested acres in 1990-1991 (Fla. Agric. Stats., 1992). Much of the production currently is from southern Florida; however, significant area is being planted to snapbeans in northern Florida. Estimates of production and marketing costs for southern Florida are about $2,300 per acre with about eight percent of this due to fertilizer (Taylor and Smith, 1991). All snapbean growers in Florida apply some N with the average applications being 128 lbs N per acre (Agric. Statistics Board, 1991). Current fertilization recommendations are based on research conducted in the mid 1960s from which the crop nutrient requirements were estimated to be bout 60, 80, and 80 lb per acre of N, P_2O_5, and K_2O, respectively (Stall and Sherman, 1989; Hochmuth and Hanlon, 1989). In that early work (Nettles and Hulbert, 1966), variable responses to rates of a mixed fertilizer (6-8-8) were obtained. In two out of three years, yield did not increase at rates of 6-8-8 fertilizer above 1100 lb per acre. In the third year, 1400 lb per acre of the 6-8-8 fertilizer produced the best yield. If most of the fertilizer response was attributed to N, then crop N requirements appear to be in the range of 60 to 80 lb N per acre. Snapbean yield was best when all or part of the N was supplied from ammoniacal sources (Nettles, 1954). Similar results were obtained in Homestead on the rockland

[1] Associate Professor, Horticultural Sciences Dept., Gainesville, FL 32611
[2] Multicounty Agent, Suwannee Valley Agricultural Research and Education Center, Live Oak, FL 32060
[3] Associate Professor, Soil and Water Science Department, Gainesville FL 32611

soil where snapbeans receiving 40, 80, or 130 lb per acre yielded 205, 215, or 218 bu per acre, respectively (Asgrow, 1987). In more recent studies, snapbean yield was maximized at 60 lb N per acre in two seasons (Rhoads et al., 1990) and at 60 lb per acre in one season (Hochmuth et al., 1992).

In research from several locations in the United States, including Florida, snapbean yields were usually maximized at 50 lb N per acre (Paterson et al., 1966). In Pennsylvania in several studies on mostly silt loam soils, snapbean yields were best about 25 lb N per acre (Smith, 1977). In Missouri, snapbean yield was not greatly affected by N rate on a silt loam soil (Brown et al., 1969). Only two studies reported responses of snapbean yield to more than 100 lb N per acre, both studies from sandy loam soils. In Alabama, yield responded to up to about 120 lb N per acre in a spring trial but only to 50 lb N in the fall for three years (Doss et al., 1977). In Kansas, snapbean yield was highest with 120 lb N per acre on a sandy soil (Asif and Greig, 1972).

The research reported herein was conducted partly to test current N fertilizer recommendations in a study where only N rate is varied, and partly to demonstrate N fertilization under sprinkler irrigation in northern Florida on a sandy soil.

MATERIALS AND METHODS

Plots were established on a Klej fine sand at the Live Oak, AREC. Mehlich-I soil-test extractant results are presented in Table 1. Soil was fumigated with 1, 3-dichloropropene (Telone II) at nine gallons per acre broadcast two weeks prior to planting. In 1989, each plot received 50 pounds per acre P_2O_5 (triple super phosphate), 80 pounds per acre K_2O (potassium magnesium sulfate) and 50 pounds per acre of a complete micronutrient mix (3.25% B, 1.0% Cu, 15.0% Mn, and 6.0% Zn) as a banded application at planting. The same rates of K_2O and micronutrients were used in 1990; however, no P_2O_5 was applied. The N (ammonium nitrate) was applied as follows: 1/3 banded at planting three inches to one side of the row and two inches deep, 1/3 broadcast at first trifoliate leaf (May 9, 1989; May 2, 1990), and 1/3 broadcast at flower bud stage (May 17, 1989; May 17, 1990). All applications were followed immediately with an application of ½ inch of water by sprinkler irrigation. The N treatments used in this study comprised the range of zero to 200 lb per acre in 40 lb increments.

The snapbean cultivar "Podsquad' was seeded on April 19, 1989 and on April 9, 1990. Seeds were planted ¾" deep at a seeding rate of eight seeds per foot. Each plot consisted of 2 rows 30 inches apart and 20 feet in length. All treatments were replicated six times in a randomized, complete-block design. The herbicide metolachlor (Dual), at 1 ½ pints per acre, was applied to the soil with ½ inch of water. Plants were maintained free of insects and disease with labeled insecticide and fungicide applications. Leaf samples (most-recently-matured tri-foliate leaf) were collected at full- bloom each year for N analyses. Dried leaf plant tissue was digested and analyzed colorimetrically for total N (Hanlon and DeVore, 1989).

Six feet of row was hand-harvested from each of two rows in each plot on June 12, 1989 and on June 4, 1990. Snapbeans from the harvested area were graded into three categories: (1) marketable, (2) broken and small (pin), and (3) rotted or diseased. A plant lodging rating was also made for each plot. The lodging rating scale was 1-5. A rating of 1 was assigned to plots with no lodging, 2 for 25% plants lodged, 3 for 50% lodged, 4 for 75% lodged, and a 5 for plots where essentially all plants exhibited severe lodging. Five randomly selected, marketable beans were evaluated for pod length and straightness. Data were statistically analyzed by analysis of variance and regression techniques. Percent relative yield (best plot = 100%) for both years was fitted to linear-plateau and quadratic models (Nelson and Anderson, 1977; SAS, 1982)

RESULTS AND DISCUSSION

Increasing N rate resulted in an increase in the amount of plant lodging both years (Table 2). Lodging approached 75% as the N rate was increased to 120 lb per acre. Severe amounts of lodging could have an adverse effect on snapbean yields by increasing the amount of rotted pods (where pods contact the soil) and by reducing the efficiency of mechanical harvesting.

Snapbean pods became more curved s the N rate increased in 1989 but N rate had no effect on pod straightness in 1990 (Table 2). Ratings above 4 indicated acceptable quality. Quality was reduced as rating fell to 3.5 or below. Average pod length increased as N rate increased to 120 lb per acre both years, then dropped (Table 2). Higher rates of N resulted in more broken pods and pin pods in 1989 (Table 2). N rate did not affect the amount of broken pods or pin pods in 1990.

Amounts of rotted pods (white mold and soft rot) were increased at increased N rates in both years (Table 2). Losses of 20 bu per acre or more occurred as the N rate was increased about 120 lb per acre in 1989. These losses at high N rates probably reflect increased foliage and lodging of plants where pods were in contact with the soil and were more subject to attack from decay-causing organisms.

For 1989 total marketable yield, contrasts of zero N versus remaining N was significant (P=.0001) and contrast of 40 lb N per acre versus 80 through 200 was significant (P=.0001). Therefore, yield increased until 80 lbs N per acre, but leveled off or decreased afterwards.

For 1990 total marketable yield, a similar result was obtained. The contrast of 80 lbs N per acre versus higher N rates was significant (P=.0001). the linear-plateau model was used for each year to describe the critical point where yield response leveled off.

Marketable yield responded in quadratic fashion both years. The equations were: Yield (bu/A) = $66.3 + 3.14N - 0.01N^2$ ($r^2=0.79$) in 1989 and Yield (bu/A) = $74.0 + 3.26N - 0.01N^2$ ($r^2=0.63$) in 1990 where N is N rate in lb per acre. Linear-plateau models described the data better than quadratic models. Critical N plateau values were 73 and 92 lb N per acre in 1989 and 1990, respectively. The linear-plateau model in 1989 was Yield (bu/A) = $2.82N + 58.1$ or $N \leq 73$ lb per acre and Yield = 265 bu/A for N greater than 73 lb per acre. In 1990, the model was Yield = $2.52N + 76.15$ bu/A for $N \leq 92$ lb per acre and Yield = 307 bu/A for N greater than 92 lb per acre. The r^2 values were 0.83 in 1989 and 0.64 in 1990.

Since yield was similar both season, percent relative yield (PRY) was caculated with the highest yield over both season set to 100% (100% relative yield = 421 bu/A). A linear-plateau model described the data well (Fig 1). The critical plateau value was 72 lb N per acre. The model was PRY = 0.719N + 14.75 for N ≤ 72 lb per acre and PRY = 67% for N > 72 lb per acre. The r^2 for the linear-plateau model was 0.69. The quadratic model (r^2 = 0.66) was PRY = 16.9 + 0.737N + $0.0025N^2$ with a predicted yield maximum at 150 lb N per acre.

Leaf-N concentration increased in linear fashion as N rate increased in 1989 but quadratically in 1990 (Table 2). Average leaf-N was 3.6% at the linear-plateau critical value in 1989 and 3.8% at the critical value in 1990. Based on these data, the critical N concentration for snapbean is between 3.5 and 4.0%. These values are similar to those reported for N in Florida (Hochmuth et al., 1991, 1992) but slightly lower than reported elsewhere (Paterson et al., 1966; Smith, 1977).

The above results show that N crop nutrient requirement for the snapbeans in this test was between 70 and 80 lb N per acre. This value is slightly higher than current IFAS recommendations for N for snapbeans, but lower than results from other research on sandy soils.

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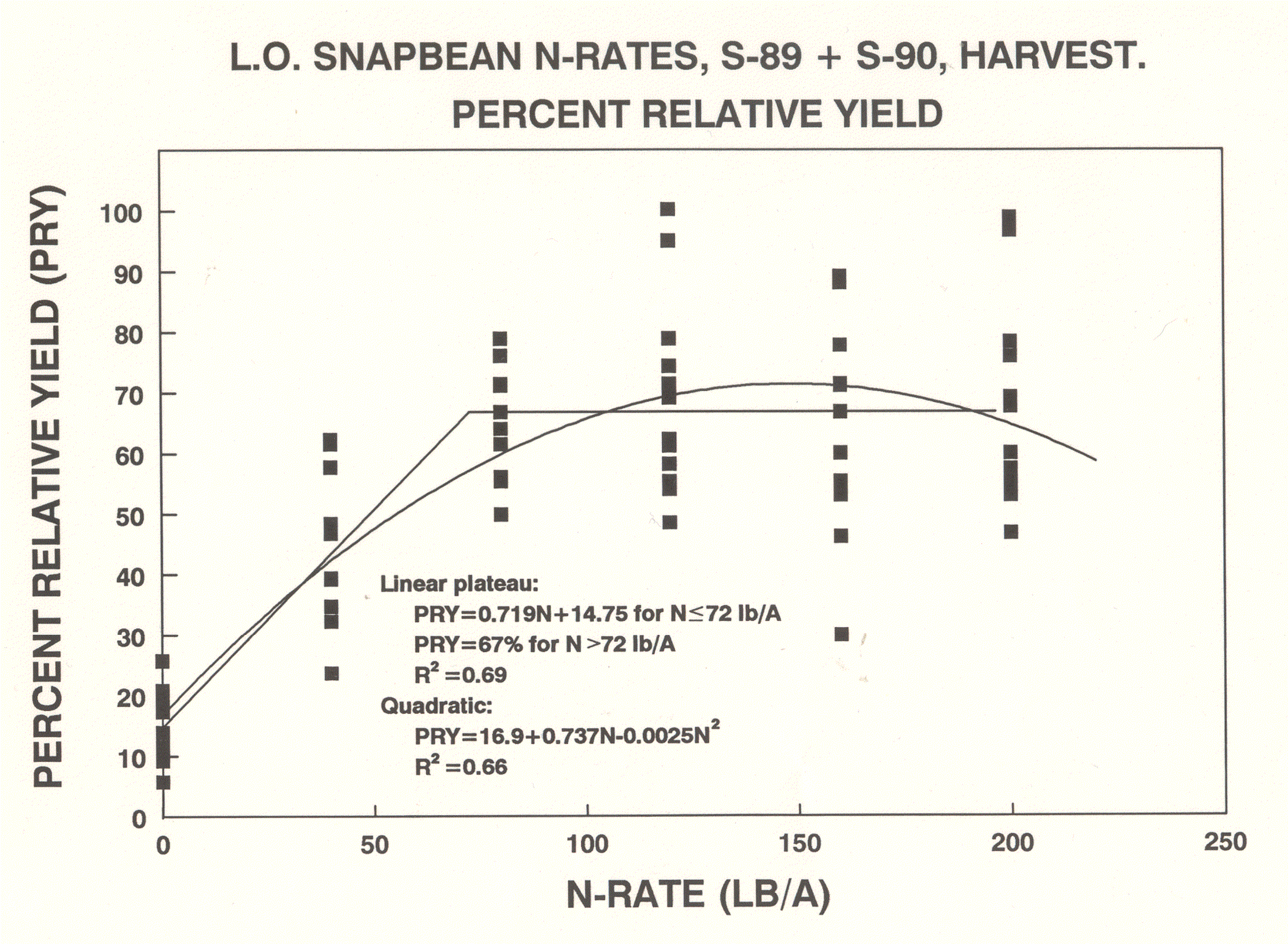

L.O. SNAPBEAN N-RATES, S-89 + S-90, HARVEST.
PERCENT RELATIVE YIELD
PERCENT RELATIVE YIELD (PRY)
N-RATE (LB/A)
Linear plateau:
PRY=0.719N+14.75 for N≤72 lb/A
PRY=67% for N >72 lb/A
R² =0.69
Quadratic:
PRY=16.9+0.737N-0.0025N²
R² =0.66

Table 1. Preplant Mehlich-I soil-test indices for snapbean N studies at Live Oak, FL.

Year	Organic Matter (%)	pH[y]	Soil-test indices (ppm)						
			P	K	Ca	Mg	Cu	Mn	Zn
1989		6.6	105 VH[z]	32 L	455	35 H	0.2	6.5	1.6
1990	1.7	5.8	60 H	51 M	166	18 M	1.3	8.3	1.9

[y] pH determined in 2:1 soil:water mixture.

[z] Interpretation: Very low (VL), Low (L), Medium (M), High (H), or Very high (VH).

Table 2. Response of snapbean to N rates in two spring season, 1989-1990 at Live Oak, FL.

N rate (lb/A)	Plant lodging rating[x]	Pod straightness rating[y]	Avg. Pod length (inch)	Yield (30-lb bu/A)			Leaf N Conc. (%)
				Broken pods and pin pods	Rotten Pods	Marketable Yield	
				1989			
0	1.0	4.4	4.1	39	1	58	3.0
40	2.2	4.1	4.5	55	8	171	3.0
80	3.2	3.8	4.8	60	14	260	3.6
120	3.7	3.8	4.8	58	17	279	4.2
160	4.0	3.7	4.8	56	26	247	4.2
200	4.0	3.7	4.7	55	26	274	4.4
Signif.[z]	L**Q**	L**Q**	L**Q**	L**Q**	L**	L**Q**	L**
R^2	0.93	0.45	0.77	0.21	0.45	0.79	0.45
				1990			
0	1.0	4.4	4.1	10	0	66	2.0
40	1.5	3.5	4.4	15	2	197	2.5
80	3.2	3.5	4.6	15	4	267	3.5
120	4.2	3.8	4.7	16	7	322	3.8
160	4.0	3.7	4.5	15	6	287	4.3
200	4.3	3.5	4.7	18	12	311	4.2
Signif.[z]	L**Q**	NS	L**Q**	NS	L**	L**Q**	L**Q**
R^2	0.75	N/A	0.40	N/A	0.25	0.63	0.89

[x] Lodging rating: 1 = no lodging; 5 = severe lodging.

[y] Pod straightness rating: 1 = very curved and crooked; 5 = straight.

[z] Significance at 1% (**) or 5% (*) probability level and responses were linear (L) or quadratic (Q).