Commercial Snap Bean Response to Fertilization with Broiler Litter

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Abstract. Commercial snap bean (*Phaseolus vulgaris* L.) yields in spring were similar when comparing a commercial fertilizer standard based on soil test recommendations to three application rates of broiler litter. Snap bean yields in the fall were higher on plots that received spring-applied broiler litter than on those receiving the commercial fertilizer standard in the fall. Increasing the application rate of broiler litter generally resulted in a linear yield response during both seasons.

Broiler litter is used as a nutrient source for commercial agronomic and horticulture crops (Link and Thomas, 1981). Increased yields have been reported on a variety of horticulture crops where broiler litter has been used as fertilizer (Liebhardt, 1976; Robertson and Wolford, 1970; Shortall and Liebhardt, 1975). Studies have been conducted to evaluate the effect of broiler litter application rate on sweet corn (*Zea mays* L.), watermelon [*Citrullus lanatus* (Thunb.) Matsum. and Nakai], and a variety of other vegetable crops (Robertson and Wolford, 1975; Sims, 1987; Sowell et al., 1963; Ware and Johnson, 1968). Based on these data, recommendations for using broiler litter can be made for several crops. We found no reports evaluating the use of a relatively high organic N source on a crop with low N requirements, such as snap beans. The objective of this research was to determine the effect of broiler litter on snap bean production, foliar nutrient content, and soil pH and nutrient concentrations on two soils in Alabama.

Soil samples were collected in Apr. 1989 at two locations: Sand Mountain Substation, Crossville, Ala. (Wynnsville sandy loam), and the North Alabama Horticulture Substation in Cullman (Hartselle sandy loam). Plots were disked in late March and early April (27 Mar., Sand Mountain; 18 Apr., Cullman), and broiler litter was broadcast and then incorporated into the upper 1.5 cm of soil at 4.8, 9.5, and 19 t·ha⁻¹. Commercial fertilizer was applied after planting as a standard treatment based on soil

test recommendations at (kg·ha⁻¹) 72.8N-32P-60K at Sand Mountain, and 86.8N-38P-72K at Cullman. Broiler litter was analyzed for N by a Kjeldahl method and for Ca, K, Mg, P, Fe, Mn, and Zn by inductively coupled argon plasma spectrophotometry (Ogg, 1960). A dry ash digestion procedure was used to prepare plant tissue samples to be analyzed. The Mehlich 1 extractant method was used for determining the P, K, Ca, and Mg levels. Broiler litter nutrient concentrations were as follows: 2.8% N, 2.08% Ca, 2.22% K, 0.33% Mg, 1.6% P, 1654 ppm Mn, and 437 ppm Zn. Rainfall was also recorded (Table 1).

In early May, plots were seeded with 'Strike' snap beans at eight to 10 seeds per 30.5 cm at Sand Mountain and four seeds per 30.5 cm at Cullman. Treatment plots consisted of six 6.1-m rows, with 0.91 m between rows and a 1.5-m alley between treatment plots. The statistical design was a randomized complete block with four replications. 2-Chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)acetamide (dual, metolachlor) was applied postplant at a rate of 2.2 kg a.i./ha, and crops were cultivated as needed.

Foliar samples, including the trifoliate leaflets and petiole, in the early reproductive stage at ≈75% blossom from fully expanded new growth were collected at both locations in mid-June. Soil samples were collected on 21 June at Sand Mountain and 20 July 1989 at Cullman. Soil and foliar analyses were conducted by the Soil Testing Laboratory at Auburn Univ., Ala., using the techniques noted for broiler litter. Snap beans were harvested at both locations on 6 July. Yield data were taken from a 1.5-m section of two interior rows of the six-row plot at Sand Mountain and from a 3.1-m section of two interior rows of a six-row plot at Cullman. Total weight was recorded.

After tilling the same treatment plots at both locations, 'Strike' snap beans were seeded in Fall 1989 by procedures similar to those described for the spring planting. Planting dates were 29 Aug. (Sand Mountain) and 6

Sept. (Cullman). Broiler litter was not applied to plots for the fall planting; however, commercial fertilizer was applied to the control plot at (kg·ha⁻¹) 72.8N-32P-60K. Foliage at the early reproductive stage and soil samples were collected for chemical analysis. Beans at both locations were harvested on 2 Oct. 1989 using the procedures described for the spring test.

Spring snap bean yields ranged from 11.1 to 14.6 t·ha⁻¹ at Sand Mountain and from 5.5 to 7.3 t·ha⁻¹ at Cullman. At both locations, applying broiler litter just before planting produced yields similar to those obtained by applying commercial fertilizer (Table 2).

Fall crop yields at Sand Mountain ranged from 8.1 to 12.2 t·ha⁻¹, while fall crop yields at Cullman ranged from 2.9 to 7.1 t·ha⁻¹. Applying broiler litter at 4.8, 9.5, and 19 t·ha⁻¹ increased yields 10%, 19%, and 35%, respectively, at Sand Mountain, compared with commercial fertilizer. Spring yields at Sand Mountain only and fall yields at both locations increased as broiler litter application rate increased. These data suggest that adequate nutrients were available from the broiler litter to support snap bean yield. Most of the previous

Table 1. Monthly and 30-year average rainfall in northern Alabama experimental areas during 1989.

Month	Rainfall (mm)		30-yr avg
	Sand Mountain	Cullman	
April	83	59	133
May	84	102	113
June	207	291	94
July	227	325	100
August	44	85	81
September	223	123	116
October	56	80	72
Total	924	1065	709

Table 2. Effect of broiler litter (BL) rate and commercial fertilizer (CF) on marketable snap bean yield in two Alabama locations.

Crop and fertilizer (t·ha ⁻¹)	Yield (t·ha ⁻¹)	
	Sand Mountain	Cullman
Spring		
CF ²	11.1	7.3
BL		
4.8	11.3	6.2
9.5	11.2	5.5
19.0	14.6	6.1
Significance		
CF vs. BL	NS	NS
BL rate linear	**	NS
Fall		
CF	8.1	3.8
BL		
4.8	8.9	2.9
9.5	9.9	3.9
19.0	12.2	7.1
Significance		
CF vs. BL	*	NS
BL rate linear	*	*

²CF: Sand Mountain for spring and fall (kg·ha⁻¹) = 72.8N-32P-60K; Cullman for spring (kg·ha⁻¹) = 86.8N-38P-72K, and for fall = 72.8N-32P-60K.

NS, *, **Nonsignificant or significant at $P=0.05$ or 0.01 , respectively.

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work has used broiler litter as an organic N source to evaluate crops with high N requirements (Albregts and Howard, 1981; Robertson and Wolford, 1975).

Mean foliar N content for Sand Mountain spring-planted beans ranged from 3.7% to 4.8%. Foliar N, Ca, K, Mg, P, and Mn responded linearly to increasing broiler litter rates (Table 3). Foliar nutrient levels were similar for commercial fertilizer and broiler litter except for K and P, which, on average, were lower with commercial fertilizer. Increasing broiler litter application rate increased leaf nutrient concentration, except for Fe and Zn.

For the fall crop, mean foliar N content ranged from 4.3% to 4.9%. Although not compared statistically, applying broiler litter at 4.8 t·ha⁻¹ in the spring resulted in higher foliar N in the fall crop (4.3% N) than in the spring crop (3.7% N). This difference indicates that N was becoming available long after the spring crop was harvested. Control plants receiving a fall application of commercial fertilizer contained higher levels of all nutrients, except P, than plants grown with broiler litter where commercial fertilizer had been applied only in spring (Table 3).

Foliar N levels for spring-planted snap beans grown at Cullman ranged from 3.8% to 4.3%. Commercial fertilizer produced higher foliar N levels than broiler litter (Table 4). Phosphorous, Fe, and Mn concentrations were higher when broiler litter was the fertilizer source, and those for P and Fe increased as the application rate increased.

Data for fall-planted Cullman beans were consistent with data for Sand Mountain beans in that the commercial fertilizer resulted in higher foliar N levels than the broiler litter. Concentrations of foliar P and Fe were higher with broiler litter than with commercial fertilizer, but only Fe concentrations increased with increasing broiler litter application rates (Table 4).

Fertilizer source influenced soil pH of the Wynnville sandy loam soil at Sand Mountain. Soil pH was lower with commercial fertilizer than with broiler litter (Table 5). Soil K levels were lower with broiler litter than with commercial fertilizer. At Cullman, soil P concentration increased as the broiler litter application rate increased, a result that agrees with results reported by Ware and Johnson (1968) for the Hartselle sandy loam soil. Soil pH was also lower at Cullman (Hartselle sandy loam) when commercial fertilizer was applied, these data agree with results from work with corn (*Z. mays*) (Liebhardt, 1976).

In summary, broiler litter provided adequate nutrients to produce snap beans. Broiler litter applied at 4.8 t·ha⁻¹ was as effective as the commercial fertilizer at both locations. These results indicate that crops with low N requirements, such as snap beans, can be produced effectively with relatively low rates of broiler litter. When snap beans were grown as a double (fall) crop following the spring crop on the same soil, yields produced with only the residual broiler litter were similar to those produced with the commercial fertilizer. Also,

Table 3. Effect of broiler litter (BL) and commercial fertilizer (CF) rate on foliar nutrient content of snap beans grown in a Wynnville sandy loam soil at Sand Mountain, Ala.

Crop and fertilizer (t·ha ⁻¹)	N	Ca	K	Mg	P	Fe	Mn	Zn
	%					ppm		
Spring								
CF ²	4.3	1.1	2.0	0.24	0.37	290	33	39
BL								
4.8	3.7	1.0	1.9	0.23	0.37	255	32	43
9.5	4.3	1.1	2.2	0.25	0.44	240	35	44
19.0	4.8	1.3	2.5	0.26	0.46	267	37	47
Significance								
CF vs. BL	NS	NS	*	NS	*	NS	NS	NS
BL rate linear	**	*	**	*	**	NS	*	NS
Fall								
CF	4.9	1.6	1.9	0.35	0.41	221	158	26
BL								
4.8	4.3	1.3	1.3	0.32	0.36	164	55	10
9.5	4.3	1.3	1.6	0.29	0.38	152	52	11
19.0	4.4	1.3	1.7	0.29	0.36	153	52	16
Significance								
CF vs. BL	**	**	**	**	NS	**	**	*
BL rate linear	NS	NS	**	NS	NS	NS	NS	NS

²CF: Sand Mountain for spring and fall (kg·ha⁻¹) = 72.8N–32P–60K.

NS, *, **Nonsignificant or significant at *P* = 0.05 or 0.01, respectively.

Table 4. Effects of broiler litter (BL) and commercial fertilizer (CF) rate on foliar nutrient content of snap beans grown in a Hartselle sandy loam soil at Cullman, Ala.

Crop and fertilizer (t·ha ⁻¹)	N	Ca	K	Mg	P	Fe	Mn	Zn
	%					ppm		
Spring								
CF ²	4.3	1.5	0.27	0.29	0.30	227	121	27
BL								
4.8	3.9	1.6	0.31	0.29	0.35	313	281	26
9.5	3.8	1.9	0.33	0.32	0.36	337	203	21
19.0	4.2	1.9	0.35	0.32	0.38	347	214	30
Significance								
CF vs. BL	*	NS	NS	NS	**	*	**	NS
BL rate linear	NS	NS	NS	NS	*	*	NS	NS
Fall								
CF	5.1	1.6	0.33	0.37	0.35	187	180	35
BL								
4.8	4.5	1.7	0.31	0.33	0.38	208	80	25
9.5	4.4	1.9	0.32	0.36	0.38	231	79	25
19.0	4.7	1.8	0.30	0.34	0.39	236	86	23
Significance								
CF vs. BL	**	NS	NS	NS	*	**	**	**
BL rate linear	NS	NS	NS	NS	NS	*	NS	NS

²CF: Cullman for spring (kg·ha⁻¹) = 86.8N–38P–72K; fall = 72.8N–32P–60K.

NS, *, **Nonsignificant or significant at *P* = 0.05 or 0.01, respectively.

Table 5. Effect of broiler litter (BL) and commercial fertilizer (CF) rate on soil analysis at two locations.

Crop and fertilizer (t·ha ⁻¹)	pH	P	K	Mg	Ca
(kg·ha ⁻¹)					
<i>Sand Mountain, Ala. (Wynnville sandy loam)</i>					
Initial sample	5.5	159	370	61	590
CF ²	5.8	255	387	195	983
BL					
4.8	6.3	210	330	222	938
9.5	6.4	222	349	273	1148
19.0	6.5	234	345	255	1165
Significance					
CF vs. BL	**	NS	**	NS	NS
BL rate linear	NS	NS	NS	NS	NS
<i>Cullman, Ala. (Hartselle sandy loam)</i>					
Initial sample	6.4	27	109	116	920
CF	6.1	56	137	129	893
BL					
4.8	6.4	60	112	157	834
9.5	6.4	74	143	169	955
19.0	6.3	119	143	166	960
Significance					
CF vs. BL	*	*	NS	*	NS
BL rate linear	NS	**	*	NS	NS

²CF: Sand Mountain for spring and fall (kg·ha⁻¹) = 72.8N–32P–60K; Cullman for spring = 86.8N–38P–72K, and for fall = 72.8N–32P–60K.

NS, *, **Nonsignificant or significant at *P* = 0.05 or 0.01, respectively.

litter applied at 19 t·ha⁻¹ did not lower yields of this low-N-requirement plant.

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