UTILIZATION OF CONSERVATION TILLAGE AND COVER CROPS IN SNAP BEAN PRODUCTION

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ABSTRACT

Experiments were conducted during 1992 and 1993 near Blairsville, GA to determine the potential for using conservation tillage and cover crops in the production of snap beans in the Mountain region of Georgia. One experiment compared no-tillage and conventional tillage snap beans following either a rye or hairy vetch cover crop. A second experiment examined the need for sidedressed nitrogen for no-tillage and conventional tillage snap beans following a hairy vetch cover crop. The rye cover crop contained **30** and 95 Ibs N/acre, respectively, during 1992 and 1993, and hairy vetch contained 71 and 68 Ibs N/acre during the two years. There was a trend for increased inorganic N in the upper 12" of soil following conventional tillage. There were no significant differences of tillage, cover crop, or sidedressed N on plant stand or shoot dry weight. Total yields from the cover crop experiment were similar for the treatment combinations; however, early yield during 1992 was 62% greater using no-tillage. Total yields from the sidedressing experiment were similar for the various treatments, but in 1993 no-tillage resulted in 44% greater early yield. These results indicate that conservation tillage and cover crops could prove useful in sustainable production of snap beans in the Mountain region.

INTRODUCTION

Excessive use of N fertilizer and tillage-intensive land preparation practices in the production of vegetable crops threatens the agricultural productivity, environmental quality, and ultimately, the economy and sustainability of rural communities throughout the southeastern USA, where the potential for soil erosion and surface runoff is often great. Pressure is increasing throughout the region for growers to adopt sustainable crop production strategies. Use of conservation tillage practices and winter cover crops are often effective management options for control of soil erosion and supply of N to cash crops (Blevins et al., 1983; Langdale et al., 1979; McVay et al., 1989).

Investigations of snap bean yield response to tillage have shown greater yields for conventional tillage (Knavel and Herron, 1986; Mullins et al., 1988). equal or greater yields for no-tillage (Skarphol et al., 19871, or inconsistent differences between the two soil preparation methods fBellinder et al., 1987; Grenoble et al., 1989; Mascianica et al., 19'86; Mullins et al., 1980). The few published reports concerning the use of cover crops in snap bean production have shown little or no difference in yields following legumes (such as hairy vetch and red clover) or cereals (such as wheat and rye), when supplemental N was used (Grenoble et al., 1989; Skarphol et al., 1987).

Additional research regarding the effects of cover cropping, tillage, and fertilizer N rate on vegetable crop production is needed in order to further refine production recommendations (Phatak, 1992). The objectives of this research were to investigate the effects of tillage and cover crops on snap bean production in the Mountain region of Georgia, and to determine whether sidedress N fertilizer is required to maintain snap bean yield in conventional and no-tillage soil management systems that utilize a winter cover crop of hairy vetch.

MATERIALS AND METHODS

Two experiments were conducted during 1992 and 1993 at the Georgia Mountain Experiment Station in Blairsville, GA. One experiment consisted of a 2 x 2 factorial experiment of cover crop and tillage. The cover crops were rye *(Secale cereale)* and hairy vetch (*Vicia villosa),* and tillage systems were conventional tillage with a moldboard plow (CT) and no-tillage (NT). The second experiment was a 2 x 2 factorial of tillage and nitrogen sidedress following a winter cover crop of hairy vetch. Nitrogen variables were sidedressing of 50 lbs

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Table 1. Average monthly minimum and maximum air temperatures and total precipitation from May to August during 1992 and 1993 at Blairsville, GA.

	Temperature					
	Minimum		Maximum		Precipitation	
Month	1992	1993	1992	1993	1992	1993
	F				in	
May	47	49	73	75	2.2	3.5
June	57	59	78	83	6.4	3.6
July	62	63	84	92	6.9	0.7
August	57	61	80	85	8.9	4.2

Table 2. Dry weight and nitrogen content of rye and hairy vetch cover crops prior to snap bean planting in 1992 and 1993.

	Dry weight		N content	
Cover crop	1992	1993	1992	1993
	lbs/acre			
Rye	2143	4550	29	95
Hairy vetch	1964	2321	71	68

N/acre 3 weeks after planting (+N) or no sidedressing (-N), and again tillage was CT and NT.

Crops in both experiments were planted in 32" wide rows, with a stand density of 6 plantslft. Individual plot size was 6 rows wide by 25 ft. long, and all treatments were replicated 4 times. The cultivar Pod-squad was used in the first experiment, and the cultivar Sentry was used in the second experiment. All plots received 25 lbs N/acre at planting, and those plots in the first experiment received the nitrogen sidedressing as well. Crops were produced dryland except for irrigation after planting to activate herbicides and promote rapid stand establishment.

To assess soil inorganic N concentrations early in the snap bean growing season, six cores per plot were composited from the O" to 6" and 6" to 12" soil depths at planting in 1992, and at five weeks after planting (WAP) in both years. Soil NH_4-N and NO_3-N concentrations were determined colorimetrically with a Lachat flow injection analyzer. Snap bean above ground dry matter production was determined every 10 to 14 days, beginning at three WAP, for a 3 ft segment of nonharvest row on each plot. Plants were counted, cut at the soil surface. separated into shoots and pods, dried, and weighed. For yield determination, marketable pods were hand-harvested from a 15 ft segment of an undisturbed center row of each plot at approximately weekly intervals three times each year. Pods taken in the first harvest represented early yield. Data were analyzed by analysis of variance (ANOVA) procedures appropriate for the experimental design.

RESULTS AND DISCUSSION

Average monthly minimum and maximum temperatures and monthly rainfall totals are given in Table 1. Temperatures were generally greater in 1993 than in 1992, particularly maximum temperatures during June, July, and August. The early part of the 1992 growing season was drier than in 1993. However, the bulk of the 1993 growing season (June, July, August) was substantially drier than in 1992. These variable weather conditions are typical of those experienced in the southeastern USA.

Cover crops produced enough biomass each year (Table 2) to provide nearly complete soil coverage by late spring. The cover crops were easily killed with glyphosate, eliminating regrowth and direct competition with snap bean during its production cycle. When killed in the spring, the hairy vetch cover crop contained 68 to 71 Ibs N/acre and the rye contained 30 to 95 Ibs N/acre each year (Table 2). It is generally well established that legume cover crops provide greater N than nonlegumes (Ebelhar et al.. 1984; Hargrove, 19861. However, this depends on the total biomass produced by the cover crop and on relative N content (Skarphol et al., 1987).

In the current experiment there was typically greater soil nitrogen at planting at both soil depths with the hairy vetch cover crop as compared to the rye in 1992 (Table 3). By 5 weeks after planting differences were not apparent at the O" to 6" depth, although they

Table 3. Effects of tillage and cover crop on the concentration of inorganic nitrogen in the 0" to 6" and 6" to 12" soil depths under snap beans in 1992. These plots received 50 lbs N/acre sidedressed 3 weeks after planting.

	At planting		5 weeks after planting	
	0-6"	6-12"	0-6"	6-12"
	- - - - - - - - - ppm - - - - - - - - -			
Tillage				
NT	18.8	7.0	14.4	7.9
CT	17.7	8.5	16.5	13.7
Cover crop				
Rye	8.3	5.6	11.8	7.5
Hairy vetch	28.1	9.9	19.1	14.1
Significance				
Tillage (T)	NS	NS	NS	NS
Cover crop (C)	**	**	NS	**
T X C	NS	*	NS	NS

NS, *, or ** represent no significance or significance at the 5% and 1% level for main effects and their interaction.

Table 4. Effects of tillage and cover crops on early and total snap bean fresh weight yields in 1992 and 1993.

	Early yield		Total yield	
	1992	1993	1992	1993
	- - - - - - - tons/acre - - - - - -			
Tillage				
NT	3.0	3.3	6.9	5.0
CT	1.2	2.4	6.8	3.8
Cover crop				
Rye	2.3	3.3	6.9	5.0
Hairy vetch	1.9	2.5	6.8	3.9
Significance				
Tillage (T)	**	NS	NS	NS
Cover crop (C)	NS	NS	NS	NS
T X C	*	NS	NS	NS

NS, *, or ** represent no significance or significance at the 5% and 1% level for main effects and their interaction.

remained at the 6" to 12" depth. Samples taken 5 weeks after planting in 1993 [data not shown) revealed no differences between cover crops at either depth during the second year. Others have shown that after 4 to 6 weeks, differences in plant available soil nitrogen in systems utilizing winter cover crops tend to diminish [Ebelhar et al., 1984; Skarphol et al., 1987). There was a trend for increased inorganic N in the upper 12" of soil following conventional tillage.

There were no differences in snap bean stands or shoot dry weight in either year in response to cover crop, tillage, or sidedressing in the two experiments (data not shown). There have been variable reports on the effects of tillage on stand establishment of snap bean (Bellinder et al., 1987; Knavel and Herron, 1986; Mullins et al., 1980; Mullins et al., 1988). It is difficult to predict the influence of tillage on stand establishment with certainty because weather greatly influences crop germination, emergence, and persistence.

Table 5. Effects of tillage and sidedress nitrogen on early and total snap bean fresh weight yields following a hairy vetch cover crop in 1992 and 1993.

Treatment	Early yield 1992	Early yield 1993	Total yield 1992	Total yield 1993
	- - - - - - - tons/acre - - - - - - -			
NT + N	3.0	3.5	6.3	5.5
CT + N	2.5	1.9	6.1	4.8
NT - N	2.3	3.7	5.0	6.6
CT - N	2.7	2.1	6.3	5.3
Significance				
Tillage (T)	NS	*	NS	NS
Nitrogen (N)	NS	NS	NS	NS
T X N	NS	NS	NS	NS

[1] NS or * represent no significance or significance at the 5% level for main effects and their interaction.
[2] NT and CT refer to no-tillage and conventional tillage, and + N and - N refer to the presence or absence of nitrogen sidedressing.

Yields from the two years of these experiments are presented in Tables 4 and 5. There was no influence of cover crop on early or total yield over the two years. Tillage did not significantly influence total yields during either year of the experiments. However, early yields in 1992 were 62% greater for NT as compared to CT in the cover crop experiment (Table 4). and were 44% greater for NT than for CT in 1993 for the sidedressing experiment (Table 5). There was no significant effect of sidedress N, or its interaction with tillage, on early or total yield in either year (Table 5). According to Mullins (1987), maximum yield of snap beans usually occurs at fertilizer N rates between 15 and 50 lbs/acre when legume cover crops are not used: however, positive yield responses to higher fertilizer N rates have been observed where the potential for N loss is great, such as on sandy soils.

These studies indicate that successful snap bean production is possible using either conventional tillage or no-tillage following a winter cover crops such as rye and hairy vetch. Snap bean yields for the two tillage extremes should be similar if soil temperatures at planting are high and weeds are controlled in no-tillage, and if soil crusting is not severe and dry periods are not prolonged in conventional tillage. Our results indicate that a hairy vetch cover crop and a modest amount of fertilizer N applied at planting can supply sufficient N for snap bean production in the Mountain region of Georgia. These results suggest that adoption of resource-conserving vegetable production systems based on no-tillage soil management and use of winter cover crops could result in improved water quality, sustained soil productivity, and greater production efficiency in the southern Appalachians.

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