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Influence of crop residues and nitrogen levels on agronomic performance of irrigated common bean

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Nitrogen fertilization in common bean under no-tillage grown after green manures provides different response patterns. Thus, the study aimed to evaluate the effect of N doses on coverage and the use of different vegetation covers on the development and yield of irrigated common bean, grown in no-tillage. The work was conducted during the years 2001 and 2002, in an area located in the city of Selvíria-MS, Brazil. The experimental design was randomized blocks in factorial arrangement (7 x 6) with four replications. The first factor it was composed of seven soil cover managements (*Pennisetum glaucum*, *Sorghum bicolor*, *Zea mays*, *Cajanus cajan*, *Crotalaria spectabilis*, *Mucuna aterrima* and a fallow area), while the second factor consisted of five N top-dressing doses (0, 25, 50, 75, 100 and 125 kg ha^{-1}). It were mensured the variables: foliar N content, dry matter of plants and yield components (number of pods plant^{-1}, number of grains plant^{-1}, number of grains pod^{-1} and mass of hundred grains) at five plants each plot; final population of plants and grain yield. Nitrogen top-dressing doses on irrigated common bean influenced only variable dry matter of plants, while the different soil covers does not influence any agronomic characteristic this culture.

Keywords: green manures, soil cover, top-dressing, *Phaseolus vulgaris* L.

INTRODUCTION

Brazil is the world's largest producer of common bean (*Phaseolus vulgaris* L.), with production estimated at 2.8 million tonnes in 2012 (FAO, 2014) and average yield of 939 kg ha^{-1} (CONAB, 2014). However, this productivity is low considering the yield potential of common bean which can exceed 4,500 kg ha^{-1}. There are several problems that contribute to this fact, as inadequate management of nutrients, pests, diseases and weeds, as well as the monoculture.

The management of nitrogen (N) fertilizer on crops has been done based on the expected of grain yield, soil organic matter content, the crop history and succession of crops. However, a major limitation is the lack of analytical characteristics sufficiently reliable for establishing the nitrogen amounts to be applied (CERETTA et al., 2002).

In Brazil, the adoption of conservation systems, like no tillage allied to nitrogen top-dressing, is a practice that has provided increases in grain yield of common bean (ARF et

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Table 1. Soil chemical attributes of experimental area at 0.00-0.20 m layer.

P resin	O.M	pH	K	Ca	Mg	H + Al	CEC	V
mg dm^{-3}	g dm^{-3}	$CaCl_2$	mmol$_c$ dm^{-3}					(%)
25	28	5,5	2,1	30	17	28	76,9	64

O.M.: organic matter; CEC: cation exchange capacity.

al., 2011; FARINELLI et al., 2006; MEIRA et al., 2005; SILVEIRA et al., 2005). Ceretta et al. (2002) ascribe these results to increase in organic matter content, and consequently, of N in the soil. Furthermore, the synergic effect these practices may minimize losses of N, mainly by nitrate leaching and ammonia volatilization (SILVEIRA et al., 2005).

However, this success depends on maintaining systems capable of generating sufficient dry matter quantities to keep the soil covered all year round. Torres et al. (2014) emphasize that the use of green manures, such as *Crotalaria spectabilis*, *Mucuna aterrima*, *Cajanus cajan* and *Pennisetum glaucum*, may be a promising alternative in N supplementation to succeeding crop, besides providing efficient soil surface coverage.

Nitrogen fertilization in common bean under no-tillage grown after green manures has provided different response patterns. Arf et al. (1999) and Silveira et al. (2005) verified that green manure cultivation provided an increase in common bean yield, besides the reduction of N top-dressing. These authors attributed these effects to improvement in chemical and physical soil properties. However, Silva et al. (2008) did not observe significant effect these practices on common bean yield.

Thus, the study aimed to evaluate the doses effect of nitrogen top-dressing on agronomic performance of irrigated common bean, grown succeeding vegetal covers.

MATERIAL AND METHODS

The experiment was conducted during the years 2001 and 2002, in an area located in the city of Selvíria/MS (51º 22' W and 20º 22' S), with an altitude of 335 meters. The local soil was classified as loamy Red Oxisol according to the criteria recommended by Embrapa (2013), whose chemical attributes of 0-0.20 m layer are contained in Table 1. Average annual rainfall is 1370 mm, and the temperature and relative humidity average annual is 23.5 °C and 75%, respectively.

In August, 2001, it was performed sowing of *Pennisetum glaucum*, *Sorghum bicolor*, *Zea mays*, *Cajanus cajan*, *Crotalaria spectabilis*, *Mucuna aterrima* and fallow. The area was under the tillage system for seven years. At flowering of each culture, the cut theses crops was done with roll-knife. Before sowing the common bean, proceeded to desiccation of remaining plants with glyphosate (1,980 g ha^{-1} do i.a.).

The sowing of common bean was performed mechanically on April 23, 2002 using the cultivar IAC Carioca Eté, and at April 24, 2003 it was used the cultivar Pérola. The plots consisted of six rows of 5.5 m long, spaced 0.50 m. The experimental design was randomized blocks in factorial arrangement (6x7) with four replications. The first factor was composed by seven cover crop managements (*Pennisetum glaucum*, *Sorghum bicolor*, *Zea mays*, *Cajanus cajan*, *Crotalaria spectabilis*, *Mucuna aterrima* and fallow), while the second factor consisted of five N top-dressing doses (0, 25, 50, 75, 100 and 125 kg ha^{-1}).

Basic fertilization was performed in the sowing furrows and consisted of 200 kg ha^{-1} at formulation 08-28-16. The nitrogen top-dressing supply (different doses) was performed at 16 days (2002) and 15 days (2003) after plant emergence, according to Ambrosano et al. (1996b). The N source was urea and after the application was held irrigation, in order to minimize losses by volatilization.

The water supply was conducted through a fixed sprinkler irrigation system comprising micro sprinklers Mamkad (nozzles 1,1 x 2,0 mm) self-compensantes, spaced 6 x 6 m, with a service pressure of 230 kPa and an average water slide of 3.3 mm per hour in nozzles. Water management over crop development was performed using the Kc recommended by Doorenbos and Kassam (1979), distributed between the periods of emergence and harvest.

The following parameters were measured: leaf N content according to the methodology proposed by Sarruge and Haag (1974), dry matter and production components (number of pods per plant, number of grains per plant, average number of grains per pod and mass of hundred grains) at five plants per plot; final plants population and grain yield by counting of plant and harvest in two center rows of each plot, whose values were extrapolated to hectare.

Data were subjected to analysis of variance. The qualitative factor (vegetal covers) was subjected to comparison of means by Tukey's test, and the quantitative factor (N doses) to polynomial regression. The best fitted equation was selected according to the coefficient of determination and the regression coefficients significance.

Table 2. Analysis of variance and mean values for final plants population and dry mass of irrigated common bean, according to vegetal covers and nitrogen top-dressing.

Treatments		Final Population (plants ha^{-1})		Dry Mass (g $plant^{-1}$)	
		2002	2003	2002	2003
Soil cover	*S. bicolor*	331,583	243,104	4.64	8.90
	P. glaucum	329,917	229,375	4.64	9.96
	Z. mays	328,167	240,729	4.65	10.23
	M. aterrima	321,167	235,625	4.05	9.87
	C. cajan	334,667	224,792	3.94	9.59
	C. spectabilis	330,667	227,167	4.47	9.19
	Fallow	340,167	230,833	4.25	9.45
N doses (kg ha^{-1})	0	337,099	240,428	3.48 [1]	7.94 [2]
	25	334,621	220,446	4.17	8.74
	50	332,143	240,089	4,61	9.31
	75	329,665	231,607	4.80	10.37
	100	327,188	243,661	4.75	11.34
	125	324,711	222,303	4.45	9.89
C.V. (%)		7	14	21	19

[1] $Y = 3.4856 + 0.0322x – 0.00019 x^2$
[2] $Y = 7.6971 + 0.0557x – 0.00027 x^2$

All analyzes were performed using the statistical software Sisvar (FERREIRA, 2011).

RESULTS AND DISCUSSION

In the two years of the experiment, there was no influence of soil cover on variables final population and dry matter (Table 2). This allows infer that the straw volume of evaluated crops not damaged sowing operation and, consequently, the final plants population, corroborating the results obtained by Franco et al. (2008). Gomes Junior et al. (2008), Nunes et al. (2006) and Silveira et al. (2005) verified effect of soil cover on the final plant population in common bean crop, due to deposition of seeds inside vegetable matter, with no contact with soil to start the germination process.

Dry matter showed quadratic fit in response to N top-dressing in two years. Taiz and Zeiger (2004) emphasize that in C3 plants, like common bean, much of the foliar N is allocated in proteins involved in the photosynthetic process, especially on Rubisco enzyme. This allows inferring that the nitrogen fertilization provides increase in plant photosynthetic capacity, increasing this variable.

The N foliar content it was not influenced by any of the factors evaluated (Table 3), remaining close to the minimum level of nitrogen for the crop, which is 30 g kg^{-1} (AMBROSANO et al., 1996). Arf et al. (1999 found that top-dressing with 45 kg kg^{-1}, combined with cultural remains of *M. aterrima* provided an increase in this variable in common bean plants. However, Arf et al. (2011) and Chidi et al. (2002) observed that N top-dressing has not provided increase of foliar N content compared to control, linking this result to effectiveness of the natural microbial population in the soil fixing atmospheric N.

There was no influence of the factors evaluated on the number of pods and grains per plant, differing from the results obtained by Bordin et al. (2003), who verified that the cultivation of *Crotalária juncea* allied to 75 kg ha^{-1} of N top-dressing provided increase these variables. Silveira et al. (2005) and Arf et al. (2005) verified, respectively, that the common bean growing on the cultural remains of *M. aterrima* caused a significant increase in the number of pods and grains per plant. However, these authors found no response these variables on the N doses, attributing these results to high biological N fixation by this crop.

Number of grains per pod it was not significantly affected by any of the factors evaluated (Table 4), possibly because it is a varietal characteristic poorly affected by the environment (ANDRADE et al., 1998). However, Silveira et al. (2005) and Bordin et al. (2003) observed that this variable was influenced by crop residues and by N doses fertilization applied on covering, indicating that a better nutrition in N may increase the number of fertilized ovules per pod.

The absence of influence of the factors evaluated for mass of hundred grains allows infer that this variable is related to genotypic characteristics of cultivar. Similar results were obtained by Silva et al. (2005), Silveira et al. (2005), Bordin et al. (2003) and Arf et al. (1999), that no

Table 3. Analysis of variance and mean values for foliar N content, number of pods and grains per plant of common bean cultivated at winter, according to vegetal covers and nitrogen top-dressing.

Treatments		Foliar N content (g kg^{-1})		Number of pods per plant		Number of grains per plant	
		2002	2003	2002	2003	2002	2003
Soil cover	*S. bicolor*	32.1	29.54	6.6	8.3	31.1	38.3
	P. glaucum	32.4	29.59	6.8	7.9	32.2	34.1
	Z. mays	32.9	29.36	6.1	8.9	31.3	41.9
	M. aterrima	33.2	29.94	6.8	8.7	34.0	39.2
	C. cajan	30.3	30.99	7.2	8.3	34.6	37.5
	C. spectabilis	33.1	30.59	6.8	9.1	34.0	39.5
	Fallow	31.1	30.75	6.6	8.1	33.9	35.5
N doses (kg ha^{-1})	0	31.4	32.91	6.5	8.0	29.1	35.2
	25	30.9	28.06	6.6	8.2	33.1	38.0
	50	31.1	29.09	6.7	8.9	32.5	41.3
	75	31.8	29.83	6.8	8.6	37.3	36.5
	100	33.0	29.38	6.8	8.7	32.3	39.6
	125	34.8	31.39	6.9	8.5	33.8	37.5
C.V. (%)		13	15	24	28	27	32

Table 4. Analysis of variance and mean values for number of grains per pod, mass of hundred grains and grain yield of irrigated common bean, according to vegetal covers and nitrogen top-dressing.

Treatments		Number of grains per pod		Mass of hundred grains (g)		Grain yield (kg ha^{-1})	
		2002	2003	2002	2003	2002	2003
Soil cover	*S. bicolor*	4.6	4.6	24.0	24.3	2,370	1,569
	P. glaucum	4.9	4.4	23.9	24.0	2,332	1,445
	Z. mays	4.9	4.5	23.8	23.9	2,259	1,525
	M. aterrima	4.9	4.5	24.1	24.2	2,348	1,663
	C. cajan	4.8	4.5	23.9	24.1	2,234	1,474
	C. spectabilis	4.9	4.3	23.8	24.4	2,401	1,412
	Fallow	5.1	4.4	23.4	24.1	2,254	1,482
N doses (kg ha^{-1})	0	4.7	4.3	23.5	24.1	2,265	1,577
	25	4.8	4.7	23.6	23.9	2,339	1,465
	50	4.9	4.5	23.8	24.0	2,405	1,495
	75	5.0	4.2	23.9	24.0	2,275	1,430
	100	4.9	4.4	24.1	24.2	2,280	1,484
	125	4.8	4.5	24.2	24.6	2,311	1,583
C.V. (%)		12	13	5	5	16	17

verified influence of crop residues and nitrogen topdressing on this variable.

Grain yield did not respond to any of the factors evaluated, disagreeing with the results obtained by Bordin et al. (2003) and Arf et al. (1999), who verified that the cultural remains of green manures provided increment this variable in common bean. This was possibly due to soil of the field have high organic matter and base saturation, which caused conditions that minimize possible effects of treatments on soil chemical attributes.

CONCLUSIONS

Nitrogen top-dressing doses on irrigated common bean only influenced the dry matter of plants. Irrigated common bean can be grown after any cover crops evaluated without influence on its agronomic performance.

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