INFLUENCE OF NITROGEN FERTILIZATION IN PRODUCTIVITY COMPONENTS IN IRRIGATED BEAN CULTURE

D. C. da Silva[1], A. Pacheco[2], R. R, Gomes Filho[3], A. S. Lopes[4], R. C. Santos[5], G. A. Biscaro[6]

SUMMARY: The objective of this study was to verify the influence of nitrogen fertilization and seed inoculation on the productivity components of common bean irrigated via central pivot. The experiment was developed in the University Unit of Aquidauana-MS (UUA / UEMS), from June to August 2014, using the cultivar IPR Tangará, whose source of nitrogen (N) was urea, with a total dose of 90 kg ha-1 and inoculation using Rhizobium tropici Semia 4077. The experimental design was a randomized block design, with four replications and nine treatments (combinations of nitrogen fertilization at sowing, N times and modes of cover application and seed with and without inoculation) using Penman-Monteith irrigation management. The number of grains per pod, number of pods per plant, mass of 100 grains and yield in kg.ha-1 were statistically analyzed by the scott-knott test. There were higher productivity the treatments in which both partial and total fertilizer treatments were used, increasing the productivity without N in the sowing, but with nitrogen fertilization in the V4 stage and seed inoculation (T8).

KEYWORDS: winter bean, nitrogen, center pivot.

MANEJO DA ADUBAÇÃO NITROGENADA NA CULTURA DO FEIJOEIRO IRRIGADO

RESUMO: Objetivou-se verificar a influência da adubação nitrogenada e inoculação de sementes sobre os componentes de produtividade do feijoeiro comum irrigado via pivô central. O experimento foi desenvolvido na Unidade Universitária de Aquidauana-MS (UUA/UEMS), no período de junho a agosto de 2014, utilizando a cultivar IPR Tangará, cuja fonte de nitrogênio (N) utilizada foi a ureia, com dose total de 90 kg ha^{-1} e inoculação

[1] Mestrando em Agronomia (Produção Vegetal), Bolsista CAPES - UFGD, Dourados, MS.
[2] Doutorando em Agronomia (Produção Vegetal), Bolsista CAPES - UEMS, Aquidauana, MS.
[3] Eng. Agrônomo, Docente do Departamento de Engenharia Agrícola, UFS/ São Cristóvão, SE.
[4] Eng. Agrônomo, Docente do Programa de Pós-Graduação em Agronomia da UEMS, Aquidauana, MS.
[5] Eng. Agrícola, Docente do Programa de Pós-Graduação em Engenharia Agrícola da UFGD, Dourados, MS, Fone (67) 999554417, E-mail: rodrigocouto@ufgd.edu.br.
[6] Eng. Agrícola, Docente do Programa de Pós-Graduação em Engenharia Agrícola da UFGD, Dourados, MS.

utilizando o Rhizobium tropici Semia 4077. O delineamento experimental foi em blocos casualizados, com quatro repetições e nove tratamentos (combinações de adubação nitrogenada em semeadura, épocas e modos de aplicação de N em cobertura e sementes com e sem inoculação) utilizando o manejo de irrigação por Penman-Monteith. Analisou-se o numero de grãos por vagem, numero de vagens por planta, massa de 100 grãos e a produtividade em kg.ha^{-1}, estatisticamente pelo teste scott-knott. Apresentaram maiores produtividades os tratamentos em empregados tanto adubação de cobertura parcelada como em dose total, atingindo maior produtividade o tratamento sem N na semeadura, porém com adubação nitrogenada em cobertura no estádio V4 e inoculação das sementes (T8).

PALAVRAS-CHAVE: feijão de inverno, nitrogênio, pivô central.

INTRODUCTION

According to Barbosa & Gonzaga (2012), common bean (*Phaseolus vulgaris*, L.) is among the most produced crops in Brazil and in the world being represented as one of the pillars of the Brazilian diet highlighting the poorest populations, not only having relevance But also because it is an important source of protein and vitamins and also has cultural importance in the cuisine of several countries. In 2010 a bean consumption in Brazil was approximately 17 kg/inhabitant/year.

According to Conab (2016), the bean yield in the country (first, second and third season) in the 2015/2016 harvest was 1115 kg ha^{-1}, with the third harvest bean reaching average productivity of 1290 kg ha $^{-1}$, being cultivated under irrigation.

According to Conab (2017), there was an increase of 13.2% in the bean planting area in Brazil, with planting area in the agricultural year 2015/2016 of 978.6 thousand ha, already in the 2016/2017 harvest the area planted Reached 1108 thousand hectares, with production expected to be 1382 thousand tons, 33.6% more than the previous crop (1034.3 thousand tons).

As the bean crop is very susceptible to climatic adversities, the lack or excess of rainfall may negatively influence yields and consequently production. In this way irrigation in the bean cultivated in the winter has been justified, where the water requirement of the crop is attended in a time of lack of water, since the bean consumes 300 to 400 mm of water during its cycle (Manos et al., (2013).

According to Parizotto & Machioro (2015), nitrogen (N) is the nutrient most extracted by the crops being directly linked to the photosynthetic activity, vigorous vegetative growth and green pigmentation of the leaves, having an important function in the phases of flowering and filling of grains. Still according to them when there is lack of the nutrient affects the vegetative growth and low emission of flowers, negatively influencing the production.

According to Merchant (2015), because the bean crop is able to fix N from the Biological Nitrogen Fixation (BNF), inoculation with rhizobio becomes an alternative to increase bean productivity by reducing costs with nitrogen fertilization. This practice still avoids the contamination of the water table and decreases the emission of greenhouse gases, making even greater the importance of using BNF as a source of N supply the crop. Studies carried out in the region of Dourados-MS, showed yields in the bean above 3000 kg ha^{-1} reached only with inoculation with rhizobia, being equivalent to the application of 80 kg ha^{-1} of N.

In this sense, it is important to study ways and times of application of N in covering and inoculation of seeds in the bean crop, mainly on irrigation regime.

MATERIAL AND METHODS

The experiment was conducted in the irrigation experimental area of UEMS-University Unit of Aquidauana-MS, with geographical coordinates 20°20' South, 55°48' West and average altitude of 207 meters. The climate of the region is classified as warm tropical sub-humid and the soil of the area was classified as Argissolo Red-Amarelo Distrófico (Schiavo, 2010).

The irrigation system used was the central pivot (1 ha), being evaluated for its uniformity of water application, with 87.2% of Christiansen Uniformity Coefficient (CUC) and 78.0% Uniformity Coefficient of Distribution (CUD) (Bernardo et al., 2007). The evapotranspiration of the crop was estimated using the Penman-Monteith method (Allen et al., 1998), with soil water depletion factor "p" of 0.5 and the kc of the crop of 0.35, 1.15 , And 1.11 (onset, flowering and end of crop cycle respectively).

Seeding was done manually in May 2014, with emergence occurring at six days after sowing and harvest at 83 days after emergence (AED). Fertilization was carried out according to the results of soil analysis in all plots at the time of sowing and, for nitrogen fertilization in cover, the different treatments were applied in their respective phenological stages, using urea as a source of nitrogen (N) with a total dose of 88.9 kg ha^{-1} of N. Seed inoculation was performed before sowing using *Rhizobium tropici* Semia 4077.

The experimental design was in randomized blocks, with 9 treatments (Table 1) and 4 replicates. The results were statistically analyzed by the Scott-Knott test at 5% probability.

The plots were composed of 4 plant lines with 6 m of length, with a spacing of 0.45 m between them, the useful area of each plot being the two plant center lines, 5 m long, totaling 4.5 m2 of experimental unit area. Seed density was 15 seeds per meter.

At the end of the crop cycle, the number of pods per plant (NVP) were evaluated, and all plants were collected within the useful area of each plot, counting the pods and separating them into productive and empty pods; Number of grains per pod (NGV), counting from the productive pods, the number of grains to obtain the average number of grains per pod; Mass of 100 grains (MCG), where five random samples of 100 grains were weighed from the working area of each plot and weighed in a precision balance of 0.01 g and correcting the humidity to 13%; And grain yield (kg ha^{-1}), estimated after weeding the pods, whose grains were weighed and then corrected to 13%, where productivity was obtained in each plot (4.5 m^2) And, subsequently, the estimated yield in kg ha^{-1}.

RESULTS AND DISCUSSION

Only grain yield (PRD) was influenced by the different treatments (Table 2). There was no difference for the characteristics of one hundred grains, number of grains per pod and number of pods per plant (Table 3). For the grain yield character, the formation of two groups was observed, in which the treatments T3, T4; T5, T7 and T8 did not differ statistically among themselves, being superior to the others.

The yields obtained were lower than those found by Oliveira et al. (2015), being still below the expected productivity of the winter bean, since the crop because it is produced under irrigation system, has better conditions to achieve high productivity. However, the productivities found in the present study are higher than the national average for winter beans that according to Conab (2016) is 1290 kg ha^{-1}.

It can be noticed that the treatments in which the mineral N was not applied in the soil under cover (T1, T6 and T9), grain yield was lower than those that received N in soil or leaf cover, except for treatment 2 (NPK at sowing and N at coverage at V4 stage). We can therefore conclude that the nitrogen fertilization in coverage becomes indispensable when high productivity is desired, corroborating with research by Oliveira et al. (2015), in which they report that it is possible to reach high yields in the irrigated winter bean crop by applying N in coverage.

Oliveira et al. (2015) state that the application of Mo via foliar provides an increase in grain yield of the bean only when combined with the supply of N in coverage. Where productivity can be increased with the application of Mo via foliar at the dose of 60 g ha^{-1} in bean cultivation (Silva et al., 2012). Therefore, it can be inferred that the increase in productivity can only be achieved when there is the use of nitrogen fertilization combined with the application of Mo. This explains the low productivity reached by the treatment 9 where it was applied Mo via foliar, without nitrogen fertilization in coverage.

The total substitution of the N mineral via soil or foliage in cover, by the exclusive supply via inoculation of the seeds (T6), is not sufficient to meet the crop demand when high productivity is objectified, making the application of N in coverage in the bean crop. In relative values, the treatment in which only inoculation of seeds without nitrogen in the cover was used was the one that obtained the lowest productivity (1994.06 kg ha^{-1}).

However, seed inoculation with the specific Rhizobium followed by the supply of N in coverage at stage V4, whether or not applied at sowing (T7 and T8), provided high yields of grains. Merchant (2015) finds similar results where it is reported that fertilization with 20 kg ha-1 of N with inoculation yielded yields equivalent to the application of 160 kg ha-1 of N. However, according to Barbosa & Gonzaga (2012), fertilizers Nitrogen fertilizers tend to reduce nodule and FBN efficiency in bean culture, but the use of 20 to 30 kg ha-1 generally does not comprise BNF. Therefore, Martins et al. (2013), say that biological nitrogen fixation (BNF) becomes a viable alternative to the substitution of nitrogen fertilization, but nodulation and biological fixation can be influenced by the availability of nutrients in the soil.

It is also important to note that treatments with a single application of N applied to the soil in the V4 (T7 and T8) or leaf foliage in R5 (T4) did not differ from those in which the N dose applied in (T3) or foliar (T5), except for treatment T2 whose grain yield differed from these treatments. These results were reached in a study by Ramos et al. (2014), where the partitioning of the N in cover provided high yields in the bean crop.

This fact is explained by Binotti et al. (2014), where the low requirement of N in the initial stage of plant growth leads to leach losses, as well as a possible drop in the percentage of germination of the seeds by the salinic effect in the sowing furrow, due to the use of a high dose Of N, compromising the initial booth. Therefore, it is necessary to fractionate the fertilization in annual crops, where they receive only a fraction of the total dose of N that they need in the sowing and the rest is applied to cover the soil.

According to Soratto et al. (2011), the N splitting via foliar presents the same performance when compared to the application via soil. This allows us to infer that, in order to obtain high levels of grain yield (above 2,300 kg ha^{-1}), the complementation of N, either via soil or foliage, becomes essential and can not be replaced, for example, by application of the Mo via foliar (T9).

CONCLUSIONS

The application of N in cover, whether via soil or foliar, becomes indispensable when high productivity in common bean is objectified;

Only the inoculation is insufficient to supply all the needs of the common bean crop, necessitating the application of N in cover as complementation;

The response to N in cover does not present difference when applied in a single V4 stage via soil or applied in R5 via foliar, with or without inoculation.

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Table 1. Treatments used and their respective management of fertilization.

Treatments	Sowing fertilizer	Coating fertilization
T1	N-P-K	Without fertilization
T2	N-P-K	Total dose of N in V4
T3	N-P-K	½ dose of N in V3 and ½ in V4
T4	N-P-K	Total dose of N in R5 (foliar)
T5	N-P-K	½ dose of N in R5 and ½ in R6 (leaf)
T6	N-P-K + inoculation	Without fertilization
T7	N-P-K + inoculation	Total dose of N in V4
T8	P-K + inoculation	Total dose of N in V4
T9	N-P-K	Molybdenum in V4 without N in coating

Table 2. Average values of Productivity (PRD) in common bean under different methods and sources of nitrogen.

Treatments	PRD (kg ha^{-1})
T1	2195,06 b
T2	2093,59 b
T3	2379,46 a
T4	2330,87 a
T5	2441,11 a
T6	1994,05 b
T7	2409,82 a
T8	2457,18 a
T9	2137,19 b
AVERAGES	2270,92
CV %	9,58
QM	115034,54

Note: T1 = NPK at sowing, without fertilization on cover; T2 = NPK at sowing and N at coverage in stage V4; T3 = NPK at sowing, ½ of cover N in V3 and ½ in V4; T4 = NPK at sowing and foliar application of N at R5; T5 = NPK at sowing ½ N foliar at R5 and ½ at R6; T6 = PK at sowing + seed inoculation, without N in coverage; T7 = NPK at sowing + seed inoculation, with N in V4 cover; T8 = PK at sowing + seed inoculation, with N in V4 cover; T9 = NPK in sowing and foliar application of Molybdenum (Mo) in V4. Means followed by equal letters in the columns do not differ from each other by the Skott and Knott grouping method at 5% probability.

Table 3. Mean values of the number of pods per plant (NVP), number of grains per pods (NGV) and mass of 100 grains (MCG) in common bean under different methods and nitrogen sources.

Treatments	MCG (g)	NGV	NVP
T1	29,39 a	4,64 a	9,20 a
T2	30,78 a	4,08 a	11,00 a
T3	30,32 a	4,59 a	10,48 a
T4	29,46 a	4,44 a	10,40 a
T5	30,40 a	4,55 a	9,95 a
T6	29,26 a	3,96 a	11,03 a
T7	29,46 a	4,36 a	11,33 a
T8	29,75 a	4,64 a	9,33 a
T9	29,09 a	4,93 a	10,48 a
EVERAGES	29,77	4,465	10,35
CV %	3,31	17,05	25,65
QM	1,39	0,36	2,19

Note: T1 = NPK at sowing, without fertilization on cover; T2 = NPK at sowing and N at coverage in stage V4; T3 = NPK at sowing, ½ of cover N in V3 and ½ in V4; T4 = NPK at sowing and foliar application of N at R5; T5 = NPK at sowing ½ N foliar at R5 and ½ at R6; T6 = PK at sowing + seed inoculation, without N in coverage; T7 = NPK at sowing + seed inoculation, with N in V4 cover; T8 = PK at sowing + seed inoculation, with N in V4 cover; T9 = NPK in sowing and foliar application of Molybdenum (Mo) in V4. Means followed by equal letters in the columns do not differ from each other by the Skott and Knott grouping method at 5% probability.