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Cientific Paper

Initial growth of the black cowpea under different environmental conditions and nitrogen fertilization

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Abstract

Besides of the management of irrigation and fertilization, some environmental factors significantly affect the growth and yield of crops, including solar radiation, air temperature, relative humidity and wind speed. The objective of this work was to study the morphological behavior of the initial phase of the black string bean crop with and without addition of nitrogen fertilization and in different cultivation shading environments. The experiment was conducted in an area belonging to FATEC Cariri, Juazeiro - CE, using treatments with and without addition of nitrogen fertilizer in a shaded and open cultivation environment, with three sampling times, composing a split plot scheme with three replications. The values of height and stem diameter were higher in plants grown with or without added nitrogen fertilizer in the external environment without shading; the black cowpea plants with added nitrogen were slightly higher in the last collection time on the stem height.

Keywords: fertilizer management; *Vigna unguiculata*; environmental factors.

Crescimento inicial do feijão de corda preto sob diferentes ambientes de cultivo e adubação nitrogenada

Resumo

Além do manejo da irrigação e adubação, alguns fatores ambientais afetam significativamente o crescimento e a produção das culturas, dentre eles a radiação solar, temperatura do ar, umidade relativa do ar e velocidade dos ventos. O objetivo deste trabalho foi estudar o comportamento morfológico da fase inicial da cultura do feijão de corda preto sem e com adição de adubação nitrogenada e em diferentes ambientes de cultivo sombreado. O experimento foi conduzido em área pertencente a FATEC Cariri, Juazeiro do Norte - CE, utilizando-se de tratamentos com e sem adição de adubação nitrogenada em ambiente de cultivo sombreado e a céu aberto, com três épocas de coletas, compondo um esquema de parcelas subsubdivididas com três repetições. Os valores de altura e o diâmetro caulinar foram mais elevados nas plantas cultivadas com ou sem adição de adubação nitrogenada em ambiente externo sem sombreamento; As plantas de feijão de corda preto com adição de adubação nitrogenada foram um pouco superiores na última época de coleta na altura caulinar.

Palavras-chave: manejo da adubação; *Vigna unguiculata*; fatores ambientais.

Crecimiento inicial de las habichuelas negras bajo diferentes ambientes de cultivo y fertilización nitrogenada

Resumen

Además del manejo de riego y fertilización, algunos factores ambientales afectan de manera significativa el crecimiento y rendimiento de los cultivos, incluyendo la radiación solar, temperatura del aire, humedad relativa y velocidad del viento. El objetivo de este trabajo fue estudiar el comportamiento morfológico de la fase inicial de las habichuelas negras (frijol negro de cuerda) con y sin la adición de la fertilización nitrogenada y diferentes ambientes sombreados. El experimento se realizó en un área perteneciente a FATEC Cariri, Juazeiro - CE, con el uso de tratamientos con y sin adición de la fertilización nitrogenada en diferentes ambientes del sistema sombreado y en ambiente al aire libre, con tres momentos de muestreo, componiendo

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un esquema de parcelas divididas con tres repeticiones. Los valores de altura y diámetro del tallo fueron mayores en plantas cultivadas con o sin la adición de la fertilización nitrogenada en el ambiente al aire libre sin sombreado. Plantas de habichuelas negras con la adición de nitrógeno fueron ligeramente superiores en la altura del tallo en la última recogida.

Palabras clave: gestión de los fertilizantes; *Vigna unguiculata*; factores ambientales.

Introduction

The cowpea [*Vigna unguiculata* (L) Walp], also known as string bean, is one of the options of income and food for the population of the Brazilian Northeast, which is consumed in the form of mature grains or green grains. In the Paraíba, it is cultivated in almost every micro region, where occupies 75% of the cultivation areas with bean. Thus, it exerts effective participation in the diet of the population, for constituting an excellent source of proteins and carbohydrates of low cost (SILVA and OLIVEIRA, 1993; SOUSA, 2007; OLIVEIRA et al., 2009).

The bean is a crop of economical, social, nutritional and functional importance. The consumption in several regions of the country orientates the research, directing the production and commercialization of the product. Besides of its economical importance, the bean constitutes in one of the basic foods of the Brazilian population and is one alternative of agricultural exploration in small properties, use of less qualified workforce and one of the main products providers of protein in the diet of the economically disadvantaged population (EMBRAPA, 2012; FEITOSA et al., 2012).

Although the cowpea is considered a tropical crop, compatible with the local ecological conditions, still presents low yield, both in the system of single cultivation as in the intercropping (MIRANDA et al., 1996), resulting from planting of traditional cultivars with low agronomical quality and absence of a program of adequate management of soil nutrients (OLIVEIRA et al., 2001). Some authors state that to obtain high yields of cowpea is necessary to use seeds with quality, and they report the providing of a balanced fertilization in organic matter and NPK (MAIA et al., 1986; OLIVEIRA et al., 2001).

In soils of the North and Northeast regions, one of the great problems in the agricultural cultivation is the low availability of nitrogen in the soil, which is worsened by the high rates of mineralization of the organic matter (XAVIER et al., 2006).

Besides the fertilization management, according to LACERDA et al. (2010) some environmental factors significantly affect the growth and production of the crops, among them the solar radiation, air temperature, relative humidity of the air and wind speed. To BRAUN et al. (2007) the adaptation of plants to the environment of light depends of the adjustment of its photosynthetic apparatus, experiencing an adaptation of the same, which can be observed through its global growth.

Considering the importance of the influence of nitrogen fertilization and of different environmental effects on the plants, the current study aimed, through the field research, to study the morphological behavior of the initial stage of cowpea crop without and with addition of nitrogen fertilization and in different environments of cultivation: greenhouse (shading protected with roof) and external environment (full sunlight).

Material and Methods

The experiment was installed in an area belonging to the Faculdade de Tecnologia Centec Cariri, situated in the municipality of Juazeiro do Norte in Ceará state, with geographical coordinates 07°12'47"S, 39°18'55"W and 377 m of altitude. According to the Köppen classification, the experiment area presents a semiarid hot tropical weather with average temperature ranging between 24 to 26 °C and rainy period from January to May, with annual average rainfall of 925 mm.

The black cowpea crop [*Vigna unguiculata* (L) Walp.], was assessed during forty days with and without addition of nitrogen fertilization and in shaded environment and at full sunlight, in a model of subdivided plots during time, in which the plants were collected at 10, 20 and 30 days after the addition of the treatments with nitrogen fertilization (DAT), configuring an essay of growth analysis.

The fertilization was differentiated as for nitrogen application and according recommendation of the Laboratory of Soils of the IFCE – Sombral *Campus* after the soil analysis, yet with basis in the recommendation of Fernandes (1993). The used treatments were 0%, 50%, 100%, 150% and 200% of the recommended total, i. e.: N_1 = 0 kg ha^{-1} of urea; N_2 = 22.5 kg ha^{-1} of urea; N_3 = 45 kg ha^{-1} of urea; N_4 = 67.5 kg ha^{-1} of urea and N_5 = 90 kg ha^{-1} of urea. All treatments received besides of the differentiated quantities of urea the equal

quantity of 176 kg ha^{-1} of simple superphosphate and 17 kg ha^{-1} of potassium chloride.

Regarding the environment, the plants were cultivated in two environments of different levels of shading: S_1= shaded environment where the plants were cultivated in covered area, being protected from insolation and rainfall and S_2= external environment where the plants were cultivated at full sunlight.

In Table 1 shows the soil chemical characterization for the layers of 0.00 – 0.20 m and 0.20 – 0.40 m of depth, from the composed samples collected randomly in the area which was used to fill the vessels of the experiment. The analyses were performed in the Laboratory of Soils of the IFCE – Sombral *Campus*, Sobral CE, according methodologies described by EMBRAPA (1997). The results of the chemical analysis provided the basis for the treatments of nitrogen fertilization applied during the cowpea crop cycle.

The used crop was the black cowpea, assessed during 45 days comprehending the period of November 22th of 2011 to January 5th of 2012. The seeds were acquired with the Vocational Technology Center of Barbalha - CVTEC Barbalha. The sowing was made in vessels with capacity of 7 liters, and was placed at its base a bed of gravel of 2 cm to avoid the clogging of drains and the remaining with sieved soil originated from the area belonging to the FATEC Cariri.

The sowing was performed, putting four seeds per vessel at a depth and spacing between them of 1 cm, at 13 after the emergence was done the thinning, leaving two plants per vessels. The vessels were disposed with spacing of 0.5 m between rows of vessels and 0.5 between vessels

The irrigation was made daily and manually, using watering cans, being carried out slowly until observing the drainage of water in the vessels, thus achieving the field capacity in every vessel.

The evaluations consisted of non-destructive samples for determination of the variables: stem height (AC) and stem diameter (DC), using, respectively, for the performance of these assessments, a graduated rule of 50 cm and a caliper.

The results were submitted to analysis of variance and of regression, through the assist of Excel spreadsheets and of the program "ASSISTAT 7.5 Beta", in model of subdivided plot during time.

Results and Discussion

According with the values of the mean square for vegetative growth which is expressed in Table 2, indicate that, for the collection times, both the height and the steam diameter were significant (p>0.01). In relation to nitrogen fertilization there was difference of behavior (p>0.01) only for the stem height, the inverse happened with the shading, where there was significant difference (p>0.01) of behavior only for the stem diameter.

Table 1. Chemical characterization of the experimental area. Juazeiro - CE, 2011.

Parameter	Unit	Layer (m)	
		0.00 – 0.20	0.20 – 0.40
Carbon	g kg^{-1}	4.02	2.52
Organic Matter	g kg^{-1}	6.93	4.34
Calcium	$mmol_c$ dm^{-3}	49.00	25.00
Magnesium	$mmol_c$ dm^{-3}	12.00	19.00
Calcium + Magnesium	$mmol_c$ dm^{-3}	61.00	44.00
Aluminium	$mmol_c$ dm^{-3}	0.00	0.50
Hydrogen + Aluminium	$mmol_c$ dm^{-3}	28.88	36.30
Potassium	$mmol_c$ dm^{-3}	64.97	28.25
Phosphorus	mg dm^{-3}	568	2,034
Sodium	$mmol_c$ dm^{-3}	0.43	0.19
pH		4.50	6.30
SB	$mmol_c$ dm^{-3}	126.40	72.44
CTC	$mmol_c$ dm^{-3}	155.28	108.74
V	%	81	67
PST	%	0	0
M	%	0	1
EC	dS m^{-1}	0.49	0.29

Table 2. Summary of analyzes of variance for stem height (AC) and stem diameter (DC)

Source of variation	GL	Mean square	
		AC (cm)	DC (mm)
Levels of nitrogen (N)	1	24.19000**	0.00063ns
Shading (S)	1	17.29174ns	23.60340**
Collection time (E)	2	529.66650**	12.71521**
Interaction N x S	1	95.87674**	0.06674ns
Interaction N x E	2	35.74950**	0.27646**
Interaction S x E	2	10.15049*	5.11340**
Interaction N x S x E	2	26.12549**	0.09299ns
Residue (N)	4	0.40646	0.05542
Residue (S)	4	3.98486	0.07653
Residue (E)	16	1.98889	0.04108
CV (N)	(%)	2.43	5.74
CV (S)	(%)	7.62	6.74
CV (E)	(%)	5.38	4.94

(**) Significant effect 1% and (*) 5% probability level; (ns) is not sifificant at the 5% level of probability for test F.

It can be also observed that, there was significant interaction (p>0.01) between the levels of nitrogen fertilization and the time of collection for all the studied variables. As regards the interaction between the levels of nitrogen fertilization and the shading, there was significant effect only for the variable stem height (p>0.01) and in the interaction shading with the collection time there was significant effect for the studied variables of height (p>0.05) and stem diameter (p>0.01).

The black cowpea in both environments of shaded cultivation as well as the absence or increment of nitrogen fertilization, obtained increasing behavior in height and diameter of the stem throughout the period studied, according with the regression analysis, besides of being statistically significant at 1 % of probability.

Both with the absence as with the addition of nitrogen fertilization in the black cowpea crop, was observed more elevated values of height and diameter of stem (Figure 1 and 2) in the plants cultivated in the external environment in relation to the shaded environment.

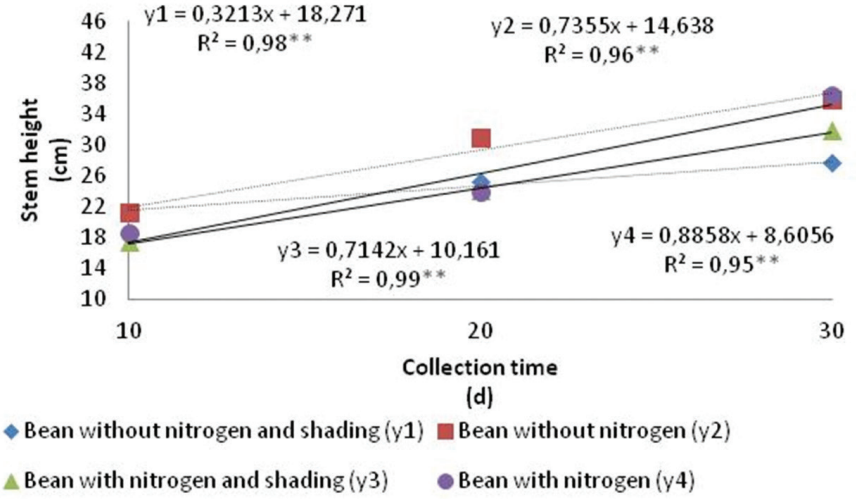

Figure 1. Stem height with different doses of nitrogen under shade and external environment.

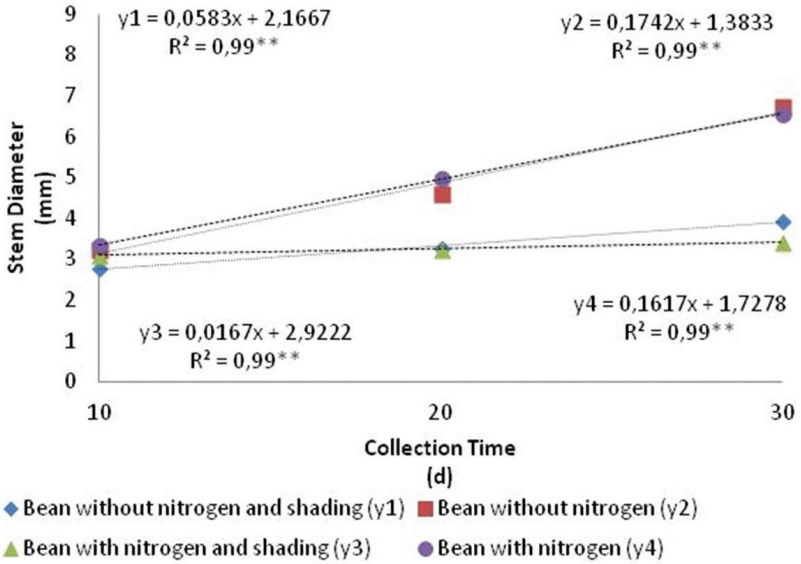

Figure 2. Stem diameter with different doses of nitrogen under shade and external environment.

PEREIRA (2002) studying the growth and development of soybean crop (*Glycine max*, L.), plant of the type C_3 under different environmental conditions, states that the crop, when submitted to low luminous intensities, presents low rates of phytomass, of growth, of liquid assimilation and, however, a high shading conditions the finishing in field conditions.

LACERDA et al. (2010), studying the development of black cowpea crop in different environments of cultivations, concluded that the values obtained for production of dry matter, were more elevated in the plants cultivated in the external environment in relation to the protected environment, and which occurred morphological changes in the crops studied with the objective of making the plant more adapted to adverse conditions.

The black cowpea crop plants with addition of nitrogen fertilization were slightly superior in the last time of collection in the stem height. Some authors state that to obtain high yields of cowpea, is necessary the use of seeds with quality, and report that the providing of a nitrogen fertilization in organic matter and NPK (MAIA et al., 1986; OLIVEIRA et al., 2001; OLIVEIRA et al., 2009).

According to FEITOSA et al. (2012), there is the need of nitrogen fertilization application in the adequate dose and correct season to the bean plant a crop achieve its maximum yield in growth and productivity.

Conclusions

The values of height and diameter of the stem were more elevated in the plants cultivated with or without addition of nitrogen fertilization in the external environment without shading.

The black cowpea plants with addition of nitrogen fertilization were slightly superior in the last time of collection in the stem height.

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