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Residual effect of potassium fertilization on melon under cowpea

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Abstract

The study aimed to evaluate the residual effect of potassium in the cowpea crop, in succession to the cultivation of melon. The research *was carried in a Latossolo Amarelo distrófico, in the Cerrado region, in the 2018/2019 harvest. The cowpea crop, cultivar Aracê, was installed in succession to the culture of melon, and potassium fertilization was carried out only when planting the melon via fertigation. A randomized block experimental design with five replications was used. Five doses do K_2O (0, 100, 150, 200, and 300 kg ha^{-1}) using potassium chloride as the source were evaluated. The following variables were evaluated: plant height and diameter, number of grains and pods, 100-grain weight, grain yield, shoot and root fresh matter, and shoot and root dry matter. The grown of cowpea is possible in areas previously cultivated to take advantage of the residual effect of potassium in the soil in Cerrado regions, aiming at increasing the income of the producer and making better use of the soil fertility. Thus, contributing to the environment. The number of pods per plant, the number of grains per plant, and the weight of one hundred grains have a direct correlation with the increase in grain yield and are characteristics with related potential to select and identify superior genotypes for the production of cowpea.*

Keywords: Multivariate statistics. Path analysis. Plant breeding. Succession of crops. *Vigna unguiculate*.

INTRODUCTION

The cowpea is a legume widely grown, mainly in the Northeast of Brazil. In its cultivation, mineral fertilizers of high solubility are generally used, which can cause numerous environmental impacts, and considerably increase production costs (SILVA et al., 2019).

According to data from Conab (2020), the Northeast region presented more than 92% of the grown area in Brazil, out of a total of 387.2 thousand hectares in the first harvest. Cowpea had an average grain yield of 404 kg ha^{-1}, resulting from the importance of the cowpea culture in the region, considered a subsistence production that, in great harvests, the surplus is sold in municipal markets.

The correct use of fertilization provides plants with adequate nutrients for their development (ZAMBIAZZI et al., 2017). Potassium has an important role in the development of the plant, acting in different physiological processes, which culminates in the development of the same and increase in the crop grain yield, being related to the opening of stomatal and photosynthetic processes (CAVALCANTE et al., 2019).

The succession of crops stands out in the supply of nutrients for the subsequent crop, and its use is widely seen in places where nitrogen fertilization is limited, in which the planting of nitrogen-fixing species is done, being also very efficient in the control of weeds and pests. (NETO et al., 2017).

The cultivation of cowpea proved to be efficient in the use of residual phosphate fertilization, promoting grain yield close to the national average (GASPAR et al., 2018). The evaluation of the residual effect of potassium on the morphological characteristics of cowpea plants and their grain yield can provide a better recommendation for the fertilization to be adopted.

This research aimed to evaluate the residual effect of potassium in the cowpea crop, in succession to the cultivation of melon, under the characteristics of growth in a Latossolo Amarelo distrófico (Oxisol).

MATERIAL AND METHODS

The experiment was carried out in the field from September to December 2018 and from June to September 2019. The experimental area had 400 m², which is located on Cerrado vegetation, located at the Center for Agricultural and Environmental Sciences of the Federal University of Maranhão, in Chapadinha - MA, at 687055.00 m W, 9586917.34 m S (UTM).

The climate of the region is tropical with the dry winter season, and Aw type according to the Köppen climate classification. The rainy season is concentrated from January to May, with an average rainfall of 1613.2 mm, and a dry period from June to December (PASSOS et al., 2016). The soil in the area was classified as a Latossolo Amarelo distrofico (LAd) or Oxisol (Staff, 2014) with a sandy-loam texture (EMBRAPA, 2018).

The chemical analysis of the soil of the experimental area in the first year was performed according to TEIXEIRA et al. (2017). The results were: pH ($CaCl_2$): 4.8; organic matter (OM): 14.2 g dm^{-3};

phosphorus (P): 33.7 mg dm^{-3}; potassium (K): 0.15 $cmol_c$ dm^{-3}; calcium (Ca): 1.97 $cmol_c$ dm^{-3}; magnesium (Mg): 0.54 $cmol_c$ dm^{-3}; hydrogen and aluminum (H + Al): 2.50 $cmol_c$ dm^{-3}; aluminum (Al): 0.00 $cmol_c$ dm^{-3}; cation exchange capacity (CEC): 5.16 $cmol_c$ dm^{-3}; sum of bases (SB): 2.66 $cmol_c$ dm^{-3}; base saturation (V): 51.5%.

The soil preparation of the experimental area was carried out conventionally using plowing, harrowing, and liming. A drip irrigation system was installed, with a nominal flow of 1.6 L h^{-1} under the pressure of 10 mca.

A randomized block experimental design with five replications was used. Five doses do K_2O (0, 100, 150, 200, and 300 kg ha^{-1}) using potassium chloride as the source were evaluated. The dimensions of the plots were 4.5 m x 5.0 m, considering as a useful area the central lines of the plot.

The topdressing fertilization was made by applying 1.19 kg ha^{-1} of N, using urea as the source, supplied using fertigation and divided into four times, being applied at 15, 30, 45, and 60 days after the melon transplanting. Phosphorus was applied (15 kg ha^{-1}) using triple superphosphate as the source, at planting.

The cowpea crop was installed in succession to the melon crop (cv. Eldorado), and potassium fertilization was carried out only at the melon transplanting, via fertigation. The cowpea, cultivar BRS Aracê, was used, which has a semi-prostrate growth, olive-colored grain, and a 70-75-day cycle. The spacing of cowpea was 0.25 m and 0.50 m between plants and rows, respectively.

At the end of the crop cycle, six random plants were collected from the central rows of the plots to measure the following variables: plant height (PH), when separating the stem root, the measurement was performed with a ruler graduated in centimeters from the base of the cut until the curvature of the last leaf; stem diameter (SD) in mm, with the aid of a digital caliper.

The height of the first pod (HFP) in cm was measured from the base where the root was cut until the insertion of the first pod; number pods per plant (NP); pod length (PL) in cm; number of grains per plant (NG); and by treatment, 100 random grains were separated, and these 100 grains (WG) were weighed in grams; grain yield (GY) in sacks ha^{-1} was determined by adjusting the standard dry weight of 100 grains to 13% moisture. With a digital scale, the weighing of shoot fresh matter (SFM) and root fresh matter (RFM) in grams were performed. In the second year, were also evaluated the shoot dry matter (SDM), root dry matter (RDM), in which the fresh material was placed to an air-forced circulation oven at 65 °C for 48 h.

Pearson correlation analysis was carried out to verify possible interactions between the variables and thus observe possible effects of one on the other, those that had a positive correlation were represented in green, negative correlations were represented in red. Statistical analyzes were performed with the aid of the software Genes - Bhering (2017). Path analysis was performed using the Genes software (CRUZ, 2013).

The results were submitted to analysis of variance and the F-test. When significant, the Tukey test was used to compare the means. All tests were conducted at a 5% significance level with the aid of the AgroEstat software (BARBOSA and MALDONADO, 2015).

RESULTS AND DISCUSSION

Table 1 shows the average of the morphological variables submitted to the residual effect of potassium doses applied to the melon crop. According to Pimentel-Gomes and Garcia (2002), the variability of an attribute can be classified according to the magnitude of its coefficient of variation (CV). Their classes were determined as low (CV <10%), medium (10% < CV <20%), high (20% < CV <30%), and very high (CV > 30%). Regarding the coefficient of variation of variables, there is a low coefficient for pod length, 100-grain weight, grain yield, and stem diameter. The other variables had coefficients from high to very high, which indicates that the data were not homogeneous. Oliveira et al. (2018) found a very high coefficient of variation for bean yield, medium CV for 100-grain weight, and low CV for stem diameter.

Table 1. Morphological variables of cowpea according to the residual effect of potassium doses applied via fertigation in the first year of the experiment

Treatments	**Variables**				
(K_2O kg ha^{-1})	**PH (cm)**	**SD (cm)**	**SFM (g)**	**RFM (g)**	**HFP (cm)**
0	71.13	5.96	46.51	2.78	18.47
100	66.57	6.07	33.16	1.90	24.37
150	79.66	5.90	57.69	3.23	18.67
200	85.57	6.05	52.31	2.76	21.38
300	87.22	6.76	51.50	2.81	22.47

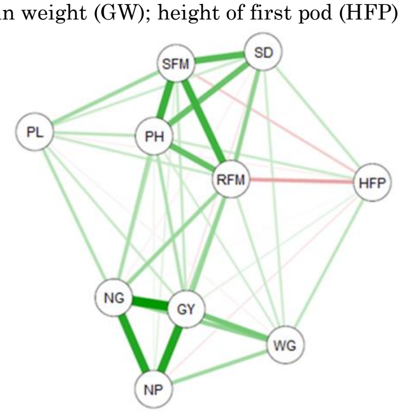
F-test	1.20^{NS}	0.75^{NS}	1.52^{NS}	1.12^{NS}	1.45^{NS}
CV (%)	23.54	14.63	35.06	38.10	22.23
	NP	PL (cm)	NG	GW (g)	GY (sack ha^{-1})
0	6.63	16.18	50.35	19.81 a	15.18
100	5.49	15.95	49.11	19.48 ab	13.32
150	6.42	16.53	56.58	18.59 b	14.30
200	5.95	15.43	50.72	19.25 ab	13.20
300	6.00	16.23	59.49	19.36 ab	15.52
F-test	0.54^{NS}	0.67^{NS}	0.58^{NS}	4.24*	0.39^{NS}
CV (%)	22.04	7.03	24.08	2.57	7.26

*Means followed by the same letters in the column do not differ by the Tukey test at a 5% probability. ^{NS}Not significant to by F-test at a 5% probability. Plant height (PH), stem diameter (SD); pod length (PL); number of grains (NG); number of pods (NP); shoot fresh matter (SFM); root fresh matter (RFM); 100-grain weight (GW); height of the first pod (HFP), Grain yield (GY).

About the mean comparison, it was observed that there was a significant effect ($p < 0.05$) only on the 100-grain weight. However, the 150 kg ha^{-1} dose differed only from the treatment without K_2O. Thus, the only variable that influenced the residual effect of potassium was the 100-grain weight negatively, and the other variables did not differ from the treatment without K_2O.

Figure 1 expresses Pearson's correlation network under the morphological characteristics and grain yield of cowpea in the first year of cultivation. There was a positive correlation between grain yield and the number of pods and grains.

Figure 1 - Correlation network of morphological traits in the 1st year of cowpea cultivation: Grain yield (GY), plant height (PH), stem diameter (SD); pod length (PL); number of grains (NG); number of pods (NP); shoot fresh matter (SFM); root fresh matter (RFM); 100-grain weight (GW); height of first pod (HFP).

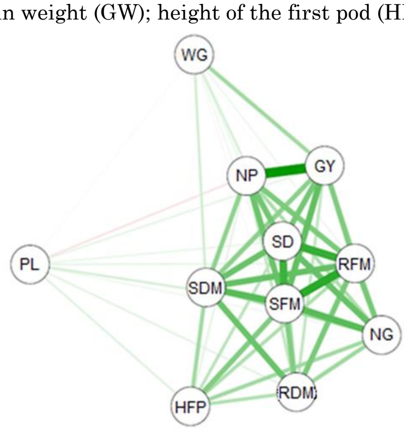


The same occurred with the shoot and root fresh matter, plant height, and stem diameter. With well-developed roots, the absorption of nutrients will be greater, which will have positive responses in the growth variables. Oliveira et al. (2018) found similar results with a positive correlation between the number of pods and grains per plant and grain yield of the bean. The correlation was negative, with the height of the first pod and the root fresh matter.

Coverage from cultivation in succession formed a protective layer of the soil, protecting it from solar radiation, and the erosive action of rains, and provide an additional gain in the production of dry matter of plants, generating greater accumulation and release of nutrients and macronutrients (FORTE et al., 2018).

Figure 2 shows a positive correlation between all the morphological characteristics of cowpea for the second year of cultivation, except the number of pod and pod length that had a negative correlation. The analysis of these results shows that the potassium doses applied in the predecessor crop were sufficient for the demand for nutrients in cowpea, this result probably occurred because the studied soil has good fertility due to being an area used constantly for crops.

Figure 2 - Correlation network of morphological traits in the 2nd year of cowpea cultivation: Grain yield (GY), plant height (PH), stem diameter (SD); pod length (PL); number of grains (NG); number of pods (NP); shoot fresh matter (SFM); root fresh matter (RFM); 100-grain weight (GW); height of the first pod (HFP).



Bezerra et al. (2015) concluded that all nitrogen and potassium fertigation management studied in the pepper culture provided sufficient nutrient accumulation in the soil to supply the cowpea nutritional demand. Figures 3 and 4 show the results of the path analysis of the first and second year of cultivation of cowpea.

Analyzing Figure 3, NG followed by NP were the primary variables that most positively influenced the grain yield of cowpea. It is important to note that the NG also influenced, in a secondary way, the NP, RFM, and GW with positive correlation values of 0.5938**, 0.2606**, and 0.2978**, respectively.

Figure 3 - Path analysis of the 1st year of cowpea between morphological traits: Grain yield (GY), plant height (PH), stem diameter (SD); pod length (PL); number of grains (NG); number of pods (NP); shoot fresh matter (SFM); root fresh matter (RFM); 100-grain weight (GW); height of first pod (HFP).

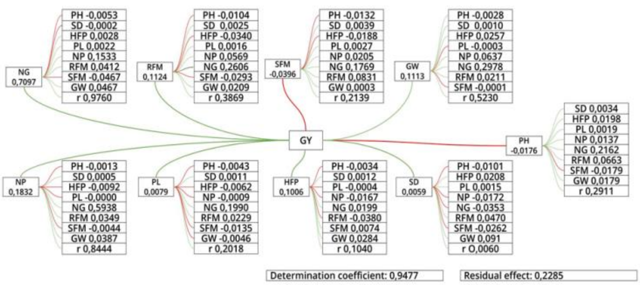
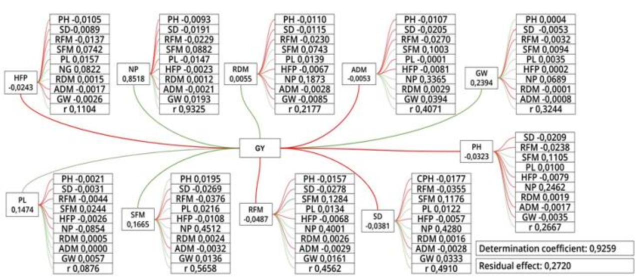


Figure 4 - Path analysis of the 2nd year of cowpea between morphological traits: Grain yield (GY), plant height (PH), stem diameter (SD); pod length (PL); number of pods (NP); shoot fresh matter (SFM); root fresh matter (RFM); 100-grain weight (GW); height of first pod (HFP); aerial part dry mass (ADM); root dry mass (RDM). (HFP); aerial part dry mass (ADM); root dry mass (RDM).



NP and GW were the primary variables that most positively influenced the grain yield of cowpea (Figure 4). NP influenced, in a secondary way, SFM, RFM, and SD with positive correlation values of 0.4512**, 0.4001**, and 0.4280**, respectively. Oliveira et al. (2018)

found as results for the bean of the Elite cultivar that the number of pods and grains per plant and 100-grain weight are the main yield components.

ENDNOTES

1 The cultivation of cowpea is possible in areas previously cultivated to take advantage of the residual effect of potassium in the soil in Cerrado regions, aiming at increasing the income of the producer and making better use of the soil fertility. Thus, contributing to the environment.

2 The number of pods per plant, the number of grains per plant, and the weight of one hundred grains have a direct correlation with the increase in grain yield and are characteristics with significant potential to select and identify superior genotypes for the production of cowpea.

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