Revista Brasileira de Agricultura Irrigada
BrazilianJournalofIrrigatedAgriculture
ISSN: 1982-7679 (on-line)
v.17, p. 28 – 38, 2023
Fortaleza, CE - www.inovagri.org.br

DOI: 10.7127/rbai.v1701283

YIELD OF COWPEA FERTILIZED WITH CASSAVA WASTEWATER

RENDIMENTO DO FEIJÃO CAUPI FERTILIZADO COM MANIPUEIRA

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ABSTRACT: Wastewater has been studied in agriculture as a source of nutrients for plants as well as its efficiency, mainly in arid and semiarid regions. In this context, this study aimed to evaluate the yield of cowpea genotype MNCO3-737F-5-1 cultivated in soil fertilized with cassava wastewater. The experiment was a completely randomized design, consisting of six treatments of cassava wastewater and five replicates (0.00; 22.50; 45.00; 90.00; 180.00 and 360.00 m3 ha-1). The following variables were evaluated at 60 days after sowing: leaf fresh phytomass (LFP) stem fresh phytomass (SFP), pod fresh phytomass (PFP), leaf dry phytomass (LDP), stem dry phytomass (SDP), pod dry phytomass (PDP), number of pods (NP) and weight of 50 dry grains (W50). The best results of weight of 50 dry grains, leaf fresh phytomass and leaf dry phytomass were obtained under 90.00 m3 ha-1 of cassava wastewater, and the highest number of pods (10.03) under a dose of 50.00 m3 ha-1 of cassava wastewater. High doses of cassava wastewater negatively affect the yield of cowpea.

Keywords: *Água amarela, ecossaneamento, gestão ambiental, Vigna unguiculata L.*

RESUMO: A água residuária vêm sendo investigada na agricultura como fonte de nutrientes para plantas, bem como o uso eficiente da água, principalmente em regiões áridas e semiáridas. Nesse contexto, o objetivo deste estudo foi avaliar a produção do feijão caupi variedade MNCO3-737F-5-1 cultivado em solo fertilizado com manipueira. O delineamento foi o casualizado, composto por seis tratamentos e cinco repetições, sendo os tratamentos da seguinte forma: doses de manipueira (0,00; 22,50; 45,00; 90,00; 180,00 e 360,00 m3 ha-1). Foram avaliadas aos 60 dias após a semeadura a: fitomassa fresca da folha (FFF), do caule (FFC), da vagem (FFV), fitomassa seca da folha (FSF), do caule (FSC), e da vagem (FSV), número de vagens (NV) e peso de 50 grãos secos (P50). O maior número de vagens (10,3) pela equação de regressão foi quando se aplicou a dose de 50.00 m3 ha-1 de manipueira. A aplicação do dose de até 180 m3ha-1 afeta de maneira positiva a produção do feijão caupi. O uso de doses elevadas de manipueira afeta negativamente a produção do feijão caupi.

Palavras-chave: *Yellow water,ecological sanitation,environmental management, Vigna unguiculataL.*

Protocolo 1283.23 - 06-12-2021- Aprovado em 21-06-2023
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Editor de área: Geocleber Sousa

INTRODUCTION

In the last few years, the development of agricultural production systems has increased solid, liquid and gaseous wastes, intensifying environmental problems in a global scale (DANTAS et al., 2017a). Among them, during cassava processing (*Manihot esculeta* C.), a liquid waste with a milky aspect and strong smell is originated,providing a source of nutrients, starch and cyanogen glycosides, with a high pollution potential (LIMA et al., 2020).

According to Santos (2012), cassava wastewater in natura provides 25 times more pollution potential when compared to domestic sewage. However, some studies verified potential in this waste as a source of nutrients for plants (DANTAS et al., 2017a).

Regarding other organic wastes, cassava wastewater presents high contents of essential elements for plants (N, P, K, Mg, Ca) as well as fermentable sugars, favorable to microorganism growth needed by the plants (MAGALHÃES et al., 2016).

Cowpea (*Vigna unguiculata* (L.) Walp) has been cultivated in Brazil mainly in the Northeast region, where it plays an important socioeconomic role for family farming (CARDOSO et al., 2015). Cowpea annual production in the

Northeast region in under large fluctuations, mainly due to water deficit and temporal and spatial variation of rain, young soils and superficial crystalline basement (BARROS et al., 2013). Thus, yield of cowpea using wastewaters (as cassava wastewater), may be a viable strategy to nutritional support as well as an efficient use of water.

Lopes et al. (2020) investigated the fertilization of cowpea under sewage sludge and mineral fertilization, and five cultivars of cowpea (BRS Pajeú, BRS Xiquexique, BRS Marataoã, BRS Pujante and BRS Cauamé), and observed that green and dry cowpea produced after fertilizationunder sewage sludge resulted in microbiological quality similar to those obtained with mineral fertilizer.

In this context, this research aimed to evaluate the effect treated cassava wastewater doses on cowpea genotypeMNCO3-737F-5-1.

MATERIAL AND METHODS

The experiment was conducted between October and December 2017, at the Academic Unity of Agriculture Engineering, Campus I, of the Federal University of Campina Grande (UFCG), Paraiba state, Brazil. Geographic coordinates 7° 13' 51" S and 35° 52' 54" W and altitude of 551 m, in a protected environment. According to the Köppen-Geiger classification, the climate of the region fits the type AS', rain period from May to September, which can be extended to October (AZEVEDO et al., 2015).

The experiment was a randomized design, consisting of six treatments and five replicates, totalizing 30 experimental units. The treatments followed the methodology proposed by Novais et al. (1991), taking into consideration potassium (K) concentration in treated cassava wastewater(150 mg K kg^{-1} of soil), as the following: T1- (control – 0.0 m^3ha^{-1}), T2 - (22.5 m^3ha^{-1}), T3 - (45.00 m^3ha^{-1}), T4 - (90.00 m^3ha^{-1}), T5 - (180.00 m^3ha^{-1}) and T6 - (360.00 m^3ha^{-1}).

Plastic pots (20 L) were adopted as experimental units and distributed at spacing of 0.80 between rows and 0.50 between plants. Each pot was perforated at the bottom to insert a drain, which was subsequently attached to a PET bottle (2 L) in order to quantify the drained volumeand return it to soil, and thus allowing nutrientsrecirculation in soil solution.

A geotextile blanket was placed on drains, followed by 500 gof crushed stone (50.8 mm to 101.6 mm) and 35 kg of soil classified as Eutrophic Litolic EMBRAPA (2013a). The soil was from the municipality of Puxinanã-PB, which physical-chemical analysis followed the methodology proposed by ALPHA (1998) and presentedthese characteristics: pH = 5.43; EC = 0.25 mmhos cm^{-1}; Al = 0.00 meq/100 g of soil; Mg = 0.62 meq/100 g of soil; Ca = 1.19 meq/100 g of soil; K = 0.09 meq/100 g of soil; Na = 0.02

meq/100 g of soil; P = 0.48 mg/100 g of soil; S = 1.92 meq/100 g of soil; Organic Carbon = 0.27%; Organic Matter = 0.46%, and soil density = 1.28 g cm^{-3}, ECs (soil saturation extract): 1.4 $mmhoscm^{-1}$, pHes: 5.43, Saturation percentage: 20%; Sodium absorption ratio: 2.48%.

Soil was brought to field capacity with the respective treatments in a single dose,which, at 15 days after fertilization (15 DAF), time required to stabilize nutrients, sowing was performed by adding four seeds in each pot.

The seeds used consisted of cowpea genotype MNCO3-737F-5-1, upright and semi upright cowpea, weight of 100 grains (17.7 g) and 1575.9 kg ha^{-1} of productivity in the climate conditionsof the North region (EMBRAPA, 2013b). After emergency, when plants presented three to four leaves completely expanded, thinning was performed leaving one plant per pot. Tap water(electrical conductivity of 0.4 $dS.m^{-1}$) was used for irrigation and the management was determined by drainage lysimeter principle (BERNARDO et al.,2008).

Cassava wastewater was originated from an artisanal starch in the municipality of Puxinanã – PB. After gathering cassava, the product was stored during 60 days and submitted to an anaerobic digestion in a hermetically sealed container (85-L capacity). A hosepipe was placed in the lidwith the opposite tipimmersed ina container withwater up to 5 cm in depth, in order to releasegases generated during the effluent digestion (ARAÚJO et al, 2019).

Chemical characterization was performed after treatment (Table 1), according to methodology proposed by Standard Methods for Wastewater APHA (2005).

Table 1. Chemical characteristics of treated cassava wastewater used in the experiment.

Treated cassava wastewater composition							
pH	EC	COD	TKN	PO_4^{-3}	K	Na	$Ca^{+}Mg$
-	(mS/cm)	(mgO_2/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg $CaCO_3$/L)
3.05	10.68	69230.76	945.50	218.26	3307.47	272.95	19.95

pH: Hydrogenionic potential; EC: Electrical Conductivity; COD: Chemical Oxygen Demand; TKN: Total Kjeldahl Nitrogen; PO_4^{-3}: Orthophosphate; K: Potassium; Na: Sodium and Ca+Mg: Total Thickness.

At 60 days after sowing, that is, when cowpea was harvested, the following variables were analyzed: leaf fresh phytomass (LFP), stem fresh phytomass (SFP), pod fresh phytomass (PFP), leaf dry phytomass (LDP), stem dry phytomass (SDP), pod dry phytomass (PDP), number of pods (NP) and weight of 50 dry grains (W50), with moisture content at 13%.

For fresh phytomass variables, fresh grains were collected separately, placed in paper bags and weighted in a digital balance (0.5 g accuracy).

Then, they remained in a greenhouse of forced air circulation at 63°C until achieving constant weight to determine dry phytomass.

The number of pods was determined by direct counting. After drying pods, they were threshed and selected (50 grains), considering homogenously, and then weighted in an analytical digital balance (0.5 g accuracy).

The reason for using 50 grains is due to plants that did not produce 100 or more grains. Data were submitted to variance analysis by F test at 1 and 5 % of probability. Significant variables were submitted to linear and quadratic regression analyses, using SISVAR – ESAL software (FERREIRA, 2019). Contrasts were defined as the following: $\hat{y}_1$ (T5 vs T6), $\hat{y}_2$ (T4 vs T6), $\hat{y}_3$ (T1 vs T5), $\hat{y}_4$ (T1 vs T4), $\hat{y}_5$ (T4 vs T1; T2; T3; T5 and T6), and $\hat{y}_6$ (T6 vs T1; T2; T3; T4; T5).

RESULTS AND DISCUSSION

The summary of variance analysis (Table 2) showed that cassava wastewater doses significantly influenced ($p<0.001$) leaf fresh phytomass (LFP), stem fresh phytomass (SFP), pod fresh phytomass (PFP), leaf dry phytomass (LDP), stem dry phytomass (SDP), pod dry phytomass (PDP), number of pods (NP) and weight of 50 dry grains of cowpea genotype MNCO3-737F-5-1 at 60 DAS.

Table 2: Summary of variance analysis of leaf fresh phytomass (LFP), stem fresh phytomass (SFP), pod fresh phytomass (PFP), leaf dry phytomass (LDP), stem dry phytomass (SDP), pod dry phytomass (PDP), number of pods (NP) and weight of 50 dry grains of cowpea genotype MNCO3-737F-5-1 under cassava wastewater doses at 60 days after sowing.

SV	DF	LFP	SFP	PFP	LDP	SDF	PDF	W50	NP
Cassava wastewater doses	5	3120.4^{**}	1907.2^{**}	2413.4^{**}	25.3^{**}	20.1^{**}	899.8^{**}	98.7^{**}	102.3^{**}
Linear regression	1	288.5^{**}	350.8^{**}	3790.6^{**}	5.8^{**}	27.62^{*}	1767.1^{**}	138.0^{*}	262.3^{**}
Quadratic regression	1	9366.5^{**}	3402.2^{**}	1801.9^{**}	68.2^{**}	6.6^{ns}	1529.3^{**}	252.6^{*}	76.3^{**}
Waste	24	41.8	5.6	35.5	0.3	5.5	2.4	0.4	1.9
CV (%)		9.7	3.5	14.4	5.6	20.2	5.8	7.5	16.8

SV: Source of Variation; DF: Degree of Freedom; ^{ns}, *, ** - not significant, significant $p<0.01$, significant $p<0.05$.

The increase in cassava wastewater dosessignificantly affected leaf fresh phytomass of cowpea genotype MNCO3-737F-5-1 at 60 days after sowing.According to regression analysis (Figure 1A), the maximum estimated value can be observed (97.37 g) per plant, when they were under 166.41 m3·h-1cassava wastewater (Figure 1A). When comparing values observed inplants fertilized withthe highest dose (360 m3h-1) to control (0.0 m3h-1), a reduction of leaf fresh phytomass can be noticed 17.53% (7.41g); this may probably be related to cyanide still present in cassava wastewater, which may reduce its use as a fertilizer (RIBAS et al., 2010).Another aspect that may berelated to this result is the higher salinity of cassava wastewater, since that salinity reduced the physiologic development of plant, for example, the selective absorption of specificsions and reduction of osmotic potential (OLIVEIRA et al., 2018).

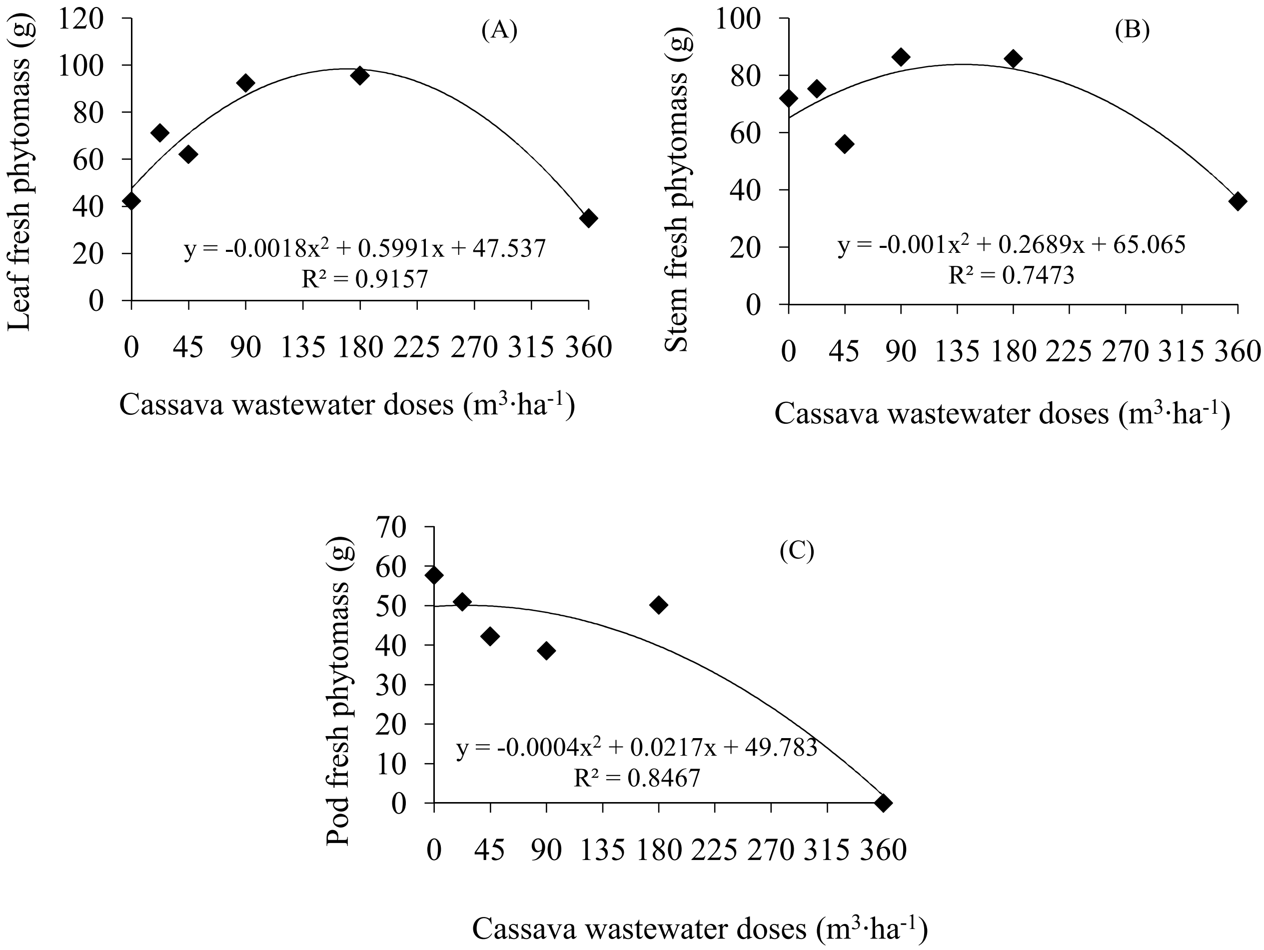

Figure 1. Leaf fresh phytomass (A), stem fresh phytomass (B) and pod fresh phytomass (C) of cowpea genotype MNCO3-737F-5-1 cultivated in soil fertilized with different cassava wastewater doses.

Cassava wastewater doses also affected stem fresh phytomass of cowpea genotype MNCO3-737F-5-1 at 60 days after sowing. Regression analysis (Figure 1B) presents the maximum yield of this variable when the dose of 134.45 m3ha-1 was applied, which promoted an increase of 83.13 g. In relative terms, variables fertilized with 360 m3ha-1 obtained a reduction of 58.38% (50.46g) in relation to variables that were under 90 m3ha-1; therefore, excessive cassava wastewater doses may cause toxic effects to the crop, increasing electrical conductivity.

Salinity also induces oxidative stress because it leads to an accumulation of reactive oxygen species (ROS), as hydrogen peroxide (H2O2) and free radicals, superoxide (O2-) and hydroxyl (OH), reducing the productive potential of the crop (Xu et al., 2017).

The reduction of stem fresh phytomass may be related to the increase of electrical conductivity in soil solution due to the use of cassava wastewater (DUARTEet al., 2013). Pod fresh phytomass of cowpea was also influenced by cassava wastewater, verifying an increase of 50.12 g, presented by the adjustment of data when the plant was under a dose of 27.12 m3 ha-1 (Figure 1C). Fertilization with a dose of 360 m3 ha-1 of cassava wastewater inhibited pods growth, which may be related to excessive potassium negatively affecting other essential nutrients for plants, as calcium, magnesium, zinc, and manganese (FAGERIA, 2001).

In relative terms, the dose of 180 m3ha-1 reduced 13.04% (7.53 pods) when compared to soil without cassava wastewater effect, implying that more attention is needed with the effluent management in agriculture practices.

Ramos et al. (2020) studied cassava wastewater use as a source of potassium and human urine as a source of nitrogen on hybrid maize AG 1051 and observed that fertigation with increasing doses of both treated human urine and cassava wastewater (1470 mL in a proportion of 51.3% and 48.7% respectively) reduced fresh and dry phytomass of the upper side of the crop. Barreto et al. (2014) state that increasing doses of cassava wastewater significantly decreased maize plant height up to a dose of 44.8 m3 ha-1.

The summary of contrast analysis (Table 3) shows that leaf dry phytomass (LDP), stem dry phytomass (SDP) and pod dry phytomass (PDP) were significantly influenced ($p<0.05$) when fertilized with different cassava wastewater doses.

Table 3. Summary of contrast analysis for leaf dry phytomass (LDP), stem dry phytomass (SDP) and pod dry phytomass (PDP) of cowpea genotype MNCO3-737F-5-1 cultivated in soil fertilized with different cassava wastewater doses.

SV	DF	Quadratic Means		
Fertilization	(5)	LDP	SDP	PDP
$\hat{y}_1$	1	47.52^{**}	17.55^{ns}	3024.81^{**}
$\hat{y}_2$	1	65.53^{**}	13.43^{ns}	1943.79^{**}
$\hat{y}_3$	1	52.02^{**}	44.90^{**}	27.39^{**}
$\hat{y}_4$	1	70.80^{**}	38.14^{**}	32.22^{**}
$\hat{y}_5$	1	49.40^{**}	26.78^{*}	5.93^{ns}
Waste	5	0.32	5.52	2.43
CV %	-	5.62	20.20	5.80

$\hat{y}_1$ (T5 vs T6), $\hat{y}_2$ (T4 vs T6), $\hat{y}_3$ (T1 vs T5), $\hat{y}_4$ (T1 vs T4), and $\hat{y}_5$ (T4 vs T1; T2; T3; T5 and T6); SV – Source of variation; DF – Degree of freedom; CV – Coefficient of variation; Significant at 5% (*) and 1% (**) of probability; (^{ns}) Not significant.

Regarding stem dry phytomass, there was a reduction of 4.23% under ŷ3 (0.0 m3 ha-1 vs 180.0 m3 ha-1) and 3.9% under ŷ4 (0.0 m3 ha-1 vs 90.00 m3 ha-1). In relation to pod dry phytomass, there was a reduction of 34.78% under ŷ1 (180.0 m3 ha-1vs 360.0 m3 ha-1), reducing the variable as the dose of cassava wastewater increased.

Applying the recommended dose of wastewaters during fertilization is a crucial practice, even with treated wastewaters, since excessive application may be harmful for both soil and plant, as nutritional unbalance of soil solution. Azevedo et al. (2018) applied doses of cassava wastewater (109.8 to 436.3 mL with mineral fertilization) in cowpea cultivation and observed an increase in growth and production up to a determined dose; moreover, they observed that great volumes of this effluent damage the crop.

Regarding leaf dry phytomass of cowpea, the adjustment of data presented the maximum crop yield when a dose of 195 m3 ha-1 was applied, corresponding to a value of 13.18 g; In relative terms, fertilization under 90 m3 ha-1 obtained 60.70% (8.07 g) higher when compared to a dose of 360 m3 ha-1(Figure 2A).

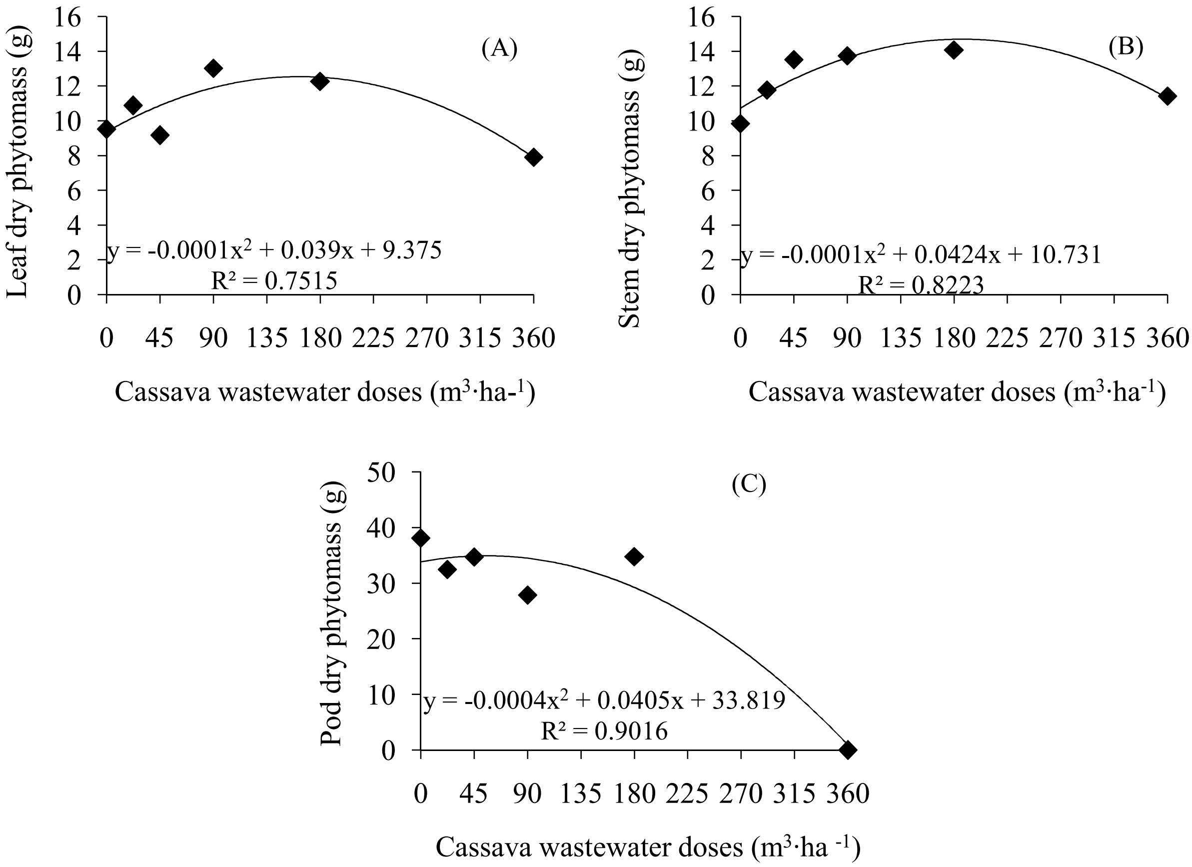

Figure 2. Leaf dry phytomass (A), stem dry phytomass (B) and pod dry phytomass (C) of cowpea genotype MNCO3-737F-5-1 cultivated in soil fertilized with different cassava wastewater doses.

In this way, high doses of this effluent may negatively affect crops, causing nutritional stress due to organic matter mineralized, pH and electrical conductivity of soil. Bezerra et al. (2017) stated that Marandu grass development was satisfactory when cultivated under cassava wastewater (0; 15; 30; 60 and 120 m3 ha-1) up to a dose of 120 m3 ha-1.

Dantas et al. (2017b) applied different doses of cassava wastewater during sunflower cultivation and observed that increasing doses of this effluent presented a positive linear response for fresh phytomass in the upper side and phytomass of chapter; however, for seed yield, oil yield and content, there was a quadratic effect under a dose of 68 m3 ha-1 with significant decreases. Regarding stem dry phytomass, the adjustment of data (Figure 2B) verified that the dose of 212 m3ha-1 provided the best increment (15.22 g); however, as cassava wastewater doses increased, a reduction was observed with 180.00 and 360.00 m3ha-1 resulting in 14.08 and 11.43 g respectively. In comparative terms, these results correspond to 18.82% (2.64 g).

In this context, there is a need to determine the effluent efficient dose to be applied to the soil, since it was observed that as effluent doses increased, a reduction was noticed for this variable. Magalhães et al. (2016) observed that from 75.6 m3ha-1 upwards cassava wastewater presented toxic effect on maize development, as burning the tips of leaves due to high potassium content.

For pod dry phytomass, the adjustment of data verified 37.92 pods when 202.5 m3ha-1 was applied, presenting a decreasing quadratic effect (Figure 2C). When comparing values concerning cowpea fertilized with 360.00 m3ha-1 to the values without cassava wastewater, it was verified that there was no pod production under 360.00 m3 ha-1; thus, it emphases that high doses may be harmful to the crop reproductive stage. Bianchi et al. (2016) state that water, radiation, temperature, gases and nutrition are, respectively, among abiotic factors that may stress plants. In relation to the number of pods (Figure 3A), the following implements were noticed: 11.8; 9.2; 12; 6.8; 10.4 and 0 pods under 0.0; 22.5; 45.00; 90.00; 180.00 and 360 m3 ha-1 respectively; thus, the adjustment of data showed that the dose of 48.00 m3 ha-1 promoted the highest number of pods of cowpea (45.12 pods).

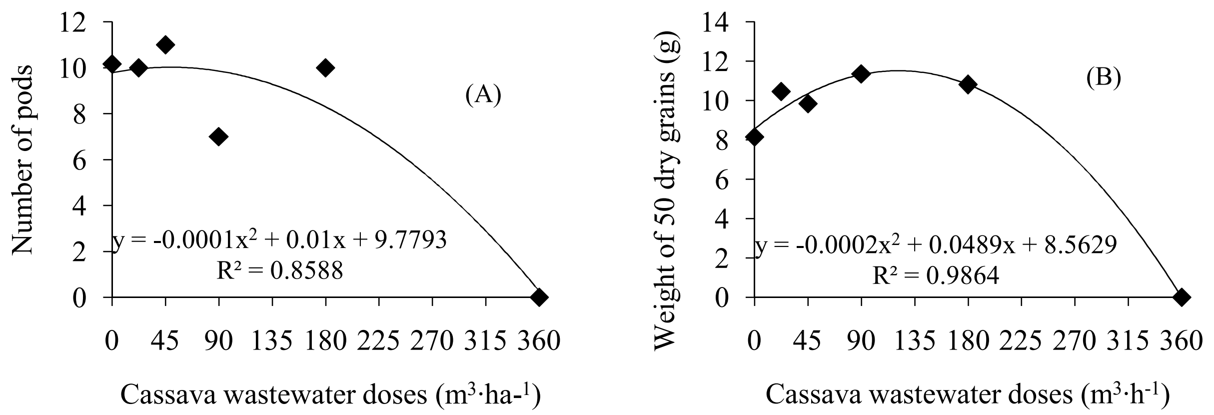

Figure 3. Number of pods per plant (A) and weight of 50 dry grains (B) of cowpea genotype MNCO3-737F-5-1 cultivated in soil fertilized with different cassava wastewater doses.

Regression equation presented the highest number of pods (10.03) under a dose of 50.00 m^3 ha^{-1} of cassava wastewater. In relative terms, a reduction of 63.6% (6.96 pods) as observed when cassava wastewater dose increased from 45.00 to 90.00 m^3 ha^{-1}. Duarte et al. (2012) studied lettuce development cv. Regina (2000) fertilized with cassava wastewater doses (0, 5, 15, 25, 45, 65 m^3 ha^{-1}) and observed a decreasing quadratic effect from 40 m^3 ha^{-1} and stated that cassava wastewater may harm both soil and plants if not used appropriately.

Regarding the weight of 50 dry grains, comparing irrigation since control to 90.00 m^3 ha^{-1}, there was an upward trend in the production, as for a dose of 90.00 m^3 ha^{-1} of cassava wastewater, which presented the best result (11.36 g). However, the adjustment of data verified that the greatest increment (13.05 g) was obtained under a dose of 122.25 m^3 ha^{-1}. In comparative terms, there was an increase of this production variable 23.04% (2.8 g) with a dose of 90 m^3 ha^{-1} when compared to cowpea without cassava wastewater use, thus, the effluent is a promising nutrient source as long as in adequate doses (Figure 3B).

According to the summary of contrast analysis, the number of pods and weight of 50 dry grains were significantly affected ($p<0.05$), as cowpea genotype MNCO3-737F-5-1 was fertilized with cassava wastewater (Table 5.

Table 5. Summary of contrast analysis of number of pods (NP) and weight of 50 dry grains of cowpea genotype MNCO3-737F-5-1 cultivated in soil fertilized with different cassava wastewater doses.

SV	DF	Quadratic Means	
Fertilization	(5)	NP	W50
$\hat{y}_1$	1	270.40**	294.19**
$\hat{y}_2$	1	115.60**	369.05**

$\hat{y}_3$	1	4.90^{ns}	5.59^{**}
$\hat{y}_4$	1	62.50^{**}	19.57^{**}
$\hat{y}_5$	1	14.72^{**}	63.93^{**}
Waste	5	1.98	0.44
CV %	-	16.83^{**}	7.52^{**}

$\hat{y}_1$ (T5 vs T6), $\hat{y}_2$ (T4 vs T6), $\hat{y}_3$ (T1vsT5), $\hat{y}_4$ (T1 vs T4), and $\hat{y}_5$ (T4 vs T1; T2; T3; T5 e T6); SV – Source of variation; DF – Degree of freedom; CV – Coefficient of variation; Significant at 5% (*) and 1% (**) of probability; (^{ns}) Not significant.

Pereira et al. (2018) carried out a study applying mineral and organic fertilization with different concentrations of cassava wastewater on cowpea cultivation *Vigna unguiculata* L. genotype MNCO3-737F-5-1 and observed that 40% or more of the recommended dose negatively affected cowpea, decreasing the production. When soil was fertilized with (180 m^3 ha^{-1}) in relation to 360 m^3 ha^{-1} (contrast $\hat{y}_1$), there was a reduction of pods 10.40%; on the other hand, $\hat{y}_5$ (90 m^3 ha^{-1}vs T1; T2; T3; T5 and T6) presented an increase of 1.88% (Table 6).

Table 6. Estimated mean of number of pods (NP) and weight of 50 dry grains (W50) of cowpea genotype MNCO3-737F-5-1 cultivated in soil fertilized with different cassava wastewater doses.

SV	DF	Quadratic Means	
Fertilization	(5)	NP	W50
$\hat{y}_1$	1	-10.40	-10.84
$\hat{y}_2$	1	-6.80	-12.15
$\hat{y}_3$	1	-1.40	-1.49
$\hat{y}_4$	1	-5.00	2.79
$\hat{y}_5$	1	1.88	-3.91

$\hat{y}_1$ (T5 vs T6), $\hat{y}_2$ (T4 vs T6), $\hat{y}_3$ (T1 vs T5), $\hat{y}_4$ (T1 vs T4), and $\hat{y}_5$ (T4 vs T1; T2; T3; T5 and T6); SV – Source of variation; DF – Degree of freedom.

A similar effect concerning the number of pods was observed in the weight of 50 dry grains, according to contrast $\hat{y}_1$, there was a reduction of 10.84%; on the other hand, $\hat{y}_4$ presented an increment of 2.79% under 90 m^3 ha^{-1}, which differed from soil without cassava wastewater application; finally, contrast $\hat{y}_2$ (T4 vs T6) presented a reduction of 12.15%.

CONCLUSION

Yield of cowpea cultivated in soil fertilized with different cassava wastewater doses is positively affected under a dose of 180 m^3 ha^{-1};

Cassava wastewater positively affects the development and productivity of cowpea up to a dose of 180 m³/ha, above dose rate production declined;

Cassava wastewater as a bio fertilizer applied on cowpea cultivation may be regarded as a substitute of mineral fertilization, mainly potassium (micronutrient).

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