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MANAGEMENT OF NITROGEN AND PHOSPHORUS IN CASTOR BEAN CULTURE

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Abstract: The castor bean (*Ricinus comunis* L.), also known as carrapateira, is demanding in nutrients, presenting good response in productivity to fertilization. Preferably, planting is recommended in well-prepared, fertile, deep and loose soils, to allow the development of the root system. This work aimed to evaluate the response of a cultivar (BRS Energy) and a lineage (CNPA 2009-7) of castor bean to increasing doses of N and P in the soil in two locations in the northeastern semi-arid region: rural areas of the municipalities of Apodi (RN) and Barbalha (CE). The doses of N tested were: 0, 50, 100, 150 and 200 kg/ha and those of P, 0, 50, 100, 150 and 200 kg/ha. The experiments were distributed in randomized blocks with four replications, making a total of 40 plots. The cv. BRS Energy showed a greater absorption of nitrogen in the soil and, consequently, synthesized more crude protein than the CNPA 2009-7 genotype. In addition, it showed greater efficiency in calcium absorption. On the other hand, the genotype proved to be more efficient in the absorption of phosphorus and magnesium. The cultivar naturally showed a higher castor bean production, as evidenced by the significantly higher variables related to the production of fruits and seeds. It also had a higher oil content in relation to the genotype. In both locations, the content of N and, consequently, of proteins, in castor bean leaves increased as a function of the dose of nitrogen fertilizer.
Keywords: Ricinus comunis, nitrogen fertilization, phosphorus fertilization.

INTRODUCTION

The castor bean (*Ricinus comunis* L.), also known as carrapateira, belongs to the Euphorbiaceae family. Its center of origin is probably in Africa, more specifically in Ethiopia. Currently the world's largest producer is India, followed by China, with Brazil coming in third place. In Brazil, the largest producing state is Bahia. The oil extracted from its seeds has numerous applications in the pharmaceutical, cosmetics, plastics and lubricants industries. The product is also used in the production of fiber optics, bulletproof glass and bone prostheses. Furthermore, it is essential to prevent the freezing of fuels and lubricants for airplanes and space rockets at extremely low temperatures.

Adequate nutrition, through the implementation of soil correction and fertilization programs based on the diagnosis of soil fertility and the nutritional requirements of the castor bean tree, is a decisive factor for obtaining high productivity of castor bean seeds. Soil chemical analysis is the main tool for diagnosing soil fertility, indicating the availability of nutrients and the presence of elements that are toxic to plants. Therefore, it must be used as a basis for establishing corrective and fertilizer recommendations. Additionally, one must consider the cultivation history, the productive potential of the cultivar used, the technological level of the producer, as well as the local climatic conditions, aspects that the more favorable they are, the greater the expectation of productivity and nutrient requirement. of culture (Scivittaro and Pillon, 2007).

The castor bean plant is sensitive to soil acidity and demanding in terms of nutrients, presenting a good response, in terms of productivity, to soil correction and fertilization. Preferably, planting is recommended in well-prepared, fertile, deep and loose soils, to enable the development of the root system in depth and density. There are restrictions, however, to cultivation in soils with very high fertility, as they favor excessive vegetative growth, prolonging the cycle and considerably expanding the flowering period (Scivittaro and Pillon, 2007).

The best castor bean development is

obtained in soil with a pH close to neutrality. Fertilization is an essential cultural practice for the castor bean crop, due to its demand for mineral nutrients taken from the soil. By producing a high amount of dry mass, especially in the leaves, the plant requires substantial amounts of nitrogen. Its seeds have very high levels of oil and protein, which makes it very demanding in terms of macronutrients in general, especially nitrogen, phosphorus, potassium, calcium and magnesium. According to Beltrão and Gondim (2006), for a productivity of 2,000 kg/ha of seeds, the castor bean removes from the soil 80 kg of nitrogen (N), 18 kg of phosphorus pentoxide (P2O5), 32 kg of potassium oxide (K2O), 12 kg of calcium oxide (CaO) and 10 kg of magnesium oxide (MgO). Therefore, it is important that this crop is implanted in soils with good fertility. If this is not possible, one must try to correct the problem with fertilizers (organic or mineral). Organic fertilization provides the soil with all the benefits of organic matter, that is, improvement in chemical, physical and biological properties. In the total or partial unavailability of organic materials to be applied to the soil before the establishment of the castor bean crop, mineral fertilization with macro and micronutrients must be used, always in accordance with the soil analysis. According to Santos (2004), as the castor bean plant is very demanding in terms of nitrogen, its deficiency in the soil can cause strong characteristic symptoms in the leaves, especially in the vegetative development phase. According to Ferreira et al. (2004), castor bean productivity is greatly affected by insufficient levels of phosphorus and potassium in the soil, especially in the initial growth phase. Studies regarding castor bean fertilization are still incipient in Brazil, especially with regard to the northeastern semi-arid region.

The research aimed to evaluate the response of a cultivar (BRS Energy) and a lineage (CNPA 2009-7) of castor bean to increasing doses of N and P in the soil in two locations in the northeastern semi-arid region: rural areas of the municipalities of Apodi (RN) and Barbalha (CE).

METHODOLOGY

To study the effect of increasing doses of N and P on the growth and production of a cultivar (BRS Energy) and a lineage (CNPA 2009-7) of castor bean, four experiments were installed on August 2, 2013, two in Apodi (RN) and two in Barbalha (CE). The Apodi experiments were set up at the Experimental Station of the Agricultural Research Company of Rio Grande do Norte (EMPARN) and the Barbalha ones at the Experimental Station of Embrapa Algodão, in the rural area of both municipalities. In each location, two 5x2 factorial experiments were installed, where five levels of N in the soil were tested in the two genotypes and, equally, five levels of P, also in the two genotypes.

The doses of N tested in the soil were: 0, 50, 100, 150 and 200 kg/ha and those of P, 0, 50, 100, 150 and 200 kg/ha. The experiments were distributed in randomized blocks with four replications, making a total of 40 experimental plots. Each plot had the following dimensions: 5 m long x 4 m wide; in each, there were 4 rows spaced 1 m apart, while each edge was 0.5 m from the last row. When planting the cultivar BRS Energy, the plants, within each row, were spaced 1 m apart, with the distance between the edge of the plot and the last plants in the row being 0.5 m. Thus, each plot consisted of 20 plants, the six central ones being useful. When planting the CNPA 2009-7 lineage, the plants, within each row, were spaced 0.5 m apart, with the distance between the edge of the plot and the last plants in the row being 0.5 m. Thus, each plot consisted of 36 plants, the 14 central ones being useful.

In the four experiments, fertilization was carried out with nitrogen (N), phosphorus (P2O5) and potassium (K2O), using ammonium sulfate (SAm), simple superphosphate (SSP) and potassium chloride (KCl) as sources, respectively, according to soil analyzes from Apodi (RN) and Barbalha (CE), except in the experiments in which increasing N and P levels were studied. In the experiments in which increasing N levels were studied, the fixed dose of P, applied in foundation, was 100 kg P_2O_5/ha, and, in the experiments with increasing levels of P, the fixed dose of N was 100 kg N/ha. In the four experiments, the fixed dose of K was 20 kg/ha. As for N application, 40% was applied at planting (foundation) and the remainder (60%) between September 23 to 27, 2013, in all experiments.

Before sowing, the seeds of cv. Energy were treated with the insecticide Gaucho at a concentration of 600 mL per 20 kg of seeds and with the fungicide Vitavax at a concentration of 0.5 L per 100 kg of seeds. The seeds of lineage 2009-7 did not receive these treatments. The soils in the experimental areas were treated to prevent weeds with the following herbicides: Herbadox 2 L/ha, Gamite 1 L/ha and Dual 0.6 L/ha. The irrigation of the experiments was by sprinkling.

At the end of the plant cycle, variables related to growth and production were taken:

- Plant height (cm);
- Height of insertion of the first bunch (cm);
- Diameter of the stem (mm);
- Number of racemes per plant;
- Length of the first bunch (cm);
- Number of sheets;
- End stand;
- Number of fruits of the first raceme;
- Production with the bark of the first bunch (g);
- Production with total bark (g);
- Production without bark (processed) of the first bunch (g);
- Production with bark (processed) total (g);
- Weight of 100 fruits (g);
- Weight of 100 seeds (g);
- Content of macronutrients in the leaves (%);
- Seed oil content (%).

To determine the macronutrient content (nitrogen, phosphorus, potassium, calcium, magnesium and sulfur) in cotton leaves, leaf samples were collected at the apex of the plant's vegetative development period. The leaves collected from the useful area of the plots were those recently matured that had already reached maximum size and were plucked at the base of the petiole. These leaves were then placed in paper bags duly identified as to the experiment, treatment and block, and taken to the Laboratory of Soils and Plant Nutrition at Embrapa Algodão (Campina Grande-PB). There they were washed and put to dry in an oven with air circulation at a temperature of 60 - 65oC for approximately 48 hours where they reached their constant weight. Then, the samples were ground and the powder placed in duly identified paper bags. For the determination of N, P and K contents, the samples underwent sulfuric digestion and, for Ca, Mg and S, nitric-perchloric digestion. The contents of N and P were determined by UV-visible spectrophotometry, those of K by flame photometry, those of Ca and Mg by titration, and those of S by atomic absorption spectrophotometry. To determine the oil content in the seeds, these were sent to the Laboratory of Advanced Chemistry at Embrapa Algodão and this variable was determined by low-field NMR using the non-destructive AOCS methodology (Ak 5-01, 2004).

Data were organized and tabulated in Microsoft Word's Excel 2013 program. Afterwards, they were submitted to statistical analysis using the SAS software (Statistical Analysis System) version 9.2. The experiments "Effects of increasing nitrogen doses on two castor bean genotypes in Apodi-RN", "Effects of increasing phosphorus doses on two castor bean genotypes in Apodi-RN", "Effects of increasing nitrogen doses on two castor bean genotypes in Barbalha-CE" and "Effects of increasing phosphorus doses on two castor bean genotypes in Barbalha-CE" were submitted to analyzes of variance in relation to genotype, nutrient dose, genotype x nutrient dose interaction and block; and the regression analyzes in relation to the dose of the nutrient, choosing the significance level of 5% of probability. The variables that gave significance in relation to the genotypes were submitted to the Tukey test at 5% probability. Those that gave significance in relation to the doses of N or P were submitted to regression analysis, choosing the largest model that gave significance at 5% of probability and that had coherence in biological terms, calculating the R2. When the genotype x nutrient dose interaction was significant, Tukey's test and regression analyzes were performed within each factor in relation to the other and vice versa.

RESULTS AND DISCUSSION

NITROGEN MANAGEMENT IN CASTOR BEAN CULTURE IN THE MUNICIPALITY OF APODI - RN

Analysis of variance gave significant F (5% probability) for the following variables:

- Concentration of N in leaves (N);
- Concentration of P.B. (crude protein) in leaves (PB);
- Concentration of Ca in the leaves (Ca);
- Concentration of Ca oxide (CaO) in leaves (CaO);
- Concentration of Mg in leaves (Mg);
- Concentration of Mg oxide (MgO) in leaves (MgO);
- Height of the first bunch (APC);
- Plant height (AP);
- Length of the first raceme (CPR);
- Number of fruits per plant of the first raceme (NFP-PR);
- Weight of unpeeled fruits of the first raceme (PFCC-PR); And
- Weight of 100 processed seeds (without shell) (P100S-SC)

All the variables described above gave significance at the 5% probability level for genotypes, but for N doses, only the variables leaf N concentration, leaf CP concentration and plant height. There was no statistically significant interaction for dose of N x genotype.

Table 1 shows the mean of the genotypes that gave significance at the 5% probability level.

The BRS Energy cv showed levels of N, crude protein, Ca and CaO in the leaves, height of the first raceme, plant height, number of fruits per plant in the first raceme, weight of unpeeled fruits (without processing) in the first raceme and weight of one hundred peeled seeds (processed) that were significantly higher than those of the CNPA 2009-7 lineage. On the other hand, the 2009-7 genotype showed levels of Mg and MgO in the leaves significantly higher than those of the cultivar, showing that the strain is more efficient in absorbing magnesium from the soil.

The variables N content and crude protein in the leaves (N and CP) showed statistical significance at the 5% probability level for the independent variable N dose in the soil, whose responses were explained by quadratic models as shown in Figures 1 and 2.

Variable	BRS Energy	CNPA2009-7	CV(%)
N (%)	4,54 a	3,82 b	7,95
PB (%)	28,39 a	23,90 b	7,94
Ca (%)	2,26 a	1,98 b	15,89
CaO (%)	3,17 a	2,77 b	15,82
Mg (%)	0,27 b	0,34 a	37,89
MgO (%)	0,46 b	0,59 a	38,04
APC (cm)	123,41 a	60,64 b	11,69
AP (cm)	144,88 a	94,19 b	15,11
CPR (cm)	37,53 a	23,43 b	17,64
NFP-PR	67,23 a	47,27 b	12,26
PFCC-PR (g)	94,71 a	71,13 b	15,36
P100S-SC (g)	33,34 a	31,28 b	7,76

Means followed by the same letter, in the lines, do not differ statistically from each other at the 5% probability level using Tukey's test.

Table 1- Average of the castor bean genotypes (cv BRS Energy and CNPA 2009-7 lineage) submitted to the Tukey test at 5%, in the experiment where increasing levels of nitrogen were tested in the rural area of the municipality of Apodi-RN.

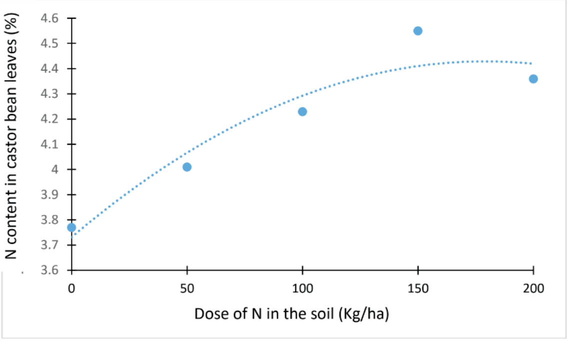

Figure 1 - N content in castor bean leaves (average of cv. BRS Energy + CNPA 2009-7 lineage) as a function of N doses in soil in the rural area of the municipality of Apodi-RN (CV=7.95). $Y = 3.73 + 0.0079N - 0.00002212N^2$ ($R^2 = 0,71$).

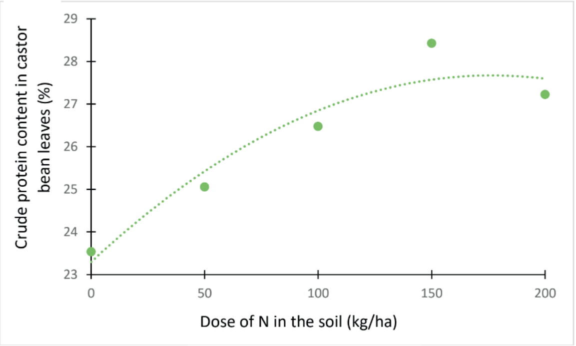

Figure 2 - Crude protein content in castor bean leaves (average of cv. BRS Energy + CNPA 2009-7 lineage) as a function of N doses in soil in the rural area of the municipality of Apodi-RN (CV=7.94). $Y = 23.3 + 0.049N - 0.000138N^2$ ($R^2 = 0,69$).

PHOSPHORUS MANAGEMENT IN CASTOR BEAN CULTURE IN THE MUNICIPALITY OF APODI – RN

Analysis of variance gave significant F (5% probability) for the following variables:

- Final Stand (StF);
- Concentration of N in leaves (N);
- Concentration of P.B. (crude protein) in leaves (PB);
- Concentration of P in the leaves (P);
- Concentration of phosphorus oxide (P2O5) in leaves (P2O5);
- Concentration of calcium oxide (CaO) in leaves (CaO)
- Height of the first bunch (APC);
- Plant height (AP);
- Length of the first raceme (CPR);
- Number of fruits per plant of the first raceme (NFP-PR);
- Weight of unpeeled fruits of the first raceme (PFCC-PR);
- Benefited castor bean production per plot (PBP/P); It is
- Weight of 100 processed seeds (P100S).

With the exception of the final stand variable (StF), the other variables described above gave significance at the 5% probability level for genotypes. Regarding the independent variable dose of N in the soil, only the variables final plant stand and P and P_2O_5 contents gave statistical significance at 5% probability. There was no statistically significant interaction for dose of N x genotype.

Table 2 shows the average of the genotypes that gave significance at the 5% probability level.

Variable	BRS Energy	CNPA2009-7	CV(%)
N (%)	4,24 a	3,59 b	12,94
PB (%)	26,51 a	22,44 b	12,94
P (%)	0,37 b	0,44 a	21,78
P_2O_5 (%)	0,85 b	1,02 a	21,83
CaO (%)	3,11 a	2,78 b	17,64
APC (cm)	115,13 a	53,43 b	18,17
AP (cm)	140,70 a	79,70 b	17,83
CPR (cm)	33,61 a	20,32 b	18,13
NFP-PR	59,06 a	42,94 b	26,44
PFCC-PR (g)	92,29 a	67,96 b	20,99
PBP/P (g)	92,76 a	77,64 b	10,55
P100S (g)	33,22 a	29,96 b	8,79

Means followed by the same letter, in the lines, do not differ statistically from each other at the 5% probability level using Tukey's test.

Table 2- Average of the castor bean genotypes (cv BRS Energy and CNPA 2009-7 lineage) submitted to the Tukey test at 5%, in the experiment where increasing levels of phosphorus were tested in the rural area of the municipality of Apodi-RN.

As we can see in Table 2, the cultivar BRS Energy has greater efficiency in absorbing and accumulating nitrogen in its tissues and, consequently, forming a greater concentration of proteins in the leaves. The CNPA 2009-7 strain, on the other hand, has greater efficiency in the absorption and accumulation of the phosphorus nutrient in its tissues. The variables related to growth and production (height of the first raceme, plant height, length of the first raceme, number of fruits per plant of the first raceme, weight of unpeeled fruits of the first raceme, processed production per plot and weight of 100 seeds beneficiaries) had statistically higher values at the 5% probability level in cv. BRS Energy. This way, the CNPA 2009-7 genotype does not have growth and production compared to that of the cv., however it shows promise to become a cultivar in the future due to its small size, which greatly facilitates cultural practices.

The final stand variable showed statistical significance at the 5% probability level for the independent variable N dose in the soil, whose response was explained by a linear model as shown in Figure 3. As we can see in Figure 3, the increase in N doses P in the soil caused the final stand of the plants to decrease.

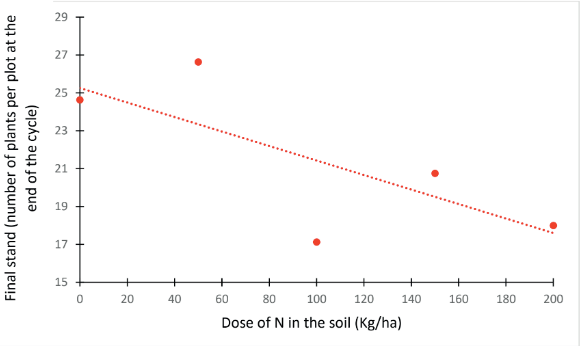

Figure 3 – Stand final (number of plants) of castor bean (average of cv. BRS Energy + CNPA 2009-7 lineage) at the end of the cycle as a function of P doses in soil in the rural area of the municipality of Apodi-RN (CV=32.77). Y = 25.25 - 0.038P (R^2 = 0,89).

NITROGEN MANAGEMENT IN CASTOR BEAN CULTURE IN THE MUNICIPALITY OF BARBALHA - CE

Analysis of variance gave significant F (5%

probability) for the following variables:

- Total production with bark (non-processed) per plot (PnBT);
- Production with bark (non-processed) from the 2nd race per plot (PnBOtR);
- Total production without bark (benefited) per plot (PBT);
- Production without bark (benefited) from the 2nd race per plot (PBOtR);
- Number of leaves at harvest per plant (NF);
- Number of racemes per plant (NR/P);
- Stem diameter (DC);
- N concentration in leaves (N);
- Concentration of P.B. (crude protein) in leaves (PB);
- P concentration in leaves (P);
- Phosphorus oxide concentration (P_2O_5) in the leaves (P_2O_5);
- Oil concentration in the seeds of the first raceme (%Oil1ºR); e
- Oil concentration in seeds of other racemes (%OilOtR).

Breaking down the treatments into factors, the variables that gave significance at the 5% probability level for the independent variable cotton genotype were: production with bark from the 2nd raceme per plot, total production without bark per plot, production without bark from of the 2nd raceme per plot, number of leaves per plant at harvest, stem diameter, number of racemes per plant, oil concentration in the seeds of the first raceme and oil concentration in the seeds of the other racemes. For the independent variable doses of N in the soil, the dependent variables that gave statistical significance at a 5% probability level were: concentration of N in the leaves, concentration of crude protein in the leaves, concentration of P in the leaves, concentration of P_2O_5 in the leaves, production with bark from the 2nd raceme per plot, production without bark from the 2nd raceme per plot, oil concentration in the seeds of the first raceme and oil concentration in the seeds of the other racemes. For the interaction genotype x N doses, only the variable total production without husk per plot was statistically significant at the 5% probability level.

Table 3 shows the average of the genotypes that gave significance at the 5% probability level.

Variable	BRS Energy	CNPA 2009-7	CV(%)
PnBOtR (g/installment)	809,00 a	568,70 b	22,98
PnBT (g/ installment)	849,45 a	597,14 b	18,80
PBOtR (g/ installment)	529,50 a	364,30 b	23,27
NF	36,90 a	24,98 b	35,30
DC (mm)	18,83 a	16,26 b	13,67
NR/P	5,67 a	3,80 b	24,21
%Óleo1ºR (%)	48,75 a	47,85 b	3,06
%ÓleoOtR (%)	47,71 b	48,97 a	3,88

Means followed by the same letter, in the lines, do not differ statistically from each other at the 5% probability level using Tukey's test.

Table 3- Average of the castor bean genotypes (cv BRS Energy and CNPA 2009-7 lineage) submitted to the Tukey test at 5%, in the experiment where increasing levels of nitrogen were tested in the rural area of the municipality of Barbalha-CE.

As we can see in Table 3, the cultivar BRS Energy is naturally more productive in relation to the CNPA 2009-7 line, since it presented statistical superiority in relation to the variables production with bark from the 2nd race per plot, total production without bark per plot and production without bark from the 2nd raceme per plot. It also showed statistically significant superiority at the

5% probability level for variables related to growth: number of leaves per plant at harvest, stem diameter and number of racemes per plant. Regarding the production of castor oil, very important in the fine chemical industry, the cultivar BRS Energy had a higher concentration of oil, in relation to the lineage, in the seeds coming from the first raceme, which is the most productive, however, in the seeds of the other racemes (from the second upwards), the CNPA 2009-7 lineage had the highest oil concentration in relation to the cultivar.

The variables N concentration in the leaves, crude protein concentration in the leaves, P concentration in the leaves, P2O5 concentration in the leaves, production with bark from the 2nd raceme per plot, production without bark from the 2nd raceme per plot, concentration of oil in the seeds of the first raceme and concentration of oil in the seeds of the other racemes showed statistical significance at the 5% probability level for the independent variable dose of N in the soil. The variables N concentration in the leaves, crude protein concentration in the leaves and oil concentration in the seeds of the first raceme were explained by a linear model; the oil concentration variable in the seeds of the other racemes was explained by a quadratic model; and, P concentration in the leaves, P2O5 concentration in the leaves, production with bark from the 2nd raceme per plot and production without bark from the 2nd raceme per plot, by cubic model.

Figures 4, 5, 6, 7, 8, 9, 10 and 11 show the effect of increasing N doses in soil in the rural area of Barbalha-CE on the variables mentioned above.

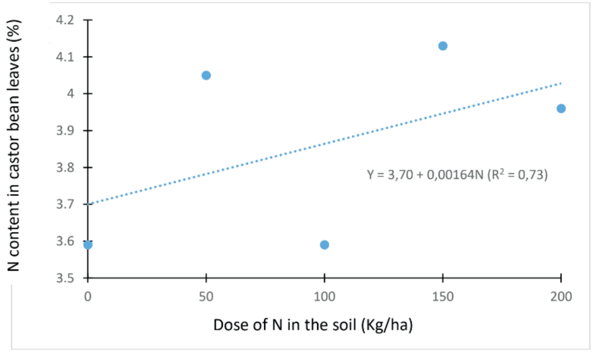

Figure 4 - N content in castor bean leaves (average of cv. BRS Energy + CNPA 2009-7 lineage) as a function of N doses in soil in the rural area of the municipality of Barbalha-CE (CV=10.88).

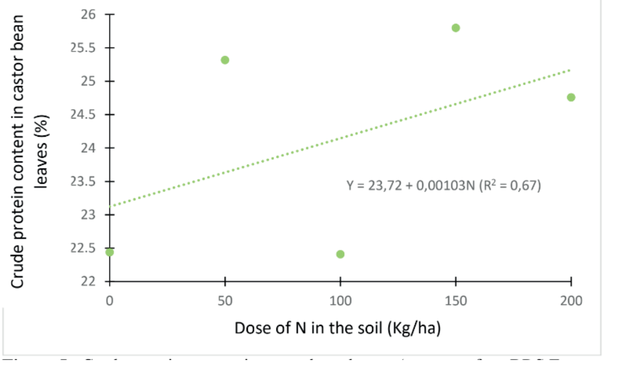

Figure 5 - Crude protein content in castor bean leaves (average of cv. BRS Energy + CNPA 2009-7 lineage) as a function of N doses in soil in the rural area of the municipality of Barbalha-CE (CV=10.88).

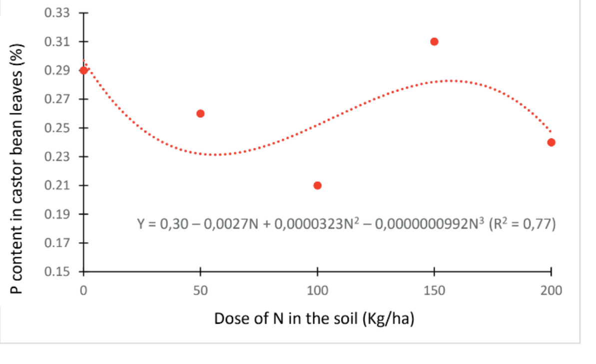

Figure 6 - P content in castor bean leaves (average of cv. BRS Energy + CNPA 2009-7 lineage) as a function of N doses in soil in the rural area of the municipality of Barbalha-CE (CV=21.14).

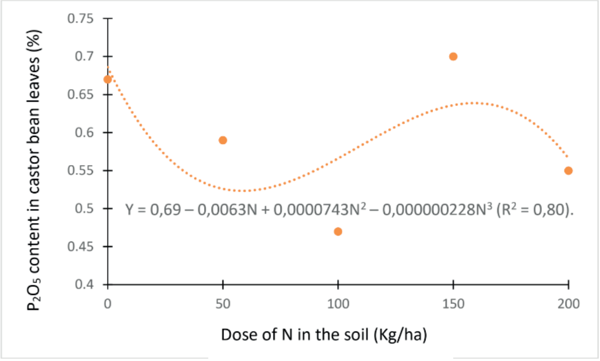

Figure 7 - P_2O_5 content in castor bean leaves (average of cv. BRS Energy + CNPA 2009-7 lineage) as a function of N doses in soil in the rural area of the municipality of Barbalha-CE (CV=21.24).

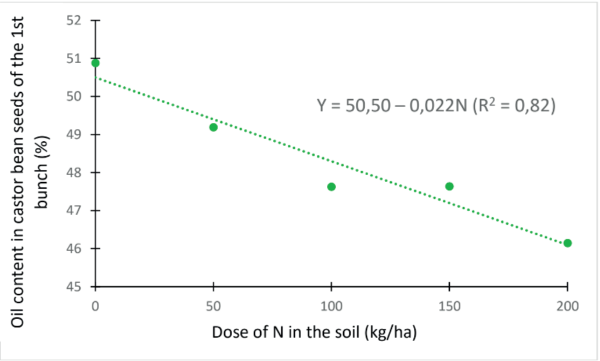

Figure 10 – Oil content of 1st race castor bean seeds (average of cv. BRS Energy + CNPA 2009-7 lineage) as a function of N doses in soil in the rural area of the municipality of Barbalha-CE (CV=3.06).

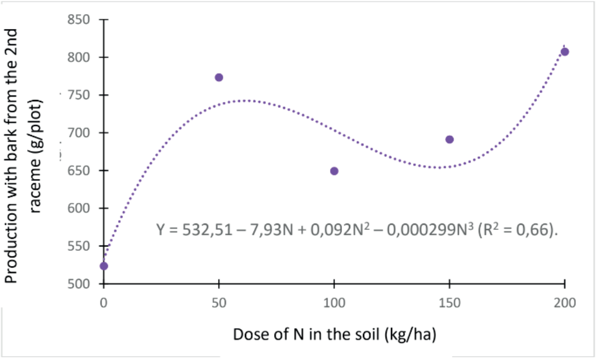

Figure 8 - Production with bark (non-processed) from the 2nd raceme (average of cv. BRS Energy + CNPA 2009-7 lineage) as a function of N doses in soil in the rural area of the municipality of Barbalha-CE (CV=22.98).

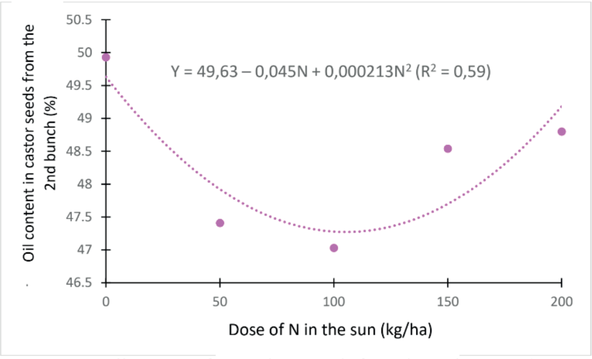

Figure 10 – Oil content of castor bean seeds from the 2nd raceme (average of cv. BRS Energy + CNPA 2009-7 lineage) as a function of N doses in soil in the rural area of the municipality of Barbalha-CE (CV=3.88).

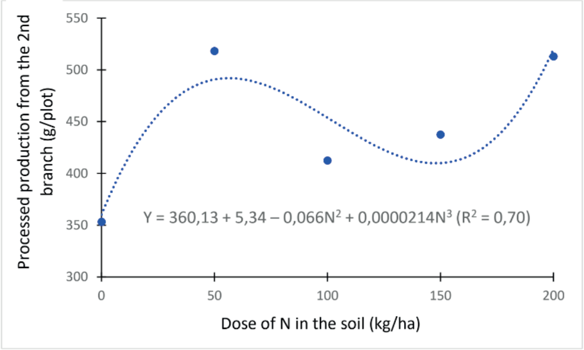

Figure 9 - Production without bark (benefited) from the 2nd raceme (average of cv. BRS Energy + CNPA 2009-7 lineage) as a function of N doses in soil in the rural area of the municipality of Barbalha-CE (CV=23.27).

As we can see by looking at the figures above, as the dose of N in the soil in the rural area of the municipality of Barbalha-CE increased, there was an increase in the content of N in the recently mature leaves harvested at the end of their expansion process (Figure 4). The same trend occurred with the crude protein content in the same leaves (Figure 5) since nitrogen is an essential component of amino acids, which are the building blocks of all proteins.

The oil content of castor bean seeds harvested from the first raceme of castor bean plants, which produce most of the seeds of agricultural interest, decreased with increasing N content in the soil (Figure 10). This was to be expected since, with the increase in N uptake by the roots due to its greater availability in the soil, the plant will direct its reserves towards vegetative growth to the detriment of production or seed quality.

For the interaction genotype x N doses, only the variable total production without husk per plot was statistically significant at the 5% probability level. Unfolding this interaction in the Analysis of Variance, it was observed that there was significance only for genotype within doses, as shown in Table 4.

Dose of N (kg/ha)	Genotypes	
	BRS Energy	CNPA 2009-7
0	873,50 a	779,00 a
50	1143,50 a	876,00 b
100	936,50 a	770,00 a
150	911,00 a	955,50 a
200	1256,00 a	793,50 b

CV=17,49%

Means followed by the same letter, in the lines, do not differ statistically from each other at the 5% probability level by Tukey's test.

Table 4- Total production without bark (g) of castor bean genotypes submitted to increasing doses of nitrogen in soil in the rural area of the municipality of Barbalha-CE.

PHOSPHORUS MANAGEMENT IN CASTOR BEAN CULTURE IN THE MUNICIPALITY OF BARBALHA – CE

Analysis of variance gave significant F (5% probability) for the following variables:

- Production with bark (non-processed) from the 2nd race per plot (PnBOtR);
- Production without bark (processed) from the 2nd race per plot (PBOtR);
- Height of the 1st cluster (A1ºR);
- Number of racemes per plant (NR/P);
- Weight of 100 seeds harvested from the 2nd raceme (P100SOtR);
- Weight of 100 seeds (P100S);

Unfolding the treatments into factors, the variables that gave significance at the 5% probability level for the independent variable cotton genotype were: height of the 1st raceme and number of racemes per plant. The other variables mentioned above gave significance at the 5% probability level for the genotype x N doses interaction. The unfolding of the interaction found that there was only significance at the 5% probability level for cultivating within doses. The results are shown in Tables 5, 6, 7, 8 and 9.

Variable	BRS Energy	CNPA 2009-7	CV(%)
A1ºR (cm)	45,25 b	53,53 a	20,67
NR/P	5,14 a	3,37 b	7,46

Means followed by the same letter, in the lines, do not differ statistically from each other at the 5% probability level using Tukey's test.

Table 5- Average of castor bean genotypes (cv BRS Energy and CNPA 2009-7 lineage) submitted to the Tukey test at 5%, in the experiment where increasing levels of phosphorus were tested in the rural area of the municipality of Barbalha-CE.

Dose de N (kg/ha)	Genotypes	
	BRS Energy	CNPA 2009-7
0	527,50 a	819,00 a
50	559,00 a	814,00 a
100	625,50 a	639,50 a
150	269,50 b	903,00 a
200	576,50 a	435,50 a

CV=40,94%

Means followed by the same letter, in the lines, do not differ statistically from each other at the 5% probability level using Tukey's test.

Table 6– Production with bark (non-processed) (g) from the 2nd race per plot of castor bean genotypes submitted to increasing doses of phosphorus in soil in the rural area of the municipality of Barbalha-CE.

Dose of N (kg/ ha)	Genotypes	
	BRS Energy	CNPA 2009-7
0	360,00 a	566,50 a
50	305,50 b	553,00 a
100	419,50 a	435,50 a
150	178,50 b	602,50 a
200	384,50 a	275,50 a

CV=40,48%

Means followed by the same letter, in the lines, do not differ statistically from each other at the 5% probability level using Tukey's test.

Table 7– Production without bark (benefited) from the 2nd raceme per plot (g) of castor bean genotypes submitted to increasing doses of phosphorus in soil in the rural area of the municipality of Barbalha-CE.

Dose of N (kg/ ha)	Genotypes	
	BRS Energy	CNPA 2009-7
0	32,29 a	32,13 a
50	33,91 a	32,07 a
100	35,12 a	29,71 b
150	29,04 a	32,34 a
200	32,93 a	31,48 a

CV=8,27%

Means followed by the same letter, in the lines, do not differ statistically from each other at the 5% probability level using Tukey's test.

Table 8– Weight of 100 fruit seeds collected from the 2nd raceme (g) of castor bean genotypes submitted to increasing doses of phosphorus in soil in the rural area of the municipality of Barbalha-CE.

Dose of N (kg/ ha)	Genotypes	
	BRS Energy	CNPA 2009-7
0	64,61 a	66,12 a
50	67,43 a	67,16 a
100	71,49 a	62,97 b
150	60,87 a	66,97 a
200	66,37 a	63,83 a

CV=6,70%

Means followed by the same letter, in the lines, do not differ statistically from each other at the 5% probability level using Tukey's test.

Table 9 – Weight of 100 seeds of castor bean genotypes submitted to increasing doses of phosphorus in soil in the rural area of the municipality of Barbalha-CE.

As we can see, the height of the first raceme and the number of racemes per plant differed significantly at the 5% probability level by Tukey's test. The 2009-7 genotype naturally presents a greater height of its 1st raceme, typical of the accession, however, a smaller number of leaves.

The phosphorus doses used in the study: 0, 50, 100, 150 and 200 kg/ha did not promote significant responses to the studied variables. Probably, in the edaphic reality of the area where the experiment was implemented, the high doses of P were fixed to oxides and sesquioxides of Fe and Al, not promoting response. It is therefore suggested that, in the next experiments with phosphate fertilization in the rural area of the municipality of Apodi-RN, the soil be investigated in relation to its physical properties and that a chemical analysis of the adsorption of P in the clay particles be carried out.

The production of castor bean seeds from the first raceme is an important variable in relation to the evaluation of the production of a cultivar and also of a genotype, as it is in this raceme where the highest proportion of castor bean productivity is concentrated, as well as the best quality seeds for the fine chemical industry.

CONCLUSIONS

- The cv. BRS Energy has a greater absorption of nitrogen in the soil and, consequently, synthesizes more crude protein than the CNPA 2009-7 genotype. In addition, it presents a greater efficiency in the absorption of calcium. On the other hand, the genotype proved to be more efficient in the absorption of phosphorus and magnesium.

- The cv. BRS Energy is larger in relation to the CNPA 2009-7 genotype, as evidenced by significantly larger: plant height, height of the first raceme, total length of the first raceme, stem diameter, number of leaves at harvest and number of racemes per plant.

- The cv. BRS Energy also naturally presents a higher castor bean production, as evidenced by the significantly higher variables related to fruit and seed production: number of fruits per plant of the first raceme, weight of fruits of the first raceme, weight of fruits harvested from the second raceme, weight of total fruits, production of castor bean seeds and weight of 100 seeds.

- The cv. BRS Energy has a higher oil content compared to the CNPA 2009-7 genotype.

- In both locations, the content of N and, consequently, of proteins, in castor bean leaves, increased as a function of the dose of nitrogen fertilizer.

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