International Journal of Plant & Soil Science

Volume 36, Issue 5, Page 578-588, 2024; Article no.IJPSS.114662
ISSN: 2320-7035

Evaluation of the Effects of Nutrient Omissions on the Growth and Seed Yield of Two Castor Plant Varieties in Southwest Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2024/v36i54555

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/114662

Original Research Article

Received: 24/01/2024
Accepted: 28/03/2024
Published: 03/04/2024

ABSTRACT

Purpose: This pot experiment determined the critical nutrient elements for improved performance of two castor varieties in the study area.
Methods: Two castor plant varieties; Indian Brown (IB) and Brazilian White (BW) were raised using ten nutrient types; 120 kg N, 50 kg P, 60 kg K, 10 kg Mo, 5 kg Zn, 2.5 kg Cu, 3 kg Fe and 5 kg Bo all in kg/ha as full nutrient (FN) with omissions of each of the element from FN and the control (no amendment) between August 2021 and January 2022 at Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Data were collected on Plant Height (PH), Stem Girth (SG), Number of Capsules (NC) and Seed Weight (SW).

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Results: The IB produced taller (71.0 cm) plants and higher SW (16.9 g/plant) compared to BW with respective values of 57.6 cm and 12.5 g/plant. At 16 weeks after sowing, the full nutrient produced the thickest stem (57.1 mm) while the omission of nitrogen produced the thinnest stem (47.9 mm). The omission of zinc produced the highest NC (30) while the omission of nitrogen (17) and boron (14) produced lowest NC. Omission of potassium produced highest SW (20.3 g/plant), while omission of nitrogen (12.5 g/plant), phosphorus (13.0 g/plant) and boron (11.3 g/plant) produced lowest SW.

Conclusions: IB should be the choice variety over BW while nitrogen, phosphorus and boron are critical nutrient elements for its improved performance in the study area.

Keywords: Castor varieties; nutrient omission; seed yield; nitrogen; nutrient elements; oilseed crops; castor plan.

1. INTRODUCTION

Castor (*Ricinus communis* L.) is an oil-producing plant that has more than 700 industrial uses [1]. It is one of the most important non-edible oilseed crops, which is grown all around the world to earn much needed foreign exchange [2,3]. Despite the fact that castor is an important medicinal and industrial crop, it has not yet been widely grown by the farmers in southwestern Nigeria on commercial basis as emphasis is given to the other major crops like, maize, yam, cassava, soybean and cowpea etc. Castor can be grown as a potential oilseed crop on all kinds of lands, which are not alkaline and well-drained, where no other important crop could be grown [4]. Castor is a nutrient-demanding crop and responsive to higher nutrient application [5]. Part of the reasons for the low yield of castor are lack of improved productive varieties and improper fertilizer inputs. Plants suffer nutrient deficiency stress when the amount of nutrients taken up, is below that required for sustaining metabolic processes in a particular growth stage. This may result from an inherently low nutrient status of soil, low mobility of nutrients within soil, poor solubility of the chemical form of the nutrient, or the soil-microbe-plant interactions [6,7]. To increase the productivity of castor plants, it is imperative to identify the nutrients limiting their growth and production. The application of different fertilizers and doses, influences plant growth, seed production and, consequently, the production of oil of different castor bean cultivars, which respond to these factors differently. Although, in Nigeria, there is no recommendation of fertilization for the castor bean in general, there are also no records in the literature on the nutritional requirements of each of these different cultivars and, consequently, differentiation in their responses to nutrient elements. Castor plant is gaining popularity in the study area as a cash crop. There is dearth of information on the general nutrient requirements of castor plant in Nigeria. Since tropical soils are generally poor in fertility, application of external nutrient inputs is imperative to increase crop yield. Therefore, it is necessary to determine the most limiting nutrient element(s) for the performance of castor plant in the study area. The aim of this study was to determine the most limiting of the ten selected nutrient elements for the growth and seed yield of two varieties of castor plant (Indian brown and Brazilian white) cultivated in the study area.

2. MATERIALS AND METHODS

2.1 Soil Sampling, Preparation and Routine Analysis

Surface soil (0-15 cm depth) samples were randomly collected at Teaching and Research Farm, LAUTECH with the use of a shovel. The soil was air dried, crushed, and milled through 2 mm and 0.5 mm mesh sieves. 15 kg of soil sieved with 2 mm mesh was weighed per pot. Sub samples samples were analyzed in the laboratory for selected chemical properties. The organic carbon was determined by the Walkey-Black method [8] and the total N was determined by macro – Kjeldahl method [9]. Available P was determined by the Bray 1 method [9] while the exchangeable cations was extracted with 1N NH_4OAc solution [10]. Sodium and potassium were measured with the flame photometer and Mg was determined on the atomic absorption spectrophotometer. Exchangeable acidity (H^+) and aluminiun of the soil was determined by the titration method [11].

2.2 Location of the Experiment

A pot experiment was conducted between August 2021 and January 2022 at the Teaching and Research Farm, Ladoke Akintola University of Technology (LAUTECH) Ogbomoso, Oyo State. Ogbomoso is located on Longitude 4º 10′ E and Latitude 8º 10′ N, altitude of 213 m above sea level in the Southern Guinea Savanna agro-ecological zone of Nigeria. It is characterized by bimodal rainfall distribution pattern. The early rainy season commences in April and ends in late July/early August with a short dry spell in August. The late rainy season commences from September to November. It has mean annual rainfall ranging between 1,150 and 1,250 mm. The mean annual temperature range between 28 and 33ºC while the average relative humidity is 74%.

2.3 Treatments and Experimental Design

The experiment consisted of two varieties of castor plants (Indian brown and Brazilian white), and ten nutrient types. The nutrient types are summarized thus:

Nutrient type 1 - The nutrient compositions of the full nutrient (FN) were:

Nitrogen =120 kg N/ha = 2 g urea/ 15 kg soil
Phosphorus = 50 kg P/ha = 4.8 g SSP/15 kg soil
Potassium = 60 kg K/ha = 0.9 g MOP/15 kg soil
Molybdenum = 10 kg Mo/ha = 0.1 g ammonium molybdate /15 kg soil
Zinc = 5 kg Zn/ha = 0.9 g Zinc oxide/15 kg soil
Copper = 2.5 kg Cu/ha = 0.05 g Copper sulphate/15 kg soil
Iron = 3 kg Fe/ha = 0.01 g Iron sulphate/15 kg soil
Boron = 5 kg Bo/ha = 0.2 g Boric acid/15 kg soil

Nutrient type 2 – FN without Nitrogen
Nutrient type 3 – FN without Phosphorus
Nutrient type 4 – FN without Potassium
Nutrient type 5 – FN without Copper
Nutrient type 6 – FN without Iron
Nutrient type 7 – FN without Molybdenum
Nutrient type 8 – FN without Zinc
Nutrient type 9 – FN without Boron
Nutrient type 10 – Control (A pot without nutrient amendment for comparison).

The experiment was a 2 × 10 factorial arrangement laid out in a Completely Randomized Design replicated four times to give 80 treatment units.

2.4 Cultural Operations

The soils in pots were watered to field capacity to equilibrate before planting. Two seeds of each variety were sown per pot filled with 15 kg soil. At two weeks after sowing, thinning and supplying were done to achieve one plant per pot. Nutrient types were applied at three weeks after sowing in a ring form. Watering was done twice in a day. Weeding was also done by hand pulling when necessary.

2.5 Data Collection

2.5.1 Growth parameters

Plant height: Plant height was measured with measuring tape starting from four weeks after planting and at four weekly intervals until 20 WAP.

Number of leaves: Visual counting of fully opened leaves of each plant was done starting from 4 WAP and at four weekly intervals until 20 WAP.

Stem girth: The stem diameter was measured at 2 cm above soil level using vernier caliper. The stem girth was computed by multiplying the stem diameter by π as shown below;

$$\text{Stem girth} = \pi d$$

Where d= stem diameter

2.6 Yield Parameters

Number of capsules per plant: The number of capsules were counted.

Number of seeds per plant: The number of seeds were counted after breaking the capsules and removing the seeds

Weight of the seed per plant: The seeds harvested from each plant were weighed using sensitive scale.

2.7 Data Analysis

The data collected were subjected to analysis of variance (ANOVA) using SAS statistical software [12]. Differences among treatment means were compared using least significant difference at 5% probability level.

3. RESULTS

3.1 Pre-sowing Soil Properties

The soil was acidic with a pH value of 5.96. It was low in nitrogen, phosphorus, extractable calcium, magnesium, sodium, organic carbon and effective cation exchange capacity. The textural class was loamy sand (Table 1).

3.2 Effect of Nutrients Omission on the Plant Height of Two Varieties of Castor Plant

The varieties differed significantly in plant height except at 4 and 8 weeks after planting (WAP) (Table 2). At 12, 16 and 20 WAP, Indian brown had taller plants (61.6, 71.0 and 79.9 cm respectively) than Brazilian white (44.8, 57.6, and 62.0 cm respectively). The nutrient treatments had no significant effect on the height of castor plant throughout the sampling period except at 20 WAP when the full nutrient had the tallest plant (75.5 cm) which was not significantly different from other treatments except for the omission of potassium (66.3 cm), zinc (64.7 cm), molybdenum (66.2 cm) and boron (67.9 cm) (Table 3).

3.3 Effect of Nutrients Omission on Stem Girth of Two Varieties of Castor Plant

Brazilian white had significantly thicker stem girth than Indian brown variety at all the growth stages (Table 4). The nutrient treatments had significant effect on the stem girth throughout the sampling periods (Table 4.3). At 4 WAP, full nutrient had the thickest stem girth (15.7 mm) which was not significantly different from other treatments except for the omission of iron which had the thinnest stem girth (12.3 mm). However at 8 WAP, the omission of boron had stem girth that was thicker (39.4 mm) than that of the omission of nitrogen (24.8 mm), phosphorus (28.2 mm) and control (22.5 mm) which had the thinnest stem girth (Table 5).

At 12 WAP, the omission of Boron produced stem girth thicker (53.5 mm) than the omission of nitrogen, phosphorus, iron, zinc and control which had thinnest stem girth. At 16 WAP, full nutrient produced thickest stem girth (57.1 mm)

Table 1. Pre-planting physical and chemical properties of the soil used for the experiment

Parameter	Value
pH (1:2) H_2O	5.96
Organic Carbon (%)	0.94
Total Nitrogen (%)	0.11
Available Phosphorus (mg / kg)	6.86
Extractable Calcium (cmol / kg)	2.76
Extractable Magnesium (cmol / kg)	0.73
Extractable Potassium (cmol / kg)	0.30
Extractable Sodium (cmol / kg)	0.44
Extractable Aluminium (cmol / kg)	0.00
Exchangeable Acidity (cmol / kg)	0.80
ECEC (meq / 100g) Zn (ppm) 1.25	5.02
Boron (ppm)	0.772
Particle size distribution	
Sand (%)	85.80
Silt (%)	7.40
Clay (%)	6.80
Textural class	Loamy sand

Table 2. Plant height (cm) of two castor plant varieties averaged across fertilizer types

	Time of sampling (Weeks after sowing)				
Varieties	4	8	12	16	20
IB	8.9	17.6	61.1	71.0	79.9
BW	9.2	15.3	44.8	57.6	62.0
LSD	1.5	3.2	5.2	5.2	6.7

BW = Brazilian white, IB = Indian brown, LSD = Least Significant Difference

Table 3. Effect of fertilizer types on averaged heights of two varieties of castor plants

	Time of sampling (Weeks after sowing)				
Nutrients	**4**	**8**	**12**	**16**	**20**
Control	9.1	14.5	52.0	68.8	75.5
FN	9.9	17.5	54.9	65.9	78.4
FN-N	9.7	14.5	50.8	65.2	70.9
FN-P	8.9	15.5	53.6	66.8	75.1
FN-K	10.8	17.2	53.4	61.7	66.3
FN-Fe	7.7	15.2	56.4	69.4	73.3
FN-Zn	8.6	18.5	53.6	58.4	64.7
FN-Mo	9.6	18.0	53.2	63.0	66.2
FN-Cu	9.0	16.6	51.5	61.2	71.1
FN-B	7.3	16.8	50.0	62.4	67.9
LSD	3.4	ns	ns	ns	9.4

FN = {120 kg N, 50 kg P, 60 kg K, 10 kg Mo, 5 kg Zn, 2.5 kg Cu, 3 kg Fe and 5 kg Bo all in kg/ha } LSD = Least Significant Difference, ns = Not significant

Table 4. Stem girth of two varieties of castor plants averaged across fertilizer types

	Time of sampling (Weeks after sowing)				
Varieties	**4**	**8**	**12**	**16**	**20**
Indian brown	12.8	32.4	47.4	49.6	50.2
Brazilian white	14.6	33.7	49.5	55.1	56.3
$LSD_{(0.05)}$	1.5	2.1	1.7	2	2.2

Table 5. Effect of fertilizer types on averaged stem girth of two varieties of castor plants

	Time of sampling (Weeks after sowing)				
Nutrients	**4**	**8**	**12**	**16**	**20**
Control	12.6	22.5	38.2	45.6	46.9
FN	15.7	37.7	53.4	57.1	60.0
FN-N	13.5	24.8	42.0	47.9	48.6
FN-P	13.3	28.2	47.1	50.8	47.5
FN-K	14.5	36.6	52.8	54.8	55.0
FN-Fe	12.3	32.1	47.8	53.4	53.7
FN-Zn	13.8	36.2	49.0	52.0	55.2
FN-Mo	14.2	37.1	50.1	51.0	53.5
FN-Cu	13.9	36.0	50.6	53.9	54.5
FN-B	13.1	39.4	53.5	56.9	57.8
LSD	3.3	4.7	3.9	4.5	3.3

FN = {120 kg N, 50 kg P, 60 kg K, 10 kg Mo, 5 kg Zn, 2.5 kg Cu, 3 kg Fe and 5 kg Bo all in kg/ha } LSD = Least Significant Difference

while the omission of nitrogen and control led to the thinnest stem girth (47.9 mm and 45.6 mm). Similarly at 20 WAP, full nutrient and boron had the thickest stem girth (60.0 mm) which was significantly different from other treatments (Table 5).

3.4 Effect of Nutrients Omission on the Number of Leaves of Castor Plant

The castor varieties differed significantly in the number of leaves they produced at all growth stages except at 4 WAP (Table 6). At 8, 12, 16, and 20 WAP, Indian brown had more average number of leaves (6.5, 7.7, 7.7 and 9 respectively) than Brazilian white (5.3, 5.9,6.1 and 5.8). Similarly, the nutrient treatments had significant effect on the number of leaves at all growth stages (Table 7). At 4 WAP, the omission of nitrogen, iron, zinc and the control had lower number of leaves. At 16 WAP, the omission of boron produced significantly higher number of leaves (8.9) than other nutrient types. While at 20 WAP, the omission of molybdenum and boron had significantly highest number of leaves (10.1 and 8.4) which were significantly different from other treatments while the omission of copper and nitrogen had the least number of leaves (6.0 and 6.1).

3.5 Effect of Nutrients Omission on the Number of Capsules of Two Varieties of Castor Plant

Indian brown variety significantly had higher number of capsule (36.3) than Brazilian white (9.0) (Fig. 1). Highest number of capsule per plant was obtained from the omission of zinc (29.8) followed by the omission of molybdenum (29.3) and potassium (28.5). Least number of capsules was observed in the absence of nitrogen and boron (16.8 and 13.8, respectively).

3.6 Effect of Nutrients Omission on the Number of Seeds of Two Varieties of Castor Plant

Indian brown variety had significantly higher mean number of seeds (90.2) than Brazilian white (26.2) (Fig. 2). Highest number of seed was observed with the omission of zinc (76.9) followed by the omission of potassium (73.5) and molybdenum (71.8). Least number of seed was observed in the absence of boron, nitrogen and control (31.8 and 43.6, 46.6 respectively).

3.7 Effect of Nutrients Omission on the Seed Weight of Two Varieties of Castor Plant

Indian brown variety had significantly higher seed weight (16.9 g/plant) than Brazilian white (12.5 g/plant) (Fig. 3). The omission of potassium influenced the highest seed weight (20.3 g/plant) while the omission of boron, nitrogen and phosphorus had lower seed weights (11.3, 12.5 and 13.0 g/plant respectively).

4. DISCUSSION

The result from the soil analysis showed that the soil was acidic (5.96), low in organic carbon (0.94%), macronutrients and micronutrients except potassium. This justifies the need for the application of external nutrients. The critical levels of nutrients in Nigeria soils reported by Esu [13] were N (0.2 g/ kg), P (20.0 mg/kg), K (0.3 cmol /kg), Zn (1.0 mg/kg), Cu (1.0 mg/kg), Fe (3.5 mg/kg), B (0.5 mg/kg), Mo (3.0 mg/kg).

Table 6. Number of leaves of two varieties of castor plants averaged across fertilizer types

	Time of sampling (Weeks after sowing)				
Varieties	**4**	**8**	**12**	**16**	**20**
Indian brown	3.6	6.5	7.7	7.7	9.0
Brazilian white	3.4	5.3	5.9	6.1	5.8
$LSD_{(0.05)}$	ns	0.3	0.6	1.0	1.2

ns = Not significant

Table 7. Effect of fertilizer types on averaged number of leaves of two varieties of castor plants

	Time of sampling (Weeks after sowing)				
Nutrients	**4**	**8**	**12**	**16**	**20**
Control	2.9	5.5	6.1	5.1	7.1
FN	4.0	6.0	7.0	7.3	7.3
FN-N	3.4	4.9	6.0	6.9	6.0
FN-P	3.5	5.6	6.6	6.6	7.6
FN-K	4.0	6.1	7.3	7.3	6.4
FN-Fe	3.4	5.9	7.3	7.9	8.4
FN-Zn	2.9	6.1	6	5.9	6.5
FN-Mo	3.8	6.3	6.5	7.1	10.1
FN-Cu	3.6	6.1	6.8	6.1	6.1
FN-B	3.5	6.3	8.0	8.9	8.3
LSD	0.5	0.8	1.4	2.3	1.7

kg N, 50 kg P, 60 kg K, 10 kg Mo, 5 kg Zn, 2.5 kg Cu, 3 kg Fe and 5 kg Bo all in kg/ha } LSD = Least Significant Difference, ns = Not significant

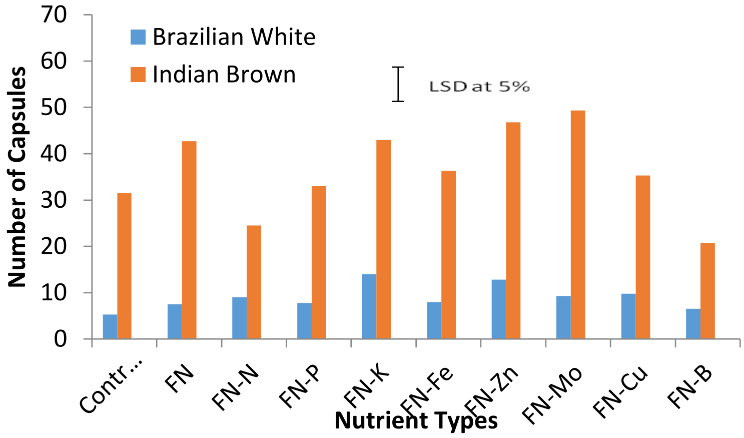

Fig. 1. Effect of nutrients omission on the number of capsules of two varieties of castor plant
FN = {120 kg N, 50 kg P, 60 kg K, 10 kg Mo, 5 kg Zn, 2.5 kg Cu, 3 kg Fe and 5 kg Bo in kg/ha}

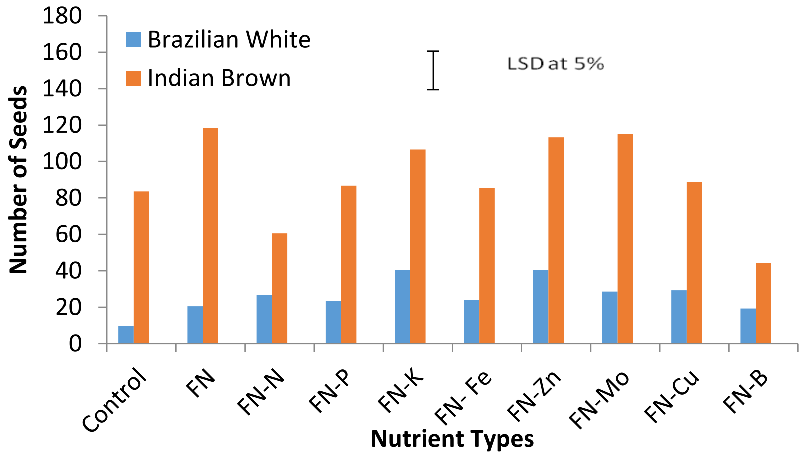

Fig. 2. Effect of nutrients omission on number of seeds of two varieties of castor plant
FN = {120 kg N, 50 kg P, 60 kg K, 10 kg Mo, 5 kg Zn, 2.5 kg Cu, 3 kg Fe and 5 kg Bo in kg/ha}

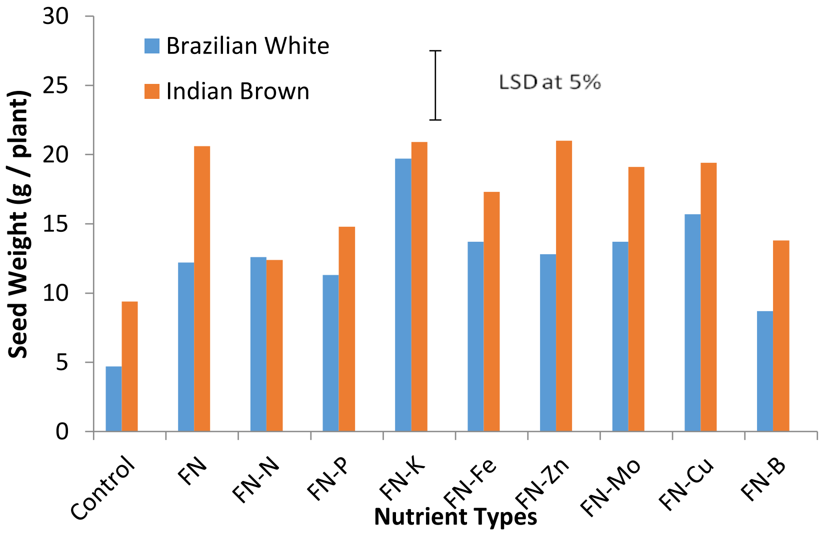

Fig. 3. Effect of nutrients omission on seed weight of two varieties of castor plant
FN = {120 kg N, 50 kg P, 60 kg K, 10 kg Mo, 5 kg Zn, 2.5 kg Cu, 3 kg Fe and 5 kg Bo in kg/ha}

The observed significant differences in the number of leaves, plant height and stem diameter of the castor varieties evaluated can be attributed to the intrinsic genetic make-up of each castor variety. This agrees with the findings of Sajjan [14], who reported that growth characters of crops varied because of differences in their genetic make-up. It also agrees with the report of Ikechukwu et al. [15] who observed significant variation among castor hybrids/varieties with respect to plant height. Similarly, Fredson et al. [16] reported plant height differences in local castor bean varieties. Enujeke [17], reported that differences observed in the number of leaves may be attributed to differences in growth characters which are influenced by genetic make-up of the plant. He also reported that the superiority of one variety over other varieties with respect to stem girth may be attributed to the special qualities credited to the variety including disease resistance, early maturity among others.

The nutrient treatments significantly influenced the growth and yield parameters of the castor plant varieties. The omission of nitrogen reduced the number of leaves. Similar results were also observed by Shehu [18] who reviewed the effect of N on the physical and morphological characters of plants. In this respect, Rallos et al. [19] and Jianbo et al. [20], found that nitrogen fertilizer application, significantly increased the number of leaves and suggested that the increase in number of leaves may be as a result of increase in number of nodes. However the omission of boron, potassium and iron produced the highest number of leaves which may be as a result of adequate amount of these nutrients in the soil. In contrast, application of potassium reduced the number of leaves while its omission resulted in increased number of leaves. This may be probably due to nutrient imbalance. Iqbal et al. [21] reported that, excess or deficient K in the growing medium hampers the overall growth of the plant, thus, managing K fertilizer is advantageous for improving plant growth. Furthermore, Durgesh et al. [22] also reported that Fe limit plant growth when they are present both in low concentrations and in excessive concentrations due to deficiency and toxicity respectively. Omission of the nutrient elements had no observed differences in the height of the castor varieties, indicating that the height differences observed was exclusively due to the genetic composition of the varieties rather than the nutrients applied.

The differences observed in the number of capsules, number of seeds and seed weight as influenced by variety suggests that the evaluated castor varieties expressed differential performance. According to the comments of Elsevier [23], variety has highly significant differences on all traits in castor bean plant. The number of capsules is a major component in seed yield, and if this trait increases, the number of seeds per plant increases too [24]. A major contributing trait to yield in castor is the number of capsules per plant [25]. In this study, the omission of nitrogen and boron led to reduction in the number of capsules. Jamil et al. [26] observed that increase in nitrogen level increased the number of capsules per cluster. Furthermore, Yousaf et al. [27] reported positive and highly significant correlation between number of capsules per plant and total seed yield of castor. It is also in line with the findings of Chatzakis et al. [28] as well as Pashazadeh and Basalma [29] who observed that increase in nitrogen and phosphorus resulted to an increase in number of capsules per plant. In contrast, the omission of zinc increased the number of capsules of castor. Halima [30] noted that castor plants grown in control soil not spiked with zinc produced significantly higher mean values for height and root length compared with those spiked with different concentrations of zinc. Uptake of excess Zn could be toxic to plants which may cause growth retardation and reduced yield among others [31]. On the other hand, the reduction in the number of capsules with the application of potassium may be due to nutrient imbalance. Franklin et al. [32] emphasized that an efficient fertilizer application program is required to generate high seed yields, which could allow determining the response curve in relation to the combination of N, P and K, for their adequate supply, in order to reduce the production costs.

The nutrient treatments had positive significant effect on the number of seed irrespective of the variety. The omission of nitrogen and boron reduced the number of seeds and this could have been as a result of the roles played by nitrogen and boron in increasing the growth and yield components of plant. This observation was similar to the report of Malik et al. [33]. Muhammad et al. [34] reported that increase in growth characters and yield components with the increase in nitrogen might be due to the role of nitrogen in stimulating development of vegetative parts of plant. It was observed that growth and yield parameters of castor bean were increased with increasing levels of nitrogen fertilizers and the maximum was at 120 kg N ha^{-1} [35]. Taylor et al*.* [36] and Zakaria [37] also reported that the highest seed yield was recorded in the treatment supplied with 120 kg N / ha for castor plant. The study by Zakaria [37] also observed a significant improvement in seed yield in tune with an increase in the nitrogen levels from 0 to 60 to 120 kg Nha^{-1}. The adequate availability of N as per the castor crop needs, might have contributed to better growth and yield attributing characters which eventually resulted in higher seed yield at a higher level of N [38]. However, the omission of potassium increased the number of seeds of castor. The high seed yield observed with the omission of potassium could be attributed to the adequate concentration of potassium (0.30 cmol/kg) in the soil. The results obtained for seed weight as influenced by the nutrient treatment, indicated that the nutrient had significant effect on the seed weight. The significantly higher seed weight was observed with the omission of potassium compared with the other nutrients because the amount of potassium (0.30 cmol/kg) present in the soil was sufficient to meet the needs of castor plant [13]. Bado and Bationo, [39] reported that imbalanced nutrient supply affects plant nutrient uptake and utilization, thus reducing crop yield. The omission of nitrogen, boron and phosphorus reduced the seed weight irrespective of the plant variety as previously noted by Malik et al*.* [33] and Hadvani et al*.* [40]. This could be as a result of inadequate availability of nitrogen for plant growth and grain yield. This also supported the findings of Blumenthal et al*.* [41] who reported stunted growth due to the non-functioning of chloroplasts following no or inadequate supply of nitrogen. Increase in seed yield due to addition of nitrogen, phosphorus and potassium was also reported by Malik et al*.* [33] and Pacheco et al*.* [42] in castor. Raja and Satyasai [43] also reported that nitrogen application is more important than the other major essential fertilizers/nutrient for successful crop production. Pacheco et al*.* [42] reported that the application of P increased castor seed yield in a soil with high levels of K and organic matter. The seed yield of castor has been reported to increase with the application of boron [44,45].

5. CONCLUSION

The results showed that Indian brown outperformed Brazilian white in almost all the growth and yield parameters. The omission of nitrogen and phosphorus had negative effect on growth parameters of castor plant. The omission of nitrogen, phosphorus and boron had negative effect on both growth and yield parameters. The omission of potassium, zinc and copper had no significant effect on growth and yield parameters of both varieties. Therefore, IB should be the choice variety over BW while nitrogen, phosphorus and boron are critical nutrient elements for its improved performance in the study area.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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