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Evaluation of Agronomic and Physiological Characteristics of Ten Castor Bean Plant Accessions in Ogbomoso, Nigeria

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Abstract
In spite of numerous industrial benefit of castor plant (*Ricinus communis* L.), its production is hindered due to lack of adequate agronomic practices. Field experiments were conducted at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria during 2014 and 2015 cropping seasons to evaluate the performance of ten accessions of castor plant. The treatments consisted of nine improved accessions of castor plant and a local variety. In each year, the 10 treatments were laid out in completely randomize block design and replicated three times. Data were collected on growth, seed yield and yield attributes parameters. Data collected in 2014 and 2015 were pooled and subjected to analysis of variance while means were separated using Least Significant Difference at 5% probability level. Growth, yield and yield attributes parameters of castor plant accessions were significantly influenced ($p \leq 0.05$). NCRICAS041 produced the tallest plant (190.0 cm) at harvest which was significantly taller than others. The highest mean number of capsules per raceme (150.33) produced by NCRICAS056 was significantly higher than others. NCRICAS056 produced the highest seed yield (1,919 kg/ha) while NCRICAS057 gave the least (1,047 kg/ha). The results of accessions seed yield attributes did not followed any specific other. In conclusion, variability among the accessions in growth and seed yield were apparent. Accessions NCRICAS041 and NCRICAS056 performed better than the locally sourced CASGPMAN. They are therefore recommended for the study area.
Keywords: Castor, Accessions, Growth parameter, Seed, Seed attributes,
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INTRODUCTION

Castor plant, (*Ricinus communis* L.) is widespread throughout the tropical regions. It is a crop grown for the production of oil by industries (Uvah, 1991). In Nigeria, castor plant is present as a wild plant and has different name according to the area where it is found. It is called 'Lara' by the Yoruba, 'Zurma' by the Hausa and 'Kwolakwola' by the Kanuris while the Igbos refers to it as Ogilisi (Oluwole, et al., 2016). Castor plant is cultivated in many countries among which is India, China, Brazil, and Madagascar mainly for industrial purposes (Tchuenteu *et al*., 2013). In 2008 Sujatha et al, reported that there is a steady increase in demand for castor oil in the world market which brings about the opportunity to improve and increase castor production. In this respect, Reddy and Matcha (2010) suggested that castor can become a cash crop in modern agriculture. Castor seeds varied in size, colour, oil and ricinus content; it could be white big, black big, grey medium and grey small with a range of 40 to 60% oil (Olaoye, 2000). The oil is colorless to very pale yellow liquid with mild or no odor or taste (Msaakpa and Obasi, 2014). Among vegetable oils, castor oil is distinguished by its higher content of ricinoleic acid than any other vegetable oil (Chakrabarti and Rafiq, 2008), and very low solidification point which makes it a useful raw material for industries. Castor oil is traditionally used as medicinal ointment (Olaniyan 2010), has many industrial uses which includes manufacturing of lubricants, hydraulic and brake fluids, paints, dyes, coating, inks, cold resistant, plastics, varnishes, lacquers, oil clothes, linoleum grease, waxes, polishes, nylon, pharmaceuticals and perfumes (Olaoye and Busari 2017). The oil has so many advantages over petroleum base oils, especially at high and low temperatures due to its high boiling and low melting points. Castor oil can also be used for reducing greenhouse gases as the oil produces relatively high crop yield with relatively low input **(**Demirbas, 2007)**.**

Performance of Castor plants, like any other crop could vary with many factors including genotype, environment, cultural and harvesting practices (Akande *et al*., 2012; Adebayo *et al*., 2013). Also, high temperatures above 35°C and water stress during the flowering and oil formation can reduce the seed oil content (Yusuf *et al*., 2015). Many studies have been initiated in this direction to introduce and study the adaptability of castor bean in different agro ecological zones (Tchuenteu *et al*., 2013). Castor plant has been demonstrated to grow well in little shade on soil rich in organic manure, well drained and possessing neutral pH (Weiss, 2000). In Nigeria there is little information about its agronomic practices despite the fact that the plant abound almost everywhere in the wild. With the view to exploring the possibility of castor oil as an alternative cash crop in Nigeria, there is the need to ascertain the growth attribute of the available accessions in the southern guinea savannah regions, where in Nigeria seems to be a favorable agricultural zone for castor production. However, there is scarcity of information on the performance of the crop under this climate, hence, the present research therefore focus on the evaluation of agronomic and physiological characteristics of ten castor plant accessions in Ogbomoso, Oyo State, Nigeria.

MATERIALS AND METHODS

The studies were conducted during July and December in 2015 and repeated at the same period in 2016 at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso. Nigeria. Ogbomoso lies on latitude $8^{o}10^{1}$ N and longitude $4^{o}10^{1}$ E with elevation of 390 m above sea level. The area had a bimodal rainfall pattern between April to July and September to November. The mean daily maximum and minimum temperatures were about 33 and 20^{o}C respectively. Mixed cropping is the major cropping pattern in the area. Prominent weed species on the site includes *Euphorbia heterophylla, Amaranthus spinosis, Commelina sp, Imperata cylindrica* and *Tithonia diversifolia.* The soil of this experimental site is classified as Olorunda series (Smyth and Montgomery, 1962) which was derived from fine-grained gnesis. The soil is moderately drained, ferruginous with sandy loam texture. The treatment is the 10 accessions of castor plant. Five of which are NCRI lines (NCR1CAS007, NCR1CAS041, NCR1CAS056, NCR1CAS057, NCR1CAS081) developed by National Cereals Research Institute (NCRI), Badegi, Niger State, Nigeria, four are IAR lines (IARCAS001, IARCAS011, IARCAS021, IARCAS023) obtained from Institute of Agricultural Research (IAR), Zaria Nigeria while the tenth accession, CASGPMAN was a local accession obtained from local market at Iluju, Orire Local Government area, Ogbomoso. The local one was used as a check while other accessions are for adaptability trial across different Agro-ecological zones in Nigeria. Each treatment plot measured 10.5 by 4.5 m, planted at 1.5 by 1.5 m, giving a plant population of 4,444 per hectare. Each treatment plot has three replicates giving a total of 30 treatment plots. Planting was done after land preparation by placing three seeds per hole; this was thinned to one plant per hole together with supplying at 2 weeks after planting. NPK 20:10:10 fertilizer was basally applied at the rate of 600 kg/ha at one month after planting. This is equivalent to 120, 60, and 60 kg N, P_2O_5 K_2O respectively. However, weed and pest were controlled using pre emergence herbicide, Atrazine at the rate of 2.5 kg per hectare, by mixing 200 g in 15 litre capacity sprayer after which two supplemental manual hoeing were carried out while insect pests were controlled by spraying Cypermetrin at the rate of 40 ml/20 liter water monthly and was done three times. Data were collected on growth, reproductive, seed and seed yield parameters. Five plants were tagged per plot. The tagged plants were assessed and their means were recorded for the following parameters: stem height at maturity, number of branches per plant, number of nodes per plant, number of racemes per branch, number of capsules per raceme, mean raceme weight, number of seeds per raceme, seed shelling percentage, weight of seed per raceme, 100 seeds weight (g) and seed yield (kg/ha). Data collected were analysed using analysis of variance while means were separated with Least Significant Difference at 5% probability level.

RESULTS

All the parameters were significantly influenced ($p \leq 0.05$) by the accession type. The highest height at harvest (190.00 cm) produced by NCRICAS041 was significantly taller than other accessions while the shortest height (73.67 cm) obtained from NCRICAS057 was also significantly shorter than other accessions (Table 1). Mean number of branches was also significantly influenced by accession type. The highest mean number of branches per plant which was significantly higher than others was produced by NCRICAS041 (8.67), while the least, (2.33) produced by NCRICAS057 was not statistically different compared with 2.67 produced by each of NCRICAS007 and IARCAS021 respectively (Table 1). In respect of number of nodes per plant, IARCAS011 produced the highest (14.67) which was significantly different compared with 12.67 produced by each of IARCAS 001 and IARCAS021 respectively. In the case of reproductive parameters, all the measured parameters were also significantly influenced by accession type (Table 2). IARCAS011 and local accession (CASGPMAN) produced the highest mean number of racemes per branch (6.33) which was significantly higher than 4.33 mean value produced by NCRICAS041, IARCAS021 and IARCAS023 (Table 2). NCRICAS057 produced the least number of racemes per plant.

Furthermore, NCRICAS accessions produced more capsules per raceme compared with IARCAS and the local accession. NCRICAS056 produced the highest (150.33) which was significantly higher than number of capsules by others while the least, 30.00 produced by IARCAS001 was statistically similar compared with 33.00 harvested from IARCAS023. The highest mean raceme weight (113.33 g) harvested from IARCAS001 was followed by NCRICAS056 (102.00 g), while least, 29.00 g was produced by NCRICAS057. IARCAS011 and NCRICAS007 had similar mean raceme weight (41.01 and 39.00 g respectively). Seed production of tried accessions was presented in Figure 1. NCRICAS056 produced 1,919 kg seed per hectare which was significantly higher than produce from others. The seed production did not follow any specific order within the source (NCRI and IAR). Least seed produce was obtained from NCRICAS057 (1,047 kg/ha) which was significantly lesser than 1,130 and 1,184 kg/ha produced by IARCAS023 and NCRICAS007 respectively. Seed yield attributes are presented in Table 3. NCRICAS056 produced the highest number of seeds per raceme (453) which was significantly higher than others while IARCAS023 produced the least (81.33). The shelling percentage did not follow any specific order within the source, 91.67 shelling percentage was obtained in respect of NCRICAS041 which was not significantly higher than 90.33% obtained from NCRICAS056 while the least (76.33%) was recorded from IARCAS023. The accessions have similar response in respect of weight of seeds per raceme and

100 seed weight. IARCAS001 has highest value in respect of the two; it however produced less number of seeds per raceme (Table 3).

DISCUSSION

Enormous variability was observed in castor accessions tested for agronomic attributes. Generally, the NCRICAS accessions where taller than IARCAS. The local accession CASGPMAN is of medium height. The growth response exhibited by the accessions could be attributed to favorable environmental conditions as reported by Udoh and Abu (2016). They however noted that the perennial growth habit and height attained by castor plants limit mechanical harvest because the plant grows very tall when the environmental conditions are desirable. In the report of Udoh *et al.* (2016), the performance of castor plant was attributed to ability to compete better for resources. In respect of seed yield and its attributes, there was significant variation among the accessions tried. Generally, the NCRICAS lines produced more seeds compared with IARCAS ones. However, despite the fact that the IARCAS lines produced less number of seeds per raceme, their seed weights were comparably higher. High variation in seed weight may likely be attributed to presence of immature seeds, damaged or unfilled seed as reported by Adu-Kwarteng *et al*., (2003). However, all the factors so noted were avoided in this trial. The shelling percentages also did not follow any specific order; some of the NCRICAS lines had higher percentages compared with IARCAS lines. Reports of higher seed weight from hybrids of castor plants (Wang *et al*., (2010); Goytia-Jiménez *et al.,* (2011) and Acosta-Navarrete *et al*., (2017)) agreed with the observations that IARCAS and NCRICAS lines produced better 100 seeds weight compared with the local accession.

CONCLUSION

It is evident that the ten accessions tested exhibited good variability to the tested traits. However, NCRICAS056 that produced significantly higher seed yield was therefore recommended for the trial location Guinea Savanna zone of south west, Nigeria for economic returns.

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Table1: Effect of accession type on growth parameters of castor plant in Ogbomoso

Accession	Height at harvest (cm)	Number of branches/plant	Number of nodes/plant
NCRICAS007	120.00f	2.67d	10.00c
NCRICAS041	190.00a	8.67a	6.67d
NCRICAS056	171.33b	5.67b	12.33b
NCRICAS057	73.67h	2.33d	6.33d
NCRICAS081	140.33d	4.33c	10.33c
IARCAS001	170.00b	4.67bc	12.67b
IARCAS011	150.33c	5.33bc	14.67a
IARCAS021	111.33g	2.67d	12.67b
IARCAS023	105.00g	4.46bc	8.67c
CASGPMAN	131.33e	4.33c	9.33c

Mean along the column with the same letter(s) are not significantly different (LSD0.05)

Table 2: Effects of accession type on reproductive parameters of castor plant in Ogbomoso

Accession	Number of racemes/branch	Number of capsules/raceme	Mean raceme weight (g)
NCRICAS007	2.67c	61.00ef	39.00h
NCRICAS041	4.33b	130.00b	50.00f
NCRICAS056	2.00cd	150.33a	102.00b
NCRICAS057	1.67d	93.00c	29.00i
NCRICAS081	4.00b	66.33e	89.33d
IARCAS001	3.67b	30.00g	113.33a
IARCAS011	6.33a	59.33f	41.01h
IARCAS021	4.33b	76.33d	97.00c
IARCAS023	4.33b	33.00g	46.00g
CASGPMAN	6.33a	59.33f	69.00e

Mean along the column with the same letter(s) are not significantly different (LSD 0.05)

Table 3: Effect of accession type on seed yield and yield parameters of castor plant in Ogbomoso

Accession	Number of seeds/raceme	Shelling (%)	Weight of seed/raceme (g)	100 seeds weight (g)
NCRICAS007	186.00d	82.00e	29.33i	18.67g
NCRICAS041	237.33b	91.67a	42.00f	18.53g
NCRICAS056	453.00a	90.33ab	82.00b	19.00g
NCRICAS057	235.00c	82.67de	21.00j	10.33h
NCRICAS081	131.00h	82.00e	66.67d	48.33b
IARCAS001	85.67i	85.33c	91.00a	87.00a
IARCAS011	145.33g	89.00b	35.00g	23.33f
IARCAS021	180.00e	84.33cd	75.33c	43.00c
IARCAS023	81.33j	76.33g	32.00h	39.33d
CASGPMAN	151.67f	80.10f	48.00e	34.00e

Mean along the column with the same letter (s) are not significantly different

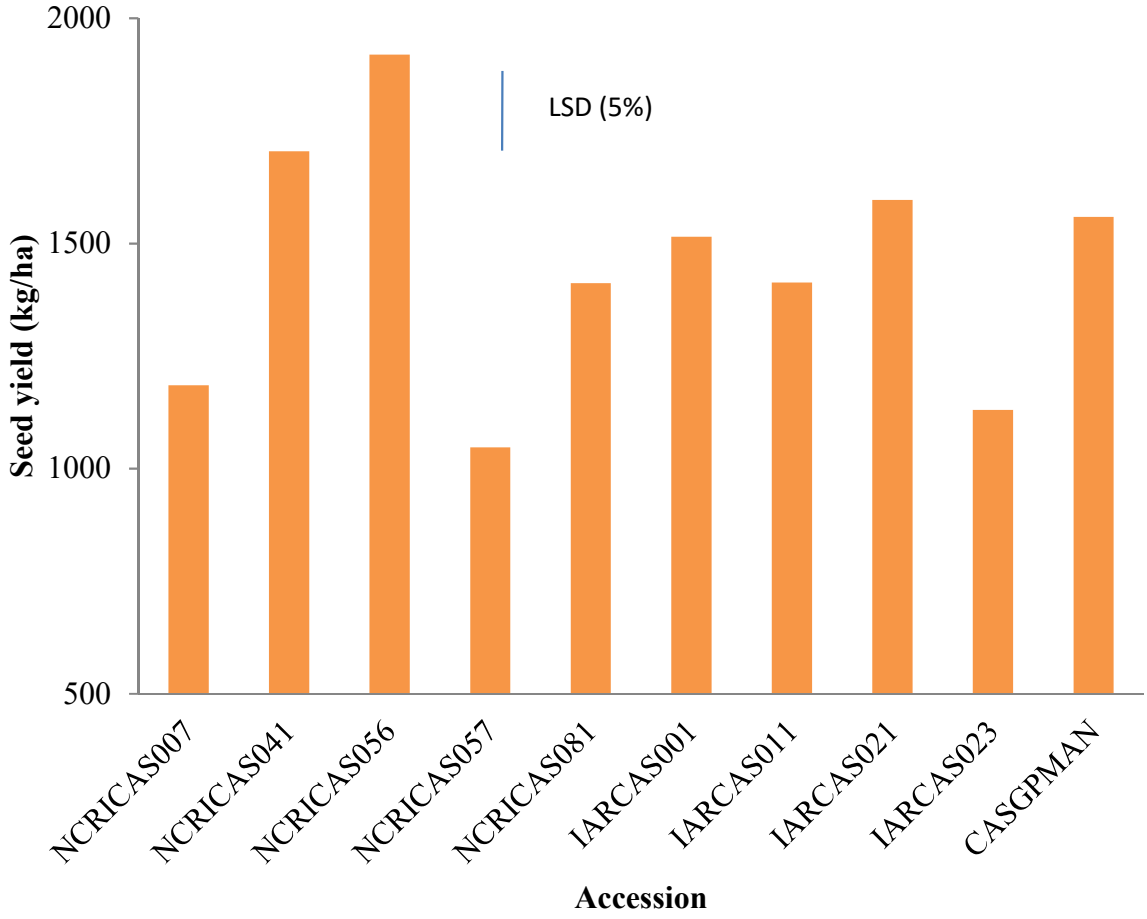

Figure 1: Effects of accession type on seed yield of castor plant in Ogbomoso
Note: The bar represents Least Significant Difference value at 5% probability