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EVALUATION OF GROWTH AND YIELD PERFORMANCE OF CASTOR HYBRIDS UNDER SOUTHERN DRY REGION IN SRI LANKA

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ABSTRACT

Castor oil is considered as a highly important industrial oil due to its unique chemical structure and properties. Although it is not yet commercially grown in Sri Lanka, there is a high potential of promoting castor cultivation in marginal lands. Due to growing interest among the private sector to initiate commercial scale cultivation, there is an immediate necessity to introduce promising castor varieties despite traditional varieties are presently grown. With this objective two castor hybrids, namely; Jiaxiang No.6 (JX-6) and Zibi No.5 (ZB5) were received from China and field evaluation was carried out at Grain Legumes and Oil Crops Research and Development Center, Angunakolapelessa (GLORDC) during 2021/22 Maha season. The experiment was layout in a Randomized Complete Block Design (RCBD) with four replicates, where a local cultivar was used as a check variety. The results revealed, plant height at flowering was not significantly different (P=0.05) among the tested genotypes. Since the local cultivar is having a perennial growth habit, significantly higher (P=0.05) branching was observed. The number of racemes per plant was significantly high (P=0.05) in the local cultivar, while average raceme length and number of fruits per raceme were significantly high (P=0.05) in both hybrids. Additionally, hybrids had higher 100 seed weight ranging from 20.82-23.1g. Hence, a significantly higher (P-0.05) seed yields has been revealed by the hybrid varieties Interestingly, both hybrids showed severe disease susceptibility specially for fusarium wilt, in which the local cultivar showed high degree of resistance. Considering the yield performance, only the hybrid of Jx-6 was selected as a promising hybrid to initiate commercial scale cultivations.

Keywords: Castor, Sri Lanka, Evaluation, Growth, Yield

INTRODUCTION

Castor (*Ricinus communis* L.) is a diploid (2n = 20) oil crop which belongs to family *Euphorbiaceae* that is found across tropical and semi tropical regions of the world. Globally, castor oil is considered as highly important in the chemical industry, since it is the only commercial source of a hydroxylated fatty acid (Severino et al, 2012). Castor oil is a non-drying oil with high viscosity, in which is not easily clogged even under a temperature as low as -56 C (Patel et al, 2016). Moreover, it is a pale-yellow liquid, which contains high amount of recinoleic acid. It is widely used as a starting material for many industrial chemical products because of its unique structure. Hence, it is used in many industries such as cosmetics, surface coatings, toiletries, pharmaceuticals, perfumes, soaps, lubricants, paints, medicines, etc.

Castor is widely grown on arid and semi- arid areas of the world, where India is the main castor producing country in the world. In Sri Lanka, there are several naturally grown perennial castor types. Traditionally, castor oil is used for medicinal purposes specially in ayurvedic medicine in Sri Lanka. Under the local climatic conditions, castor can be grown throughout the year. Since castor can tolerate in unfavorable environmental conditions such as drought, salinity and low soil fertility, there is a potential of promoting castor in such marginal lands in Sri Lanka.

The global castor oil market has reached a volume of 740.5 kt which is expected to be expanding. Currently, China is the main importer of Castor. During the last decade, the interest in castor cultivation has escalated due to the global demand of castor oil, where many countries are making serious efforts to commercialize the castor cultivation (Anjani K, 2014).

Castor reproduces predominately (80%) by cross pollination, in which the primary pollinating agent is the wind (Milani and Nobrega, 2013). Therefore, great variation in phenotypic expression is observed in wild populations of castor. Cultivar/variety development of castor is practiced through several breeding techniques such as mass selection, conventional sexual hybridization and selection, recurrent selection and hybrid development. The advantages of hybrids over cultivars have resulted growing areas predominately with hybrids.

Currently in Sri Lanka, there are no elite cultivars available since there were no efforts to cultivate castor in a commercial scale. Recently there is some interest among private sector to initiate castor cultivation as an industry. Hence, there is an immediate necessity of introducing exotic varieties/hybrids to the country. With this objective we have received two exotic hybrids from Republic of China for the testing of adaptability under local condition. The plant growth and yield performances of the hybrids were compared with a locally available cultivar in order to recommend hybrids for commercial cultivation in Sri Lanka.

METHODOLOGY

Experimental site

The Field trial was conducted at an isolated research field of Grain Legumes and Oil Crops Research and Development Center, Angunakolapelessa, Sri Lanka (GLORDC) which belongs to DL_{2b} agro-ecological zone during 2021/22 *Maha* (from October 2021 to March 2022) season.

Experimental materials

Seeds of two castor F1 hybrids namely Jiaxiang No:6 (JX-6) and Zibi No:5 (ZB-5) which developed in China were received from Pearlead International (Pvt) Ltd, Sri Lanka. A local cultivar was used as a control to compare the performance of two hybrids. These two hybrids were initially selected by considering the climatic factors in Sri Lanka. The local cultivar was the predominant cultivar available in the country which is phenotypically having reddish color stems.

Experimental design

Two imported hybrids (JX-6 and ZB-5) along with the local cultivar as the control were layout in a field experiment in a Randomized Complete Block design (RCBD) with four replicates with a plot size of 6 x 4.5 m. Each plot was prepared as raised beds in which 3-4 seeds were planted in each hole with a spacing of 90 cm between rows and 60 cm within row. Thinning out was carried out in two weeks after emergence keeping only one vigorous plant per hill.

General agronomic practices

Since there were no recommended agronomic package for castor in Sri Lanka, following agronomic practices were carried out considering the recommendation for the hybrid castor cultivation in China. Mainly, Basal fertilizer was added to the soil with a rate of Urea- 135 Kg/ha, Triple Super Phosphate (TSP)- 138.75 Kg/ha and Muriate of Potash (MOP)- 101.25 Kg/ha. Additional urea was applied in a rate of 150 Kg/ha, during the flowering stage. Additionally, manual weeding was done once each at growth stages such as seedling, flowering and harvesting. Supplementary irrigation was provided whenever required.

Collection of data

Total of five plants in each plot avoiding the border plants were tagged for data collection. The main growth and yield parameters were recorded (Table 01) partly considering the characterization of castor described in Da silva et al 2019. Moreover, the number of plants showed a fungal disease symptom of wilting (The exact disease was not formally identified) at first two harvesting periods were recorded.

Table 01: Description of evaluation methodology of plant growth and yield parameters

Descriptor	Evaluation
Plant height at flowering	Measurement from the soil to the first point of the primary raceme
Stem diameter at flowering	The middle third of the stem, using a digital caliper
Number of branches/plant	Count the number of branches at 60 days after emergence
Number of racemes/plant	Count the number of racemes in each plant at 90 days after emergence
Average raceme length	Measure using a ruler in first three racemes of the plant and calculate the average.
Number of fruits/raceme	Count the number of fruits in first three racemes and calculate the average
Mean seed yield	Seed yield of plants in the middle plants of each plot up to 120 days after emergence was measured and converted to per hectare yield.
100 seed weight	Determine the weight of 100 random seeds at 9% moisture level.
Oil yield (%)	Extracted using Soxhlet method in a 1g of dry seed sample.

Data analysis

Rain fall data during the cropping period was obtained from the climatology unit of GLORDC in order to compare the initial growth of the tested genotypes. The growth and yield data were subjected to ANOVA using SAS statistical package version 9.1.3 and the least significance difference (LSD) was used to compare the means.

RESULTS AND DISCUSSION

Both hybrid varieties showed a rapid initial growth rate (seedling) in comparison to the local cultivar. Interestingly, both hybrids were not uniform, where several plant characters such as stem color, presence of stem wax were showed a variation in the population.

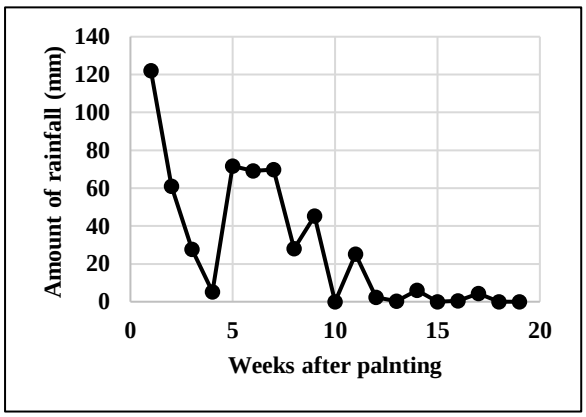

Figure 01: Weekly rainfall (mm) from date of planting (2021/10/22) to end of February 2022

Heavy rainfalls were observed during the initial stage of the crop, which may have affected the optimum crop growth. Due to these frequent rainfalls, water table in the experimental plots were above normal during that period (Figure 01).

Table 02: Variation in major plant growth parameters among the tested castor lines

Hybrid / Cultivar	Ph at fl. (cm)	Sd at fl. (mm)	NoB /plant (at 60 DAE)	NoD to first pick from seedling emergence
ZB-5	50.67a	19.75ab	2.72b	75
JX-6	56.30a	21.62a	3.16b	75
Local cultivar	46.12a	15.50b	9.30a	75
LSD	17.25	5.79	2.54	
CV %	19.5	17.6	29.1	

Within each column, the means followed by the same letters are not significantly different p = 0.05; Ph-Plant height; DAE-Days After Emergence; Sd–Stem diameter; NoB-No. of Branches; NoD-No. of days; fl-flowering

Plant height at the flowering stage were ranged between 46.12 cm to 56.30 cm (Table 02) among the three genotypes and were not significantly different (P=0.05). Stem diameter at flowering showed a significant variation, where two hybrids had higher stem diameter at flowering stage than the local cultivar. Interestingly, higher branching habit was observed in the local cultivar in comparison to the hybrids indicating determinate growth habit in the hybrids (Table 02).

According to the visual observations disease severity was increased with the water stress.

Variability of major yield parameters in the tested castor lines are listed in the table 03. Number of racemes per plant were significantly higher (P=0.05) in the local cultivar while the average raceme length and number of fruits per raceme was significantly higher in the two hybrids. Considering the mean seed yield, both hybrids have performed better than the local cultivar. The mean seed yield of two hybrids were in the range of 1487.3-1987.9 Kg/ha in 4 to 5 picks. Since the number of racemes per plant is high in the local cultivar, the frequency of harvesting is high. Further, local cultivar can be harvested for a long period of time. The ratooning ability of hybrids need to be studied in order to understand the performance for a long period of time.

Table 03: Variation in the major yield parameters

Hybrid / Cultivar	No: of raceme/ plant	Average raceme length (cm)	No: of fruits /raceme	Mean seed yield (Kg/ha)
ZB-5	2.7b	46.80b	61.85b	1487.3a
JX-6	3.9b	58.85a	78.47a	1987.9a
Local cultivar	9.4a	35.92c	31.02c	878.3b
LSD	1.50	9.58	7.98	571.24
CV %	16.29	11.73	8.08	17.36

Within each column, the means followed by the same letters are not significantly different p = 0.05.

According to the visual observations of the genotypes to the abiotic stresses, local cultivar has more ability than two hybrids to tolerate water stress.

Both hybrids showed larger seed size, in which the 100 seed weight were ranging 20.82 to 23.11 grams. In comparison, local cultivar had low 100 seed weight (Table 04). Considering the oil yield in the tested lines, the local cultivar showed the highest while the oil content of exotic lines had comparatively lower value (Table 03).

Table 04: 100 seed weight and oil yield of tested lines

Hybrid / cultivar	100 seed weight (g) ± SD	Oil yield (%) ± SD
ZB-5	20.82 ± 1.07	44.48 ± 3.35
JX-6	23.11 ± 0.76	53.43 ± 4.74
Local cultivar	8.19 ± 0.46	60.17 ± 4.68

SD- Standard deviation of mean (n=4).

Considering the response to biotic stresses, no severe pest damages were observed. During the vegetative stage several plants were attacked by leaf eating caterpillars and leaf minors, which were controlled by chemical applications.

Interestingly, during the harvesting stage hybrid plants showed wilting of plants, probably caused by soil borne fungal organism to the root system.

Table 05: Number of plants observed with disease symptoms at two harvesting stages

Hybrid/ cultivar	Mean value of wilted plants at first harvest (Total plants/plot-50, n=4)	Mean value of wilted plants at second harvest (Total plants/plot-50, n=4)
ZB-5	13.5	18.7
JX-6	7	11.2
Local cultivar	0	0

Both exotic hybrids were susceptible to the disease, although disease severity was high in variety ZB-5, in which JX-6 has shown some field tolerance. Interestingly, local cultivar was highly resistant to the disease (Table 05). Further studies need to be carried out in order to understand the causal organism of the disease.

CONCLUSIONS

Global Castor oil industry is on an expanding trend, in which a secure market would be the highest concern in planning a commercial cultivation in Sri Lanka. Although, there are abundant wild cultivars in the country, currently no distinct variety or cultivar has been identified. Therefore, it is important to identify promising cultivars/varieties in order to initial castor cultivation at commercial level.

The two exotic hybrids had superior performance in terms of the yield parameters such as average raceme length, number of fruits per raceme and seed weight. Therefore, both hybrids have given significantly high seed yield over the local cultivar. Interestingly, considering the disease incidences, local cultivar had shown superior characteristics. Since, commercial scale cultivation can be initiated with exotic hybrids as they have high yield potential, it is important to incorporate the beneficial characteristics of local cultivars in order to develop well adapted castor varieties in the future.

Both commercial hybrids have performed better than the local cultivar tested, in terms of the seed yield. Overall, exotic hybrid; Jiaxiang No:6 (JX-6) has performed well under field conditions. Further, disease severity was comparatively low in hybrid; Jx-6 and proper cultural practices can be very important in a commercial scale cultivation.

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