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Variability of physiological and yield parameters of castor genotypes under rainfed conditions

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Abstract

A field study was carried out with twenty castor genotypes in Regional Agricultural Research Station, Palem from *Kharif*, 2014 to 2016 to assess variability in physiological parameter like LAI, SCMR, stomatal resistance along with yield and yield related parameter *i.e.* days to fifty percent flowering, spikes per plant, Primary spike length, 100 seed weight and seed yield. The results from the three years pooled data *i.e.* 2014 to 2016 revealed that PCH-111 recorded highest yield followed by PCH-222. The underlying physiological parameters contributing to the highest yield and yield related parameter is SCMR, Lower stomatal conductance with optimum LAI needed to improve seed yield under rainfed condition. Hence, these parameters should be considered while the genotypes are selected for exploiting yield in rainfed conditions.

Keywords: Castor, genotypes, seed yield, SCMR and stomatal conductance

Introduction

Castor (*Ricinus communis* L.) belongs to Euphorbiaceae family which is found in both tropical and sub-tropical regions of the world (Weiss, 2000) [10]. Castor is indigenous to the southeastern Mediterranean Basin, Eastern Africa and India but is widespread throughout tropical regions. Castor seed is the source of castor oil, which has a wide variety of uses. Castor oil is one of the important raw materials for the chemical and polymer industries (Mutlu and Meier, 2010) [4] are used as biodiesel stock (Hall *et al.*, 2009; Da Silva Cesar and Batalha, 2010) [3, 1]. With its unlimited applications, castor oil has a tremendous worldwide demand and it accounts for 0.15% of vegetable oils (Scholz and da Silva, 2008) [7]. India and Brazil together accounts for more than 80% of the castor oil supply. In India, castor is cultivated in an area of 8.4 lakh ha under both irrigated and rainfed conditions. Castor has the potential for its use in bioenergy and industrial feed stock due to its high oil content and has the adaptability to grow under drought and saline conditions (Severino *et al.*, 2012) [8]. India is the first country in the world to exploit hybrid vigour of castor crop on commercial scale (Ramchandram and Rao, 2012) [5]. Castor is considered to be a drought hardy crop and grows well under dry and warm regions receiving a rainfall of 500-750 mm. It has a wide range of adaptation and has the ability to grow on marginal sites subjected to drought and saline conditions. To produce higher yields, it requires a moderate temperature of 20-26°C and low humidity (Gangaiah, 2008) [2]. High temperature above 41°C at flowering time even for a short period results in blasting of flowers and poor seed set. The *kharif* season crop essentially grown as rainfed crop, require a minimum of 500-700 mm rainfall depending on the soil type and higher yield can be obtained with 1-2 supplemental irrigations (Sharma *et al.*, 2010) [9]. In India, Telangana and Gujarat are well known for castor production and productivity. To develop high yielding castor genotypes that get fit into the present cropping system, it is important to create the genetic variability for the selection of desirable variant (Sarwar and Chaudhry, 2008) [6]. However, as major cropped area is under rainfed, the physiological efficiency of the genotypes especially water use efficiency has become pivotal. Under limited water supply, it maintains efficient stomatal control with a high level of net CO₂ fixation (Severino *et al.*, 2012) [8]. In order to identify the variability in the physiological parameters which are indicative of moisture stress tolerance and towards this endeavour twenty genotypes of castor were evaluated at field conditions along with the popular check to find out the best lines with better physiological efficiency coupled with higher seed yield. This identification of better lines would be helpful in the process of improving castor productivity and production under rainfed situation.

Materials and methods

A field experiment was conducted from year 2014 to 2016 *Kharif* with twenty castor genotypes *viz.* PCH111, Superabhay, Laxmi, Brahmos, NewgenesN08, Corona, Jaki,

NBCH22, Gauch-4, Gauch-1, Bhoomika-9, DSP-801, MRCA-09, Balwan, Kranti, Haritha, Kiran, PCS 262, Jwala and PCH-222 at Regional Agricultural Research, Palem, Nagarkurnool District. The crop was sown on July 1st for three consecutive years in Randomized Block Design with three replications and the crop was raised purely under rainfed conditions as sole crop. Each genotypes was sown in 6 meter length in three rows with spacing of 90X60 cm². All recommended management practice to raise healthy crop is practiced. At 50% flowering of primaries the physiological observation such as LAI, SCMR and stomatal conductance (g_s) are recorded. LAI is measured using leaf area meter (LICOR) and stomatal conductance was measured by LICOR steady state porometer. SCMR was measured by SPAD meter by taking readings of leaves present in top, middle and bottom of canopy all three strata readings as average is represented as SCMR for that plant. The plant height is recorded at 90 DAS by measuring base to top of the plant and yield and yield parameter are recorded at harvesting stage. The capsule of first (Primary), Second (secondaries) and third (tertiaries) order spikes were pooled and seed and yield components were recorded per plant basis.

Results and discussions

Plant height values (Table 1) ranged from 40cm to 107 cm in castor genotypes studied. Genotype balwan recorded lowest plant height (40cm), which was at par with NBCH22 (41.76cm). Castor genotypes showed significant variations for LAI. Leaf Area Index values ranged from 0.65cm² to 2.81

cm². Among the twenty castor genotypes, PCH-222 recorded highest LAI value (2.81 cm²), which was at par with PCH-111 (2.66 cm²). Value of SPAD chlorophyll meter readings ranged from 50.19 to 36.09. Among twenty castor genotypes studied only two genotypes balwan (36.09) and MRCA 409(36.42) recorded lowest SCMR values and rest of the genotypes showed almost higher and at par SCMR values. For the trait, stomatal resistance, genotype carona (1.44cm²s⁻¹) recorded lower stomatal resistance which was at with new genes no. 08 (1.45 cm²s⁻¹), Laxmi (1.46 cm²s⁻¹), Brahmos (1.51 cm²s⁻¹), Super abhay (1.56 cm²s⁻¹) and PCH-111(1.57 cm²s⁻¹). Lowest stomatal resistance is important for survival under water stress conditions. Value of days to 50% flowering ranged from 41.72 days to 51.73 days. Among the castor genotype studied bhoomika (41.72) taken lesser time to 50% flowering. For the character spikes per plant, PCH-111 (7.69) recorded significantly superior spike number per plant (Table 2) and the same genotype also recorded significant superior primary spike length (64.7cm). 100 seed weight values ranged from 24.10g to 33.41g in castor genotypes. Genotype DSP 801 recorded highest and significant 100 seed weight (33.41g) followed by laxmi (32.80g). whereas, lowest hundred seed weight was recorded in Gauch-1 (24.10g). Yield parameter showed lot of variation in genotypes studied. Among twenty genotypes studied, PCH-111 recorded highest seed yield (1613.56 kg/ha) which was significantly superior over other genotypes and at par with PCH-222 (1599.07 kg/ha) and PCS-262 (1578 kg/ha).

Table 1: Effect of rainfed conditions on the yield, yield attributes and physiological parameters of Castor genotypes over pooled (Kharif, 2014, Kharif, 2015, Kharif, 2016).

	Genotype	Plant height (cm)	LAI cm ²	SCMR	Stomatal resistance
1	PCH111	58.56	2.66	47.30	1.57
2	Super abhay	67.25	0.75	47.13	1.56
3	Laxmi	60.20	0.65	45.27	1.46
4	Brahmos	48.41	1.60	43.86	1.51
5	New genes no08	56.37	1.56	43.78	1.45
6	Carona	55.35	1.32	43.70	1.44
7	Jaki	48.48	2.17	48.89	1.73
8	NBCH22	41.76	2.17	48.81	1.71
9	Gauch4	54.70	1.82	48.98	1.75
10	Gauch1	60.07	2.21	50.19	1.68
11	Bhumika9	70.03	2.17	49.55	1.66
12	DSP801	45.65	2.13	48.00	1.66
13	MRCA409	53.78	0.97	36.42	1.88
14	Balwan	40.00	0.96	36.09	1.84
15	Kranthi	78.11	1.01	37.59	1.58
16	Haritha	88.87	1.56	45.23	1.87
17	Kiran	107.41	1.54	44.67	1.85
18	PCS262	100.78	1.45	42.90	1.87
19	Jwala	102.54	0.84	47.44	2.15
20	PCH222	104.00	2.81	47.27	2.12
	C.D at 5%	4.08	0.30	8.65	0.16
	SE(m)	1.46	0.11	3.01	0.06
	SE(d)	2.07	0.15	4.25	0.08
	C.V.	6.53	12.80	11.54	5.77

Table 2: Effect of rainfed conditions on the yield, yield attributes and physiological parameters of Castor genotypes over pooled (*Kharif*, 2014, *Kharif*, 2015, *Kharif*, 2016).

S. No.	Treatment	DFF	Spikes per plant	Primary spike length (cm)	100 seed weight (g)	Seed Yield (Kg/ha)
1	PCH111	43.89	7.69	64.70	29.22	1613.56
2	Super Abhay	45.33	5.14	56.30	29.33	1410.11
3	Laxmi	46.24	5.33	53.72	32.80	1597.26
4	Brahmos	45.37	5.55	57.11	28.67	1471.26
5	Newgenes NO08	47.33	5.41	46.70	30.56	1399.07
6	Carona	45.04	5.40	44.14	26.28	1445.00
7	Jaki	46.48	6.01	56.25	31.40	1585.41
8	NBCH22	46.48	6.04	63.01	26.67	1530.74
9	Gauch4	46.64	5.09	59.40	27.05	1591.96
10	Gauch1	45.06	5.47	50.19	24.10	1347.04
11	Bhumika9	41.72	5.44	54.59	30.30	1479.74
12	DSP801	51.73	6.42	56.47	33.41	1464.00
13	MRC409	47.94	5.26	53.94	30.85	1490.48
14	Balwan	42.17	5.58	50.68	29.38	1483.59
15	Kranthi	44.82	7.03	53.61	26.78	1515.19
16	Haritha	44.02	7.18	54.67	24.70	1415.41
17	Kiran	47.62	5.73	48.06	25.96	1414.11
18	PCS262	45.89	6.92	55.20	30.44	1578.67
19	Jwala	47.15	5.05	47.17	29.15	1335.59
20	PCH222	49.64	7.58	53.48	27.52	1599.07
	C.D at 5%	0.17	0.23	1.52	1.41	78.63
	SE(m)	0.06	0.08	0.54	0.50	28.11
	SE(d)	0.09	0.11	0.77	0.71	39.76
	C.V.	4.77	5.46	3.01	5.26	5.65

Conclusion: Based on physiological and yield performance of selected castor genotypes under rainfed conditions, it can be concluded that there is significant variability in these parameters. Among the physiological parameters and found positively correlated with seed yield. It can be summarized that for rainfed condition, the castor genotypes need to have not only high seed yield but also have lower stomatal resistance, optimum LAI and SCMR values.

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