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Assessment of genetic variability for important traits in castor (*Ricinus communis* L.) germplasm accessions

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Abstract
Castor (*Ricinus communis* L.), a monotypic genus originated from Ethiopian-East African region. Castor oil has wide range of uses *viz.*, industrial uses, medicinal uses… Success of any crop improvement programme depends on the use of diversified germplasm. Large size of germplasm restricted the researchers for accurate characterization and resulted in limited utilization of genetic resources in crop improvement programmes. An attempt is made in the present study to effectively characterize a relatively smaller size of the collections for a number of economic traits was conducted at the Zonal Agricultural and Horticultural Research Station, Hiriyur, Chitradurga district, Karnataka during 2015-16 *kharif* season to study their potentiality with respect to yield trait mainly. The results revealed there was a significant difference for all the parameters studied; which indicates the existence of sufficient variation for effective selection among the accessions.

Keywords: Castor, genetic variability, germplasm

Introduction
The castor (*Ricinus communis* L.; Family: Euphorbiaceae) is the monotype of the genus *Ricinus* under cultivation. The castor plant is native to the Ethiopian region of East Africa. Nearly 3400 accessions including 3051 indigenous and 365 exotic collections introduced from 39 countries are being maintained at ICAR-IIOR (Anjani, 2010) [1]. It grows in tropical and warm temperate regions throughout the world. The use of diversified germplasm is one of the important step to success of crop improvement programmes. Huge size of germplasm has restricted the researchers for accurate characterization and resulted in limited utilization of genetic resources in crop improvement programmes. The relatively smaller size of the collections could be effectively characterized for a number of economic traits.

Methodology
The present investigation comprised of around 155 different Germplasm accessions collected locally (around 69), from IIOR Hyderabad (around 67) and from Junagadh, Gujarat (19) and 5 checks viz., DCH-177, DCH-519, JC-12, GCH-4 and HCH-6 were evaluated at the Zonal Agricultural and Horticultural Research Station, Hiriyur, Chitradurga district, Karnataka during 2015-16 *kharif* season to study their potentiality with respect to yield primarily. The seed material was sown in 2 rows with 10 plants per row. Recommended Agronomic and Plant protection practices were followed during crop growth period to raise a good crop. Important growth, yield and yield attributing traits like days 50% flowering, plant height (cm), plant stand at the time of harvesting, number of branches/plant, spike length (cm), effective spike length (cm), number of internodes/ plant, number of capsules/plant, 100 seed weight (g), oil (%) and seed yield (g) were recorded and statistically analyzed.
Genetic diversity was assessed in 155 germplasm accessions using principal components analysis as conceptualized by Pearson (1901) [7] and described by Hotelling (1933) [5]. Standardized, and uncorrelated Morpho Agronomic traits mean values were used for principal component analysis. Based on first two major principal components which explained maximum diversity among the accessions, a scatter graph was plotted.

Results & Discussion
The results revealed there was a significant difference for all the parameters studied; which indicates the existence of sufficient variation for effective selection among the accessions. Plant height was recorded with a minimum of 37.67 cm to maximum of 335.00cm with a mean of 122.98 cm. Number of branches/plant recorded 2.33 and 9 minimum and maximum respectively with a mean of 5.45. Number of spikes/plant minimum of 4 and maximum of 12

with a mean of 8.04. The spike length recorded a minimum of 23 cm to a maximum of 79.00cm with a mean of 43.25cm. Effective spike length recorded a minimum of 17.33 cm and maximum of 66.0 cm with a mean of 33.68cm. Number of capsules/spike ranges from 21.00 to maximum of 57.00 with a mean of 36.79. Number of internodes ranges from 6.33 to 22.67 with a mean of 16.47. Days to 50% flowering ranges from 33 days to maximum of 105 days with a mean of 58.47 days. Seed yield per plant ranges from 170.80 g to 448.96g with a mean of 342.41g. Similarly oil percentage ranges from 40.98% to maximum of 51.98% with a mean of 48.33 (Table 1).

Genetic expectations of skewness (-3/2 d2 h) reveal the nature of genetic control of the traits (Fisher *et al.* 1932) [3]. The parameters'd' represent additive gene effects and 'h' represents dominance gene effects. Kurtosis indicates the relative number of genes controlling the traits (Robson, 1956) [8]. The study of coefficients of skewness and kurtosis provides information about the nature of gene action and number of genes controlling the traits respectively.

Skewness and kurtosis are the fourth degree statistics. Plant height trait recorded 0.79 and 0.85 for kurtosis and skewness respectively. Number of branches/plant recoded -0.47 for kurtosis and 0.11 for skewness. Number of spikes/plant recorded kurtosis value 0.20 and -0.01 for skewness. Spike length recorded kurtosis value 1.79 and 0.79 skewness. Effective spike length recorded kurtosis and skewness values 1.08 and 0.75 respectively. -0.04 and 0.25 kurtosis and skewness values respectively recorded by number of capsules/plant. Number of internodes recorded 0.32 and -0.80 for kurtosis and skewness respectively. Days to 50% flowering recorded 0.09 and 0.72; for yield 2.48 and -1.35; oil % 1.51 and -1.17 for kurtosis and skewness respectively (Table 1).

Genetic Diversity

First two Principal components explained about 92.00 percent of total variability among the 155 accessions (Table 1). Based on scatter plot (Fig. 1) of first two principal components, they show wide differentiation among them. The differentiation of the accessions was so much that many belongs to same group. The substantial genetic diversity among the accessions could be attributed to differences in natural selection pressures governed by genotypic as well as interaction between genotype and phenotype (Goodarzi1 *et al.* 2011) [4].

The accessions belongs to the same group shows less variation and indicates selection within the same group ineffective. The selections for the accessions among the groups can be made and further they can be used in hybridization programme.

Character specific accessions

The advanced utilization of germplasm resources requires identification of accessions having useful traits. In the various International crop research organizations, where character-based breeding is followed, identification of character-specific accessions is a prerequisite. The accessions like RG-39, RG-107, RG-3308, RG-24 andRG-3294 with lowest days to 50% flowering, HCG-92, HCG-41, HCG77, HCG-37 and HCG-94 with highest plant height and HCG-19, HCG-79, RG-27, HCG-68 and RG-3798 with highest grin yield (g) (Table 3) are useful in breeding early duration with higher grain yield cultivars. The accessions contrasting for economic traits are useful in inheritance studies and developing character-based mapping populations for chromosomal localization and molecular dissection of genes controlling the economic traits. The accessions that are contrasting for plant height, number of productive tillers plant^{-1} and grain yield plot^{-1} are useful for developing multiple character-based mapping population for molecular dissection, chromosomal localization and unravelling mode of action of genes controlling these traits simultaneously (Goodarzi1 *et al.* 2011, Dhanalakshmi *et al.* 2014) [4, 2].

Table 1: Descriptive statistics values in castor Germplasm accessions

Parameters	Mean	Kurtosis	Skewness	Range	
				Minimum	Maximum
Plant height (cm)	122.98	0.79	0.85	37.67	335.00
Number of branches/plant	5.45	-0.47	0.11	2.33	9.00
Number of spikes/plant	8.04	0.20	-0.01	4.00	12.00
Spike length	43.25	1.79	0.79	23.00	79.00
Effective spike length	33.68	1.08	0.75	17.33	66.00
Number of capsules/ spike	36.79	-0.04	0.25	21.00	57.00
Number of internodes	16.47	0.32	-0.80	6.33	22.67
Yiled (g)	342.41	2.48	-1.35	170.80	448.96
Oil%	48.33	1.51	-1.17	40.98	51.98
Days to 50% flowering	58.47	0.09	0.72	33.00	105.00

Table 2: Number of Principal components and their Eigen values and contribution to total variability for different Morpho-agronomic traits in castor (*Ricinus communis* L.) Germplasm accessions

Principal Component Variation	Eigen Value	% Contribution to Total
1	3392.18	54.887
2	2376.2	38.448
3	199.8	3.2329
4	133.244	2.156
5	28.1593	0.45563
6	22.3383	0.36145
7	14.2266	0.23019
8	6.12951	0.099179
9	4.07191	0.065886
10	3.5211	0.056973

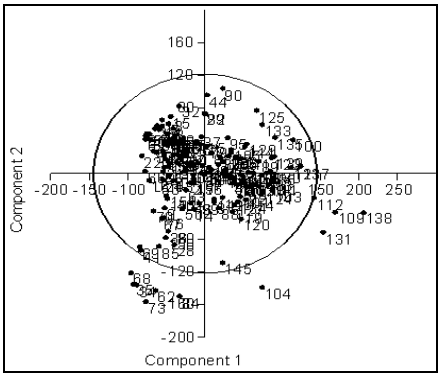

Fig 1: scatter plot based on first two principal components for various Morpho-Agronomic traits in castor (*Ricinus communis* L.) Germplasm accessions

Table 3: Accessions with contrasting expressions for different quantitative traits in castor germplasm accessions

S. No	Characters	Accessions with Lowest performance	Accessions mean value for the trait	Accessions with highest performance	Accessions mean value for the trait
1	Plant height (cm)	RG-72	37.67	HCG-92	239.33
2		SKI-348	39.00	HCG-41	268.00
3		RG-50	39.00	HCG-77	289.33
4		JI-427	40.00	HCG-37	300.00
5		RG-44	42.67	HCG-94	335.00
1	Number of branches/plant	HCG-41	2.33	RG-2	8.33
2		HCG-76	2.33	RG-37	8.33
3		RG-22	2.67	JI-430	8.67
4		HCG-68	2.67	RG-3291	8.67
5		HCG-119	2.67	SKI-350	9
1	Spike length (cm)	RG-25	23	JI-344	65
2		HCG-120	23.67	RG-3797	70.67
3		RG-50	25	RG-3794	71.34
4		JI-427	26.34	RG-3293	74.34
5		RG-905	26.67	SKI-346	79
1	Effective Spike length (cm)	RG-13	17.34	HCG-127	53.33
2		RG-3	18	JI-344	56.67
3		RG-41	18	RG-3794	61.67
4		RG-2048	19	RG-3293	65.67
5		RG-72	19.34	RG-3797	66
1	Number of capsules/plant	RG-41	21.00	RG-3291	49.00
2		HCG-68	21.33	RG-3794	51.00
3		HCG-120	22.67	RG-3293	53.33
4		HCG-76	23.67	RG-3797	54.67
5		HCG-112	24.67	HCG-51	57.00
1	Number of Internodes/plant	RG-72	6.33	HCG-127	20.67
2		SKI-348	8.33	HCG-92	21.00
3		RG-44	8.67	RG-22	21.33
4		RG-50	9.33	HCG-109	21.33
5		JI-427	9.67	RG-23	22.67
1	Yield (g)	RG-3073	170.80	HCG-19	413.93
2		RG-17	186.88	HCG-79	420.58
3		RG-107	186.90	RG-27	435.53
4		RG-16	187.03	HCG-68	436.48
5		RG-3297	188.98	RG-3798	448.96
1	oil %	HCG-30	40.98	HCG-77	51.16
2		JI-415	41.36	JI-344	51.24
3		HCG-85	41.78	RG-3405	51.26
4		RG-3336	42.24	HCG-1	51.49
5		RG-2706	42.25	RG-3797	51.98
1	Days to 50% flowering	RG-39	33	HCG-118	88
2		RG-107	35	HCG-68	89
3		RG-3308	35	HCG-10	91
4		RG-24	36	HCG-19	93
5		RG-3294	36	HCG-46	105
1	100 seed weight (g)	HCG-85	16.1	RG-3794	40.3
2		RG-16	16.7	RG-3293	40.5
3		RG-2	19.8	HCG-47	41.5
4		HCG-120	19.9	HCG-28	42.6
5		HCG-37	20.1	RG-5	42.9

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