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RESEARCH PAPER

Stability analysis of varieties and hybrids in castor (*Ricinus communis* L.)

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Abstract: The stability analysis of yield and yield attributing parameters of selected castor hybrids and varieties was conducted during *kharif* 2014 and *kharif* 2015 at, the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad; Agricultural Research Station, Hanumanamatti and Horticultural Research and Extension Station, Devihosur. Analysis of variance for stability indicated highly significant differences among the hybrids for all the characters. Significant difference for mean squares due to genotypes × environment for effective length of primary spike and seed yield suggested differential behaviour of the hybrids across the locations for these two characters. Estimation of environmental indices clearly indicated that Dharwad was the most congenial than either of the environments for better expression of traits like days to flower initiation, effective length of primary spike, number of spikes per plant, average number of capsules per spike and oil content followed by Devihosur favourable for superior expression of plant height, seed yield and 100 seed weight. It was observed that none of the genotypes were found to be stable for all the characters. Of the 14 genotypes studied, GCH-6, PCH-111 and GCH-4 (c) were found to be stable for three characters, followed by genotypes GCH-5, DCH-519, DCH-177, GC-3 and 48-1 (c) which were stable for two characters each.

Key words: Castor, Environmental index, Spike, Stability

Introduction

Castor belongs to *Euphorbiaceae* family and found across all the tropical and semi-tropical regions of the world (Weiss, 2000). It is one of the most important non-edible oilseed which is grown throughout the world in an area of 16.34 lakh hectares with the production and productivity of 15.20 lakh tonnes and 830 kg ha^{-1}, respectively (Anon., 2016).

India ranks first in area and production with 68 and 76 per cent, respectively in the world. In India, castor is grown in an area of 10.27 lakh ha with the production and productivity of 12.32 lakh tonnes and 1229 kg ha^{-1}, respectively. Gujarat accounts for nearly 62.55 per cent of area and 73.92 per cent of production with an average yield of 1454 kg ha^{-1} in the country (Anon., 2016a). Gujarat, Rajasthan and Andhra Pradesh are the major castor growing states in the country. In Karnataka, the crop is grown in an area of 20,000 hectares with the production of 18,000 tonnes and productivity of 900 kg ha^{-1}.

Castor oil is important commercial source hydroxylated fatty acid at global for many industry. Castor has tremendous future potential as an industrial oilseed crop because of its high seed oil content (more than 480 g kg^{-1}), unique fatty acid composition (900 g kg^{-1} of ricinoleic acid), potentially high oil yields (1250-2500 L ha^{-1}) and ability to be grown under drought and saline conditions. The castor oil has pivotal usage in petrochemicals, pharmaceuticals, cosmetics, textile, soap, leather, paint, varnish, ink, nylon and plastic industries.

The development and deployment of castor hybrids and varieties, adaptable to different agro-climatic situation is expected to increase productivity in India. Castor crop is more sensitive to environmental variations, particularly differences in fertility status of soil, temperature, photoperiod and relative humidity during growth period and moisture availability (Thakkar *et al.,* 2010). The sensitivity of castor genotypes to environmental variations suggested the need of using array of environments instead of single environment to study the nature response and inheritance of components of adaption (Solanki and Joshi, 2000; Patel *et al.,* 2010).

In view of this 12 promising genotypes along with two checks were evaluated to study their response for seed yield and other component characters over three environments of northern transitional zone of Karnataka for two seasons.

Material and methods

The material for present investigation included promising and high yielding castor genotypes comprising seven hybrids *viz.,* GCH-5, GCH- 6, GCH-7, DCH-177, DCH-519, RHC-1 and PCH-111 and five varieties *viz.,* DCS-107, PCS-4, PCS-136, PCS-262 and GC-3 along with checks GCH-4 and 48-1, for hybrids and varieties, respectively. The genotypes were evaluated in three environments *viz.,* Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Agricultural Research Station, Hanumanamatti and Horticultural Research and Extension Station, Devihosur, for two seasons *viz., kharif* 2014 and *kharif* 2015 in Randomized Complete Block Design with three replications. Each entry was sown in six rows of 6.0 meters length with a row to row spacing of 0.90 m and 0.60 m between plants within a row. All the recommended agronomic practices were followed for raising healthy crop. Observations were recorded on five randomly selected plants in each entry and in each replication for eight quantitative characters.

Observations were recorded on plant height (cm), days to flower initiation, effective length of primary spike (cm), number of spikes/ plant, average number of capsules per spike, seed yield (kg/ha), 100 seed weight (g) and oil content (%). Data of each trait for a location over two seasons (*kharif* 2014 and *kharif* 2015) was averaged and trait mean data over three environments of 14 genotypes was used to assess the stability. The results of stability parameters are interpreted using Ebarhart and Russel (1966) stability model.

Results and discussion

Analysis of variance for stability indicated that genotypic pooled differences over environments were significant for most of the characters (Table 1). Variance due to environments and environments (linear) was significant for all the characters. Significant mean squares due to genotypes × environment for effective length of primary spike and seed yield suggested differential behaviour of the hybrids across the locations for these two characters**,** whereas, G ×E (linear) were found to be significant for the characters *viz.,* days to flower initiation, effective length of primary spike, seed yield and oil content. The differential behaviour of genotypes was entirely unpredictable with respect to plant height, number of capsules per spike and 100 seed weight, as suggested from significance of mean squares due to pooled deviation. However, the variation in the performance of the genotypes with respect to days to 50 per cent flowering was predictable as indicated from significance of mean squares due to both pooled deviation and genotype × environment (linear) interaction. Madariya *et al.* (2010) and Patel *et al.* (2010) also reported similar findings.

Estimation of environmental indices (Table 2) clearly indicates that Dharwad was the most congenial than either of the environments for better expression of traits like days to flower initiation, effective length of primary spike, number of spikes per plant, average number of capsules per spike and oil content. Devihosur also exhibited favourable conditions than other environments for superior expression of plant height, seed yield and 100 seed weight.

Genotype and environment interaction being significant for important traits, the immediate goal was to identify stable genotypes which interact moderately with the environments thus, resulting in a near consistent performance across environments.

With respect to plant height, PCH-111 and 48-1 (c) possessed higher mean than the population mean with regression coefficient value (bi) near to one and non-significant deviation from regression (S^2di). These genotypes had mean optimum plant height indicating that these genotypes are most stable and ideal across environments for plant height. While, the GCH-7 and GC-3 had high mean value with regression coefficient value nearer to unity and significant deviation from regression (S^2di # 0), thus, indicating its suitability for all environments with unpredictable performance. The genotype which require minimum number of days to flower initiation are more desirable. So, the stability parameters for days to flower initiation showed that genotypes GCH-6, PCH-111 and PCS-262 were stable across the environments for earliness as they recorded lower mean than that of population and regression coefficient near to unity with non-significant deviation from regression (Table 3a). Patel *et al.* (2010) and Manivel and Hussain (2001) reported similar findings.

Table 1. Analysis of variance for stability of castor genotypes for twelve quantitative traits of castor (*Ricinus communis* L.) over three environments

Sources	d.f.	Mean Squares							
		Plant height (cm)	Days to flower initiation	Effective length of primary spike	Number of spikes/ plant	Average number capsules per spike	Seed yield	100 Seed weight	Oil content
Genotypes	13	353.29	15.71**	52.73**	1.15	17.68	13.51**	4.71*	3.12**
Environment+ (Genotypes ×Env.)	28	784.72*	6.72*	45.50**	1.18	13.75	14.16**	2.34	0.39*
Environments	2	6852.66**	22.97**	382.67**	5.84*	67.67**	84.39**	12.45**	1.61**
Genotypes × Environments	26	317.95	5.47	19.56*	0.82	9.60	8.76**	1.56	0.29
Environments (Linear)	1	13705.33**	45.94**	765.35**	11.69**	135.35**	168.78**	24.90**	3.21**
Genotypes × Environments (Linear)	13	334.11	7.85*	31.07**	0.48	9.95	15.87**	1.48	0.42*
Pooled deviation	14	280.24**	2.88*	7.48	1.08**	8.58**	1.54	1.51**	0.16
Pooled error	78	17.63	1.46	7.95	0.14	1.89	1.52	0.42	0.29

* Significant at 0.05 probability level and ** Significant at 0.01 probability level

Table 2. Estimates of environmental indices for eight quantitative traits in castor at different environments

Trait	Dharwad	Devihosur	Hanumanamatti
Plant height (cm)	11.69	13.82	-25.52
Days to flower initiation	1.39	-0.25	-1.14
Effective length of primary spike (cm)	6.00	-2.41	-3.59
Number of spikes per plant	0.41	-0.75	0.34
Average number of capsules per spike	2.35	-0.34	-2.01
Seed yield (q ha^{-1})	-1.88	2.70	-0.83
100 Seed weight (g)	0.51	0.58	-1.09
Oil content (%)	0.20	0.19	-0.39

Table 3a. Stability parameters for plant height, days to flower initiation, effective length of primary spike and number of spikes per plant

Genotypes	Plant height			Days to flower initiation			Effective length of primaryspike			Number of spikes/ plant		
	μ	S²di	bi	μ	S²di	bi	μ	S²di	bi	μ	S²di	bi
GCH-5	165.95	270.53**	2.15	40.67	9.23**	1.14	43.67	-6.04	0.51	8.81	1.18**	1.66
GCH-6	158.609	48.53	1.63	37.22	-0.41	0.36	43.79	23.68	1.05	9.24	4.68**	1.67
GCH-7	159.484	453.39**	1.49	37.67	2.83	2.58	52.61	-7.82	2.07*	8.81	-0.05	0.55
DCH-177	154.134	52.252	1.23	38.00	2.81	0.07	48.88	-7.93	0.42	8.36	0.16	-0.68
DCH-519	173.929	525.34**	1.84	41.00	-0.30	0.69	47.54	3.75	1.02	8.25	-0.07	0.71
RHC-1	146.063	1025.03**	0.68	40.11	-1.38	-1.73*	41.42	-4.99	0.56	7.11	2.89**	1.05
PCH-111	157.677	-3.308	0.90	34.67	-0.81	1.12	39.74	-3.52	-0.43	8.65	0.44*	1.11
DCS-107	152.222	92.39*	0.62	43.11	9.82**	1.64	44.35	-5.81	1.81	8.23	0.15	0.87
PCS-4	145.946	49.13	0.31	36.33	-1.08	1.80	41.36	-8.04	1.23	7.94	1.11**	0.53
PCS-136	149.432	157.88**	0.33	40.56	-0.97	-0.99	47.26	12.33	0.42	9.09	0.07	2.71
PCS-262	155.622	246.84**	0.45	37.11	0.79	1.18	48.70	10.89	0.41	9.19	1.04**	0.67
GC-3	169.213	712.63**	0.56	40.44	-0.36	1.15	43.13	-4.22	0.91	8.81	-0.04	1.10
Checks												
GCH-4	133.472	-5.64	1.05	37.00	-0.04	0.24	53.91	-6.67	1.88	9.32	-0.08	0.70
48-1	168.178	45.23	0.78	38.67	0.56	4.76	46.20	-4.11	2.14	9.22	1.79**	1.36
Population mean	156.42			38.75			45.90			8.64		

* Significant at 0.05 probability level, ** Significant at 0.01 probability level, μ- Overall mean, S²di – Deviation from regression, bi – Regression coefficient

Table 3b. Stability parameters for average number of capsules per spike, seed yield, 100 seed weight and oil content

Genotypes	Average number of capsules per spike			Seed yield (kg/ha)			100 Seed weight (g)			Oil content (%)		
	μ	S²di	bi	μ	S²di	bi	μ	S²di	bi	μ	S²di	bi
GCH-5	61.99	0.29	1.12	61.99	0.29	1.12	28.2	-0.3	2.42	48.67	-0.17	1.31
GCH-6	61.30	-1.69	1.42	61.30	-1.69	1.42	28.7	-0.02	1.23	48.19	-0.24	-1.47
GCH-7	66.13	-1.30	2.50	66.13	-1.30	2.50	27.75	5.42**	0.27	48.08	-0.28	3.43*
DCH-177	66.44	22.81**	1.37	66.44	22.81**	1.37	26.2	-0.11	1.21	48.07	-0.29	-0.91*
DCH-519	61.30	-0.05	0.63	61.30	-0.05	0.63	27.8	0.96	-0.1	49.13	-0.08	2.57
RHC-1	63.94	1.79	1.63	63.94	1.79	1.63	25.56	-0.01	1.24	48.12	-0.09	0.32
PCH-111	61.21	0.21	1.94	61.21	0.21	1.94	27.33	-0.2	1.65	47.33	0.09	2.25
DCS-107	62.99	5.18	1.48	62.99	5.18	1.48	25.65	0.27	-0.26	46.76	0.2	0.37
PCS-4	63.28	11.37**	1.50	63.28	11.37**	1.50	26.52	2.67**	1	49.94	-0.21	0.14
PCS-136	64.42	26.95**	-1.43	64.42	26.95**	-1.43	25.89	0.17	2.97	50.33	-0.24	0.29
PCS-262	68.26	7.70	-0.70	68.26	7.70	-0.70	26.71	1.80*	0.59	49.26	-0.25	2.12
GC-3	60.33	-0.14	0.91	60.33	-0.14	0.91	25.83	1.1	1.1	48.92	-0.28	1.02
Checks												
GCH-4	66.32	22.19**	0.63	66.32	22.19**	0.63	25.68	-0.38	0.43	47.74	-0.25	1.76
48-1	65.26	-0.07	0.99	65.26	-0.07	0.99	24.15	4.14*	0.26	49.72	0.25	0.81
Population mean	63.80			63.80			26.57			48.59		

* Significant at 0.05 probability level, ** Significant at 0.01 probability level, μ- Overall mean, S²di – Deviation from regression, bi – Regression coefficient

Effective spike length is an important yield contributing trait and larger spikes are preferred. DCH-519, DCH-177 and PCS-136 showed higher mean, b_i value near to one and non-significant deviation from regression. Hence, these genotypes are ideal genotypes with stable performance. Whereas, genotypes GCH-7, GCH-4(c) and 48-1(c) also had higher mean, but regression value more than one and non-significant deviation from regression indicating that these are highly sensitive to environmental changes but adapted to favourable environment. For number of spikes per plant, genotypes GCH-7, GC-3 and GCH-4(c) exhibited higher mean number of spike per plant along with unit regression coefficient and non-significant deviation from regression indicating their stable performance (Table 3a). Manivel and Hussain (2001) also reported similar results.

The stability parameters for average number of capsules per spike showed that genotypes RHC-1 and 48-1(c) were stable across environments with b_i=1 and S^2di=0 indicating their stable performance in the tested environments. The genotypes DCH-177 and PCS-4 had their mean higher than population along with regression values near to unity and significant deviation from regression indicating average sensitivity of the genotype with unpredictable performance. Thakkar *et al.* (2010) reported similar results in their findings.

The stability parameters for total yield showed that genotypes GCH-5, GCH-6 and GCH-4(c) are stable across environments with b_i=1 and S^2di=0. DCH-177 and PCS-136 had X_i < ì along with b_i<1 and non-significant deviation from regression indicating its suitability to poor conditions. Genotypes GCH-7 and PCH-111 recorded higher mean values over the population mean along with b_i>1 and non-significant deviation from regression indicating that these are highly sensitive to environmental changes but better adapted to favourable environments (Table 3b). Madariya *et al.* (2010), Solanki and Joshi (2000) and Kumara *et al.* (2003) reported similar findings.

The genotypes GCH-6 and PCH-111 showed stable performance with higher mean 100-seed weight across environments and considered as ideal for this trait. While, genotypes GCH-7 and PCS-262 had X_i > ì along with b_i=1 and S^2di # 0 indicating average sensitivity of the genotype with unpredictable performance. GCH-5, GC-3and 48-1 (c) showed stable performance across the environments with X_i > ì , b_i=1 and S^2di=0 indicating that these genotypes were average sensitive to environmental variations and adapted to all environments. Genotypes DCH-519 and PCS-262 were found highly sensitive to environmental changes but better adapted to favourable environments with X_i > ì along with b_i >1 and S^2di = 0, whereas, PCS-4 and PCS-136 had X_i > ì , b_i<1 and S^2di = 0 indicating its suitability to poor conditions.

Conclusion

Stability analysis was carried out for 14 genotypes. Out of 14 genotypes studied, none of the genotypes were found to be stable for all the characters across the locations. The genotype GCH-6, PCH-111 and GCH-4 were found to be stable for three characters, followed by genotypes GCH-5, DCH-519, DCH-177, GC-3 and 48-1 were stable for two characters each and genotype DCS-107 was not stable for single character. This shows that influence of environment is significantly high on each genotype across the location hence, concluded that genotypes should be specific for each environment.

References

Anonymous, 2016, Comprehensive castor oil report, http:// castoroil.in.

Anonymous, 2016a, SEA data book and Neilson crop survey; February report.

Eberhart, S. A. and Russell, W. A., 1966, Stability parameters for comparing varieties. *Crop Sci.,* 6: 36-40.

Kumara, T. R., Subramanyam, D. and Sreedhar, N., 2003, Stability analysis in castor (*Ricinus communis* L.).*Crop Res.,* 25: 96-102.

Madariya, R. B., Chovatia, V. P., Kavani, R. H., Barad, V. G. and Padhur, P. R., 2010, Phenotypic stability in castor (*Ricinus communis* L.). *J. Oilseeds Res.,* 27: 27-30.

Manivel, P. and Hussain, H. S. J., 2001, Genotype × environment interaction in castor. *Madras Agric. J.,* 87: 394-397.

Patel, J. A., Patel, B. N., Alpesh, R. and Patel, R. K., 2010, Genotype × environment interaction and stability parameters for yield and component characters in castor (*Ricinus communis* L.). *J. Oilseeds Res.,* 27: 47-49.

Solanki, S. S. and Joshi, P., 2000, Stability parameters for sex expression in castor (*Ricinus communis* L.). *J. Oilseeds Res.,* 17: 242-248.

Thakkar, D. A., Gami, R. A. and Patel, P. S., 2010, G × E and stability studies on castor hybrids for yield and its attributing characters. *J. Oilseeds Res.,* 27: 74-77.

Weiss, E. A., 2000, Castor. In: *Oilseed Crops,* Second Edition, Blackwell Science, Oxford, U. K., pp. 13-52.