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Identification of Stable and High Yielding Dual Season Genotypes in Blackgram [*Vigna mungo* (L.) Hepper]

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ABSTRACT

Background: The production of pulses recorded a negative growth rate due to stagnation in expansion of pulse growing area and very slow progress in the improvement of productivity of important pulses. Therefore, there is urgent need to increase the area under pulse crops by promoting them into new areas and seasons. Blackgram [*Vigna mungo* (L.) Hepper] is third most important pulse crop both in acreage and production in India and hence, identification of high yielding dual season (*kharif* and summer) stable blackgram genotypes is very crucial for horizontal expansion of crop, which in turn leading to increased production. The present study was thus envisaged to identify stable, high yielding dual season (*kharif* and summer) genotypes.

Methods: Twenty-five blackgram genotypes were evaluated at three different locations during *kharif* and summer seasons to identify high yielding, stable and suitable for dual season. The data obtained from six environments was subjected to stability analysis as per Eberhart and Russell (1966).

Result: Analysis of variance for stability revealed that variance due to genotypes, environment and environment + (genotype × environment) were highly significant for all the characters. The genotypes *viz.,* TRCRU-136, BDU-20, BDU-18, AKU-15 and TRCRU-22 were found early maturing with wider adaptability to unfavourable environments. While, BDU-18 and LBG-465 were found stable in expression with high mean performance across the six environments for 100-seed weight. From the present study, six promising stable genotypes *viz.,* BDU-17, TRCRU-22, BDU-18, TRCRU-339, TRCRU-18 and IC 436778 were identified for cultivation during *kharif* as well as summer seasons.

Key words: Blackgram, Deviation due to regression (S^2di), Genotype, Regression coefficient (bi), Stability.

INTRODUCTION

During the post green revolution period, the production of pulses recorded a negative growth rate due to stagnation in expansion of pulse growing area and very slow progress in the improvement of productivity of all pulses. There is urgent need to increase the area under pulse crops by promoting them into new areas and seasons. Identification of high yielding dual season (*kharif* and summer) stable blackgram genotypes is very crucial for horizontal expansion of crop, which in turn leading to increased production. The present study was thus envisaged to identify stable, high yielding dual season (*kharif* and summer) genotypes.

Blackgram [*Vigna mungo* (L.) Hepper] is an important pulse crop in India. It is a short duration, self-pollinated and diploid grain legume (Gupta and Gopalakrishna, 2008). Among the pulses grown in India, blackgram is third most important pulse crop both in acreage and production. In India, it is grown over an area of 4.49 million ha with an annual production of 2.93 million tonnes (Anonymous, 2017). It is mainly grown in the states of Madhya Pradesh, Maharashtra, Uttar Pradesh, Rajasthan, Karnataka and Bihar. The productivity of blackgram in the country is 651 kg/ha, which is one of the lowest in the world because of inconsistent performance of the varieties under varied environmental conditions leading to unstable production. Therefore, one of the ways of alleviating this problem is to breed varieties which are less sensitive to variations in weather conditions so that the productivity and production become stable. In addition to this, there is also a need to develop/identify blackgram varieties suitable for summer for horizontal expansion of area which in turn leads to increased production. There is a scope for cultivation of summer blackgram in Tunga-Bhadra and Upper Krishna Project command areas after *kharif* rice to diversify unsustainable rice-rice system into a more sustainable rice-summer

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legume (blackgram) system. Further, a genotype suitable for either *kharif* or summer season alone makes the seed production and supply to the farmer a laborious process as it requires separate seed production and maintenance of different varieties for different seasons. The identification of dual season genotypes suitable for cultivation during both *kharif* as well as summer seasons, will not only circumvent the above-mentioned issues but also helps in horizontal expansion of blackgram area. The present study was thus envisaged to identify stable, high yielding dual season (*kharif* and summer) genotypes.

MATERIALS AND METHODS

The material for study consisted of 23 blackgram genotypes collected from different sources *viz.,* Agricultural Research station, Bidar, Nuclear Agriculture and Biotechnology (NABT) division, BARC, Trombay, Indian Institute of Pulse Research, regional station, Dharwad and Regional Agricultural Research Station, LAM, Guntur and two local checks. These were evaluated during *kharif*-2018 and summer-2019 over three locations *viz.,* Agricultural Research Station, Bidar (representing North Eastern Transition Zone-1 of Karnataka), Agricultural Research Station, Kalaburagi and Agricultural Research Station, Bheemarayanagudi (representing North Eastern Dry Zone-2 of Karnataka). The experimental trial was laid out in a randomized block design with two replications. Each genotype in each replication was represented by a plot of 4 rows of 4 meter length with a spacing of 30 cm between rows and 10 cm between plants within a row. All the recommended agronomic practices were followed to raise a good crop. Observations on 12 quantitative characters were recorded. Observations on plant height, branches per plant, clusters per plant, pods per plant, seeds per pod, pod length, 100-seed weight and seed yield per plant were recorded on five competitive plants selected at random per genotype in each replication. Whereas, observations on days to 50 per cent flowering, days to maturity, reproductive period and seed yield (kg/ha) were recorded on plot basis. Days to 50 per cent flowering was recorded as number of days from sowing to the opening of the flower in 50 per cent of the plants, days to maturity was recorded as number of days from sowing to 50 per cent pod maturity, reproductive period was recorded as number of days from flowering to maturity and the seed yield per plot was recorded and weighed in kilograms (kg) and converted into seed yield in kg/ha in each of the genotype. The data obtained from six environments was subjected to stability analysis as per Eberhart and Russell (1966).

RESULTS AND DISCUSSION

The results of pooled analysis of variance for stability obtained from the evaluation of the 25 blackgram genotypes indicated that variation due to varieties and environments as well as the Environment + (variety × environment) component were highly significant for all the characters (Table 1). Since, these selected genotypes came from diverse sources with different selection history in different

Table 1: Pooled analysis of variance for stability analysis (Eberhart and Russell, 1966) for 11 quantitative traits in selected 25 genotypes of blackgram.

Source of Variations	df	Days to 50% flowering	Days to maturity	Reproductive period	Plant height (cm)	Number of branches per plant	Number of pods per plant	Number of clusters per plant	Number of seeds per pod	Pod length (cm)	100- seed weight (g)	Seed yield (kg/ha)
Varieties	24	3.38**	15.73**	13.42**	44.69**	0.46**	48.38**	2.07*	0.18	0.07	0.67**	5.23**
Environments	5	24.12**	121.01**	123.77**	242.35**	27.46**	322.08**	84.36**	11.71**	2.89**	2.40**	103.53**
Env.+ (Var. x Env.)	125	2.76**	12.60**	13.24**	30.77*	1.31**	25.44**	4.39**	0.59**	0.19**	0.17**	5.83**
Environments (Lin.)	1	120.59**	605.09**	618.83**	1211.78**	137.28**	1610.39**	421.81**	58.57**	14.42**	12.01**	517.67**
Var.x Env. (Lin.)	24	2.52	15.50**	16.98**	25.63	0.17	4.30	0.90	0.14	0.08	0.14**	2.68*
Pooled Deviation	100	1.64	5.98	6.28	20.20**	0.23**	14.67**	1.05**	0.12	0.08**	0.06**	1.46**
Pooled Error	144	0.00	0.00	0.00	3.28	0.09	2.60	0.16	0.09	0.03	0.01	0.31

*Significant at 5% probability. **Significant at 1% probability.

environments, it was expected that the varietal differences are significant. The components of variance due to environments were also highly significant as expected because the test environments represented two distinct agro-ecological zones and two environments over three locations.

The genotype × environmental (linear) was significant for characters *viz.,* days to maturity, reproductive period, 100-seed weight and seed yield indicating significant rate of linear response of the genotypes to environmental changes for these characters. The pooled deviation was found significant for all the characters except days to 50 per cent flowering, days to maturity and reproductive period revealing the importance of non-linear component accounting for total G × E interaction for these characters. Similar findings were reported earlier by Natarajan (2001), Kuchanur and Tembhurne (2008) and Babu *et al.* (2013) in blackgram. The environmental indices for various yield component traits presented in Table 2 indicated that E-1, E-3 and E-4 were most favourable whereas, E-5 was most unfavourable environment under study. Similarly, Kuchanur and Tembhurne (2008) and Mohanlal *et al.* (2019) reported most favourable and unfavourable environments for expression of different yield component traits in blackgram.

According to Eberhart and Russell's (1966) model, a variety is said to be stable when the deviation due to regression (S^2di) is non-significant. The non-significant S^2di also indicates predictable nature of the performance of the variety. The regression coefficient value (bi) helps to characterise the genotypes regarding their suitability/ adaptability to either rich, poor or average environments. The regression coefficient value (bi) equal to unity indicates that the variety is having general adaptability, bi value of more than unity indicates below average stability and it implies the suitability of the variety to rich environment. Likewise, bi value of less than unity indicates above average stability and variety showing such value is said to be better suited for poor environment. The stability parameters for yield and its important component traits are presented in Table 3. The estimation of stability parameters helped in identifying the stable genotypes for yield and its important component traits.

Generally, for maturity the genotypes which require minimum number days for maturity are generally considered more desirable. In the present investigation, the genotypes *viz.,* TRCRU-136, BDU-20, BDU-18, AKU-15, TRCRU-22 were found early maturing coupled with regression values less than unity (bi <1) and non-significant deviation from regression ($S^2di=0$), indicating their above average stability and wider adaptability to unfavourable environments. Previously, stable genotypes for days to maturity were reported by Koteswara *et al.* (2006), Kuchanur and Tembhurne (2008) and Rita *et al*. (2016) for *kharif* and Rajmohan and Rao (2015) for across seasons (*kharif* and summer) over locations in blackgram.

The length of reproductive period is an important parameter influencing yield through its positive association with main components of yield. Genotype, COBG-657 was found stable across environments as it recorded high mean, near unit regression and minimum deviation from regression for reproductive period. The genotypes *viz.,* PU-31, BDU-17, RU-16-10, TAU-1 and LBG-685 with high mean values for reproductive period, regression value of more than unity and non-significant S^2di values indicating their suitability for favourable environments. Stable genotypes for reproductive period were also reported by Konda *et al.* (2009).

The genotype, LBG-20 was stable across environments with respect to number of branches per plant as it recorded high mean with bi value near to unity and non-significant deviation from regression ($S^2di=0$). Four genotypes *viz.,* BDU-17, TRCRU-22, TRCRU-339 and TRCRU-18 recorded high mean for number of branches per plant with non-significant bi value more than unity and non-significant S^2di values indicating their suitability to favourable environments. The genotype, BDU-18 recorded high mean coupled with bi

Table 2: Environmental indices for each character under different environments.

Environments/ Characters	E-1	E-2	E-3	E-4	E-5	E-6
Days to 50% flowering	- 0.073	-0.233	0.207	1.807	-0.833	-0.873
Days to maturity	1.493	1.933	2.373	-1.027	-2.667	-2.107
Reproductive period	1.567	2.167	2.167	-2.833	-1.833	-1.233
Plant height (cm)	2.255	-0.763	2.067	3.591	-3.381	-3.769
Number of branches per plant	0.272	-0.504	-0.516	1.972	-0.972	-0.252
Number of pods per plant	-2.441	-2.025	5.705	2.653	-3.843	-0.049
Number of clusters per plant	1.642	-1.006	2.508	-2.078	-1.530	0.464
Number of seeds per pod	0.636	-0.640	0.390	0.540	-1.036	0.108
Pod length (cm)	0.584	0.197	-0.313	-0.074	-0.285	-0.110
100- seed weight (g)	0.597	-0.130	0.056	-0.086	-0.248	-0.188
Seed yield (kg/ha)	3.491	-2.268	-0.934	1.073	-1.142	-0.220

E-1: Bidar - *kharif* season-2018; E-2: Kalaburagi- *kharif*-2018; E-3: B'gudi- *kharif*-2018; E-4: Bidar - summer season-2019;
E-5: Kalaburagi- summer season-2019; E-6: B'gudi - summer season-2019.

value less than unity and non-significant S^2di indicating its wider adaptability under unfavourable conditions. Similarly, Senthilkumar and Chinna (2012) and Rajmohan and Rao (2015) reported stable blackgram genotypes across season and locations based on the mean, bi and S^2di values.

With respect to clusters per plant, the deviation from regression values (S^2di) were significantly different from zero for 18 genotypes indicating their unpredicted adaptability. The genotypes TRCRU-18, RU-16-9, TRCRU-339 with high mean coupled with non-significant bi values closer to unity and non-significant S^2di indicating their wider adaptability in all the environments. Stable genotypes for number of clusters per plant in blackgram were also reported by Kuchanur and Tembhurne (2008), Senthilkumar and Chinna (2012) and Rita *et al*. (2016) in blackgram.

Seed weight is an important yield component as well as the character deciding consumer preference and market acceptability. Usually, a variety with larger seed size is preferred by farmers, consumers as well as trades. For 100-seed weight, the genotypes BDU-18 and LBG-465 were found to be stable in expression with high mean performance across the six environments. The genotypes *viz.,* DU-1, TAU-1, BDU-20, TRCRU-22 and TRCRU-339 had high mean performance coupled with regression values of less than unity and non-significant S^2di indicating their suitability to unfavourable environments. Such studies were also conducted by Revanappa and Kajjidoni (2004) Kuchanur and Tembhurne (2008) and Rita *et al*. (2016) in blackgram to identify stable genotypes for 100-seed weight.

Development of varieties with high yield potential is the ultimate goal of plant breeders in a crop improvement programme. In addition to high yield potential, the new cultivar should have stable performance and broad adaptation over a wide range of environments. The results revealed that the 13 genotypes *viz.,* IC-436516, TRCRU-262, LBG-20, TU-94-2, TRCRU-134, TRCRU-43-1, BDU-20, PU-31, COBG-657, BG-17-10, RU-16-10, LBG-685, DU-1 and TAU-1 recorded significant regression coefficients for seed yield, indicating unpredictable adaptability of these genotypes (Table 3). Two genotypes TRCRU-18 (931 kg/ha) and IC 436778 (870 kg/ha) exhibited high mean performance along with regression value near to one and non-significant deviation from regression (S^2di = 0) indicating their wider adaptability across the environments. Four genotypes *viz.,* BDU-17 (1013 kg/ha), BDU-18 (995 kg/ha), TRCRU-22 (1006 kg/ha) and TRCRU-339 (977 kg/ha) registered high mean performance, regression value more than one and non-significant deviation from regression (S^2di), indicating their specific adaptability to favourable environments. Contrastingly, high performing genotypes *viz.,*

Table 3: Estimates of stability parameters for seed yield and its component traits.

Genotypes	Days to maturity			Reproductive period			Number of branches per plant		
	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
AKU-15	71.67	0.43	8.23	33	0.15	9.37	3.08	0.95	-0.08
BDU-17	76.17	2.59**	1.16	37.5	2.10*	3.46	3.85	1.16	0.12*
BDU-18	71.5	0.2	2.14	32.5	-0.28**	0.39	3.7	0.8	0.13*
BDU-20	71.33	0.36	4.04	34	-0.07	9.47	3.15	0.99	0.23*
BG-17-10	72.5	0.45	4.66	33.83	0.35	3.96	2.73	0.65	0.06
COBG-657	74	1.67*	0.57	36.17	1.02	0.81	3.07	1.13	0.02
IC-436516	74.17	0.89	10.92	35	0.7	13.94	3.27	0.88	0.34**
IC-436778	73.33	0.15	5.2	33.67	0.76	4.74	3.13	0.93	-0.04
LBG-20	74.67	0.83	13.66	35.67	1.12	16.6	3.3	1.11	-0.01
LBG-465	75.67	1.05	8.1	35.83	1.31	10.58	3.03	1.02	0.00
LBG-685	76.83	1.02	1.36	36.17	1.39	2.28	3.22	0.88	0.03
PU-31	76.67	2.17*	2.87	37.83	2.30*	2.59	3.27	0.95	0.28**
RU-16-10	74.5	2.35**	2.05	37	1.75	1.98	3.07	1.12	0.22*
RU-16-9	73	0.51	29.45	34.5	0.67	28.13	3.02	1.04	0.04
RU-16-05	75	0.8	6.16	36	1.41	6.63	2.98	1	0.14
TRCRU-134	72.83	1.03	4.26	34.5	1.09	4.46	3.15	0.94	0.14
TRCRU-136	71.33	0.39	3.89	32.33	-0.14**	1.21	2.97	1.01	0.17*
TRCRU-18	74.67	0.94	1.44	35.17	1.85**	0.55	3.33	1.23	0.06
TRCRU-22	72.67	-0.93*	1.12	34	-0.74*	8.58	3.8	1.42	0.13
TRCRU-262	72.5	1.14	8.53	34	0.63	3.54	2.97	0.91	0.03
TRCRU-339	73.33	0.64	6.32	33.83	0.61	4.93	3.62	1.27	0.11
TRCRU-43-1	74.83	0.83	1.5	36	1.54*	0.42	2.92	1.05	0.1
TU-94-2	74.33	1.73	15.16	34.67	1.51	15.31	3.03	1.06	-0.02
DU-1	73.67	1.60	3.37	35.83	1.50	2.86	2.93	0.84	0.37**
TAU-1	75.50	2.15*	3.45	36.83	2.49**	0.34	3.02	0.64	0.36**
Population mean	73.87			35.05			3.18		

Table 3: Continue..

Genotypes	Number of clusters per plant			100- seed weight			Seed yield (kg/ha)		
	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
AKU-15	5.58	1.04	-0.08	4.4	1.23	0.14**	820	1.04	-0.02
BDU-17	6.7	1.14	1.71**	4.97	0.62	0.02*	1013	1.27	0.12
BDU-18	7.02	1.19	2.57**	4.91	1.01	0.01	995	1.19	0.29
BDU-20	6.52	1.22	1.41**	4.74	0.47*	0	941	1.32	1.08**
BG-17-10	5	0.79	0.51**	4.41	1.42	0.02	728	0.25	2.15**
COBG-657	5.93	1.24	0.80**	4.45	0.94	0.18**	880	1.1	0.63*
IC-436516	5.48	1.01	1.09**	4.84	1.52	0.02*	737	0.89	2.99**
IC-436778	5.8	1.12	-0.11	4.88	2.17**	0	870	1.02	0.32
LBG-20	5.76	1.19	0.38*	4.85	1.02	0.12**	856	1.08	1.45**
LBG-465	5.57	0.82	-0.05	4.87	0.98	0	837	0.96	0.11
LBG-685	5.8	0.72	0.82**	4.34	0.95	0.03*	867	1.21	0.62*
PU-31	5.62	0.74	2.09**	4.52	0.33	0.12**	803	0.46	2.54**
RU-16-10	5.35	1.03	0.82**	4.26	1.26	0.01	763	1.07	2.55**
RU-16-9	6.07	1.07	0.17	4.48	0.78	0.15**	850	0.83	0.01
RU-16-05	5.3	1.07	0.52**	4.22	0.84	0.03**	785	1.25*	-0.21
TRCRU-134	5.43	0.97	1.04**	4.38	0.96	0.02*	832	1.12	0.38
TRCRU-136	5.18	0.8	0.30*	4.44	0.76	0.06**	790	0.88	0.14
TRCRU-18	6.37	0.92	0.13	4.54	0.71	0.02*	931	1.01	-0.16
TRCRU-22	6.72	0.99	0.56**	4.68	0.51*	0	1006	1.22	0.36
TRCRU-262	4.71	0.51*	0.03	4.26	1.61	0.08**	727	0.31*	0.56*
TRCRU-339	6.75	1.11	0.19	4.64	0.47*	-0.01	977	1.27	0.31
TRCRU-43-1	5.55	0.62	1.11**	4.4	2.63*	0.14**	819	0.69	0.52*
TU-94-2	5.38	0.89	0.69**	4.18	0.83	0	848	0.77	0.41*
DU-1	5.73	1.21	2.03**	5.06	0.49*	0.00	860	1.43	4.80**
TAU-1	6.03	1.58	2.81**	4.94	0.49*	0.00	835	1.37	7.51**
Population mean	5.81			4.59			855		

**Significant at 1% and *significant at 5% level.

BDU-20, COBG-657 and LBG-685 were found suitable for rich environments (bi>1) but their performance was unpredictable due to significant deviation from regression (S^2di # 0). Earlier, Babu *et al*. (2013), Senthilkumar and Chinna (2012), Rajmohan and Rao (2015) and Mohanlal *et al*. (2019) identified dual season (*kharif* and summer) stable genotypes for seed yield.

CONCLUSION

From the present study, it is concluded that, genotypes *viz.,* BDU-17, TRCRU-22, BDU-18 and TRCRU-339, TRCRU-18 and IC 436778 were found suitable for both *kharif* and summer season and could be recommended for dual season cultivation.

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