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GENERAL COMBINING ABILITY ANALYSIS IN PIGEONPEA (*CAJANUS CAJAN* L.) MILLSP

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Abstract

Combining ability revealed significant differences among males and females in respect of gca for all the characters in both the generations except pod length and days to maturity in F_2 generation for gca due to males. None of the parents was found to be a good general combiner for all the characters. However, parent T_7 for days to initial flowering, number of primary branches / plant, number of pods /cluster, number of seeds / pod, pod length, 100-seed weight and grain yield / plant; K 35 for days to initial flowering, plant height, 100-seed weight, seed density and protein content: KA 12 for plant height. pod length and 100-seed weight; KA 26-9 for pod length, 100 seed weight and seed density: K 9125 (B) for number of primary branches per plant, pod length and days to maturity; KA 1 for number of pods per cluster, seed density and grain yield / plant; K 9125 (M) for number of primary branches / plant, number of pods / plant and grain yield / plant; KA 26-8 for number of pods / plant, 100-seed weight and grain yield / plant: C_{11} for number of clusters / plant, number of pods / plant and grain yield / plant: K 26-10 for days to initial flowering, number of clusters / plant and protein content; DPPA 8515 for days to initial flowering and number of pods / Cluster; ICPL 8887 for number of clusters / plant and 100-seed weight: and DKF_2 for number of pods / plant and seed density contributed significantly desirable gca effects in both the generations .On the basis of present finding, breeding procedure have been suggested for improvement in pigeonpea are development of hybrids and different schemes of recurrent selection were suggested depending upon the nature and magnitude of gene action in different characters.

Introduction

In india, pigeonpea or arhar or red gram (*Cajanus cajan* (L.) Millsp. 2n=22) is an important pulse crop next to chickpea. Pigeonpea is a rich source of protein and supplies a major share of the protein requirement of the vegetarian population. It is mainly consumed as split dal and is considered as 'meat' for Hindu priest as well as for poor people. The husk of pods along with the dried green leaves are very nutritive cattle feed. The dried stalk of pigeonpea is very good fuel and is more precious now a days when the fuel wood is scarcely available. It is also used for thatching the temporary mud house by poor persons besides various other purposes like broom, baskets, temporary partition wall etc. being a legume, it fixes atmospheric nitrogen in to the soil. Its deep root system is reported to break the plough pans, thus improving the soil structure. No wonder the pigeonpea is often called a "biological plough".

The line x tester mating design suggested by Kempthorne (1957) appears to be a effective method to evaluate a large number of genotypes for their combining ability variances and effects. This design has an added advantage of its application in a situation of incomplete set of crosses. Since availability of such type of genetic information is very limited in this crop and hence, the present investigation entitled, to estimate the general combining ability variances and effects, has been taken up with selected varieties/lines in a 16 x 3 parent-line x tester mating design. The genetic information gathered on the yield and its economic traits would be of considerable use in planning a more efficient breeding programme of improvement of this important pulse crop of India.

Material and methods

The final experiment was laid out with 115 treatments consisting 19 parents (16 lines and 3testers), 48 F_1s and 48 F_2s which were grown in Randomized Complete Block Design with 3 replications. The non-segregating population (Parents and F_1 s) were sown in single row and segregation population (F_2 s) in two rows each of 5 m length. The inter and intra-row spacing were 60 cm and 20 cm, respectively. All the recommended agronomic practices were adopted for growing a good crop. The observations were recorded for thirteen quantitative traits namely, days to initial flowering, plant height, number of primary branches / plant, number of clusters / plant, number of pods / cluster, number of seeds / pod, pod length, days to maturity, 100-seed weight, seed density, grain yield / plant and protein content. The data were recorded on five randomly taken plants in each parents and F_1s, and ten plants in each F_2's in each replication. The analysis of variance for combining ability was carried out according to method outlined by Kempthorne (1957). The analysis of variance for the experiment was carried out for all characters for testing the significance of difference among treatments. Mean sun of squares due to treatments were partitioned into parents. crosses and parents Vs. crosses (F_1+F_2). Variance due to crosses were also partitioned in to F_1s, F_2s and F_1 Vs F_2s.

Result and discussion

General combining ability effects of parents in F_1 and F_2 generations are presented in Table 1. It was evident that none of the parents was identified as good general combiner for all the characters. However, among all the parents studied, the parents with significant and desirable gca effects having common in both the generations were K 35. DPPA 8515 and K 26-10 for earliness; K 15, K 35, KA 12 and KPBR 80-2 for plant height; K 9125 (M), K 9125 (B) and T_7 for number of primary branches per plant; C_{11} and ICPL 8887 for number of clusters per plant; DPPA 8515, KA 1 and T_7 for number of pods per cluster: C_{11},. KA 26-8, KDF_2. K 9125 (M) and Banda palera for number of pods per plant: T_7 for number of seeds per pod: T_7, KA 26-9, K 9125 (B) and KA 12 for pod length: K 26-10 and K 9125 (B) for days to maturity: KA 26-8, K 35, T_7, KA 12 and KA 26-9 for 100-seed weight: KA 26-9, KA-1, X 35 and KDF 2 for seed density: C_{11}. KA 26-8, T_7, KA 1 and K 9125 (M) for grain yield per plant; and KA 97, K 26-10, K 15 and K 35 for protein content. This indicates that the best general combiners are also stable in their performance over generations. The stability for important agronomic traits has been considered as one of the important requisites in any breeding objective (Allard and Bradshaw, 1964).

The best common parents screened out on the basis of their relative mean performance and general combining ability effects both in F_1 and F_2 generations were DPPA 8515 and K 26-10 for days to initial flowering: K 15 and KA 12 for plant height, T_7 for number of primary branches per plant, number of pods per cluster and number of seeds per pod: ICPL 8887 for number of clusters per plant: KA 26-8 and KDF2 for number of pods per plant: T. X 9125 (B) and KA 12 for pod length: K 26-10 and K 9125 (B) for days to maturity: T_7 and KA 12 for 100-seed weight: KA-1 for seed density: KA 26-8, T_7 and KA 1 for grain yield per plant and KA 97, K 26-10, K 15 and K 35 for protein content. It indicates that mean performance may have some predictive values for pod length, grain yield per plant and protein content. Venkateswarlu and Singh (1981) also observed similar results.

Close relationship among per se performance and combining ability effects (10 of the 19 parents showed this trend) is due to predominance of additive gene effects for these traits. Thus intercrossing of such parents followed by mass selection would result in quick accumulation of the favourable additive genes. The similarity in the estimates of combining ability for these parents in F_1 and F_2 generations indicates that best general combiners are also stable in their performance over seasons and generations. Rojas and Sprague (1952) pointed out that gca effects would be more stable over years or locations as compared to sca effects. Hence, it is likely that the lines selected on the basis of seasons and generations for high gca effects could be expected to be dependable over seasons and generations. Since these 10 parents KA 26-10, DPPA 8515, KA 12, T_7, K 15, KA 26-8, K 9125 (B), KA 1 and KA 97 which are superior in both F_1 and F_2 may be used for intermating and subsequently handled through mass selection and concurred intermating.It is also evident (Table 2.) that parent T_7 for seven characters followed by K 35 for five characters, KA 12, KA 26-9, K 9125 (B), KA 1, K 9125 (M), KA 26-8, C_{11} and K 26-10 each for three characters, and DPPA 8515, ICPL 8887 and KDF_2 each for two characters were with desirable gca effects in both the generations.

The present study suggested a good degree of agreement for line x tester mating design of the gca effects based on F_1 and F_2 data in respect of most of the characters. An examination of the gca estimates further reflects a desirable situation in which the highest ranking varieties for grain yield/ plant exhibited superiority in respect of other characters of economic importance. For instance, parent $T_{7,}$ the gca estimates for the characters viz. days to initial flowering. number of primary branches / plant, number of pods / cluster, number of seeds / pod, pod length and 100-seed weight, indicated desirable effects.

Table 1: Ranking of desirable parents, in order of merit, on the basis of gca effect in F_1 and F_2 generation and per se performance for 13 characters in pigeonpea

Character	Good general combiners		Common in F_1 and F_2	Per se performance
	F_1	F_2		
Days to initial flowering	K 35 DPPA 8515** KA 15* K 9125 (M) K 26-10** T_7	K 26-10** K 35 DPPA 8515** KA 108* C_{11}* KA 32-1*	K 35 DPPA 8515** K 26-10**	K 26-10** ICPL 8887 DPPA 8515** KA 32-1* C_{11} * KA 108* K 15* KA 26-8 KA 12
Plant Height	ICPL 8887* K 15* K 35 KA 12** KPBR 80-2	K 35 K 15** KA 97* KA 12** KA 108 KDF_2 KA 26-9* KPBR 80-2	K 15** K 35 KA 12** KPBR 80-2	KA 26-9* KA 98* KA 12** K 26-10 K 15** KA 26-8 ICPL 8887* K 9125(B) KA 1
Number of primary branches/ plant	K 9125 (M) T_7** K 9125(B) KA 108* KA 97* KPBR 80-2* KA1 C_{11}*	K 9125(M) KDF_2 K 9125(B) T_7** KA 32-1* Banda palera	K 9125(M) K 9125(B) T_7**	K 35 KA 32-1* T_7** KA 108* KA 26-8 C_{11}* K 15 KPBR 80-2* KA 97*
Number of clusters / plant	C_{11} K 26-8* K 26-10* KDF_2 ICPL 8887** K 15* ICPL 8515 Banda palera*	ICPL 8887** C_{11} KA 97 K 9125(M) KPBR 80-2	C_{11} ICPL 8887*	KA 26-8* KA 1 K 26-10* Bandra palera* KA 26-9 T_7* ICPL 8887* K 15* KA 32-1

Character	**Good generation combiners**		**Common in F_1 and F_2**	**Per se performance**
	F_1	**F_2**		
Number of pods / cluster	DPPA 8515 C_{11}* K 9125(M) KA 1 T_7** KA 12* KA 32-1* KA 97	KA 1 K 15 DPPA 8515 T_7**	DPPA 8515 KA 1 T_7**	K 35 T_7** KDF_2 KA 32-1* K 9125(B) C_{11}* KA 108 KA 12* ICPL 8887
Number of pods / plants	C_{11} KA 26-8** DPPA 8515 KDF_2 T_7* K 9125(M) K 26-18* KA 32-1* Banda palera**	C_{11} ICPL 8887* K 9125(M) K 15 KA 1 KA 97 KA 26-8** Banda palera** KDF_1**	C_{11} KA 26-8** KDF_2 K 9125(M) Banda palera**	KA 26-8** KA 1* K 26-10* T_7* KA 32-1* K 35 Banda palera** KA 32-1* KDF_2** ICPL 8887*
Number of seeds / pod	KA 12* T_7** K 9125(B)*	T_7** KA 1* K 15 KA 32-1* KA 26-8* DPPA 8515 KA 108*	T_7**	K 9125(M) KPBR 80-2 K 9125(B)* KA 108* KA 1* KA 12* KA 32-1* KA 26-8* T_7**
Pod Length	T_7** KA 26-9 C_{11} K 9125(B)** K 26-10 KA 12** Banda palera	T_7** KA 26-8 KA 12** KA 1* KA 26-9 K 9125(B)**	T_7** KA 26-9 K 9125(B)** KA 12**	KA 1* KDF_2 K 9125(B)** T_7** KA 108 K 15 KA 31-1 K 35 KA 12**
Days to maturity	KA 97* K 26-10** K 9125(B)** KA 108** K 35	K 9125(B)** K 26-10**	K 26-10** K 9125(B)**	KA 97* K 9125(B)** ICPL 8887 T_7 C_{11}

Character	Good generation combiners		Common in F_1 and F_2	Per se performance
	F_1	F_2		
				KA 32-1 K 26-10** KA 108* KA 26-8
100-seed weight	KA 26-8 KA 1* ICPL 8887 K 35 T_7** KA 12** KA 26-9 KA 32-1* K 9125(B)*	KA 26-8 KA 12** K 35 T_7** K 9125(M) KA 26-9	KA 26-8 K 35 T_7** KA 12** KA 26-9	K 9125(B)* KA 108 C_{11} KA 1* KPBR 80-2 Banda palera T_7** KA 32-1*
Seed density	KA 26-9 C_{11}* K 9125(M)* KA 1** K 35 KA 32-1 KDF_2 K 9125(B)	ICPL 8887* KA 1** KA 108* K 35 KPBR 80-2 KA 26-9 KA 26-8 KDF_2 K 26-10*	KA 26-9 KA 1** K 35 KDF_2 KA 1** K 9125(M)* C_{11}*	DPPA 8515 K 26-10* Banda palera T_7 ICPL 8887*
Grain yield / plant	C_{11} KA 26-8** T_7* DPPA 8515 KA 1** KA 32-1* K 9125(M)	KA 26-8** KA 1** T_7** ICPL 8887 K 15 K 9125(M) C_{11} Banda palera	C_{11} KA 26-8** T_7** KA 1** K 9125(M)	KA 108* KA 1** KA 26-8** T_7** Banda palera* KA 32-1* K 9125(B) KA 108 K 35 K 26-10
Protein content	KA 97** K 26-10** K 15** C_{11} K 35**	K 26-10** KA 97** K 35** KA 108 K 15** ICPL 8887*	KA 97** K 26-10** K 15** K 35**	ICPL 8887* KA 26-9 K 15** KA 97** K 26-10** DPPA 8515 KA 32-1 KA 12 K 35**

**Parents are common in all the procedure.

*Parents are common based on per se performance and gca effects in F_1/F_2.

Table 2: Parents exhibiting significant and desirable gca effects both in F_1 and F_2 generation for more than one character in pigeopen.

Parents	Character for which significant and desirable gca effects were observed
KA 12	Plant height , pod length and 100- seed weight
KA 26-9	Pod length , 100-seed weight and seed density
K 9125(B)	Number of primary branches per plants , pod length and day to maturity.
KA 1	Number of pods per cluster, seed density and grain yield per plant
T_7	Days to initial flowering, number of primary branches per plant, number of pods per cluster, number of seeds per pod, pod length, 100-seed weight, grain yield per plant
K 9125(M)	Number of primary branches per plant, number of pods per plant, grain yield per plant
DPPA 8515	Days to initial flowering and number of pods per cluster Days to initial flowering, plant height, 100-seed weight, seed density and protein content
ICPL 8887	Number of clusters per plant and 100-seed weight
KA 26-8	Number of pods per plant, 100-seed weight, grain yield per plant
KDF_2	Number of pods per plant and seed density
C_{11}	Number of clusters per plant, Number of pods per plant and grain yield per plant
K 26-10	Days to initial flowering, number of clusters per plant and protein content

References

Charlu, C.; Murlidhar, V. and Venkateswarlu (1989).Heterosis in relation to combining ability in pigeonpea. Indian J. Agric. Sci.9(1):68-70.

Ghodke, M.K.; Patil , R,A.; Kardile, K.R.;Jahagirdar,J.E. and Dahiwal,A.L.(1993).Combining ability studies in pigeonpea. Inter. Pigeonpea Newsletter.18:6-7.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol.Sci.9:463-493.

Indrani Dana and T.Dasgupta (2010). Combing ability in blackgram. Indian J. Genet. 61(2):170-171.

Kempthorne, O. (1957). An Introduction of Genetic statistics. John Willey and sons Inc. New York: Chapinan and hall, London.

Lakhan, R. ;Gupta ,M.P.; Singh I.B.; Mishra ,R. and Singh, P.(1986).Combining ability for yield and some other characters in pigeonpea. Crop Improv. 13(1):92-94.

Patel. J.A.; Pathak, A.R.; Zaveri, P.P. and Shah, R.M.(1987). Combiming ability analysis in pigeonpea. Indian J. Genet. 47(2):183-188.

Patel.G. V.; Zaveri, P.P. and Pathak , A.R. (1992). Combining ability analysis of parents and hybrids using genetic male sterility in pigeonpea. Indian J. Genet. 52(3):292-296.

Patel, D.B. (1990).Heterosis and combining ability in pigeonpea (Cajanus cajan(L.) Millsp.).Indian J. Pulse Res.3(1):7-12.

Patel, H.S.; Patel, A.M.Chaudhary, N.B.; Patel, P.C. and Viradiya. Y.A. (2015). Investigation of combining ability and gene action for seed yield and its component traits in pigeonpea. Int. J. Curr. Microbiol. App. Sci. 9(8):1095-1103.

Rojas, B.A. and Sprague, G.F. (1952). A comparison of variance components in corn yield trials. General specific combining ability and their interactions with locations and years. Agron. J. 44:462-466.

Sinha, S.C.; Singh, K.N. and Ram Lakhan (1994). Combining ability and heterosis in pigeonpea. Indian J. Pulse Res. 7(1):63-65.

Singh, S. P.; Govil, J.N. and Ram, H. (1983). Combining ability and heterosis in early pigeonpea hybrids .Indian J. Genet. 43(3):481-486.

Venkateswarlu, S. and Singh, R. B. (1981).Combining ability for earliness in pigeonpea (Cajanus cajan (L.) Millsp.). Biometrics.17:229-250.