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Combining ability and gene action studies in cowpea (*Vigna unguiculata* (L.) Walp)

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Abstract

The combining ability of the parents as well as the hybrids of cowpea (*Vigna unguiculata*) involving three lines and five testers was studied. The parents and their resultant 15 hybrids were evaluated in line x tester mating design and observations were recorded for six quantitative traits. Among the parents, female parent C-152 and male parent Wali 4 were good general combiner for yield components. The crosses GC-3 X Wali 4 and C-152 X VCM-8 exhibited higher specific combining ability effects for yield components. The variances due to specific combining ability were higher in magnitude than general combining ability for majority of the characters which indicated predominance of non-additive gene action for these characters.

Key words: Cowpea, GCA, hybrids, parents, SCA

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) is cultivated in India from ancient times for grains, tender pods, cover crop, green manure and fodder. Cowpea cultivation is neglected due to its low yielding ability. This crop is not exploited as compared to other pulse crop due to low yield potential. Hence, there is a need to give more attention for systematic genetic study and developing high yielding varieties in order to solve malnutrition problems. India is a leading producer of cowpea. It is grown in central and peninsular regions. In order to replace the old outdated genetically eroded varieties, there is urgent need to develop high yielding varieties through systemic research programme where agronomically superior and biotic / abiotic stress tolerant types can be developed. Combining ability analysis gives useful information regarding selection of parents based on performance of their hybrids. Further, it serves as a powerful tool to elucidate the nature and magnitude of various types of gene action involved in the expression of quantitative traits. The line x tester analysis technique provides a systematic approach to assess the combining ability of parents and crosses for different quantitative characters (Kempthorne 1957). An added advantage of this method is that it gives overall genetic picture of the material under investigation in a single generation and more number of genotypes can be studied at time. The present investigation was therefore undertaken in a line x tester mating design to determine combining ability and gene action for different quantitative characters.

Materials and Methods

The present investigation was conducted at the Pulse Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar during 2005 and 2006. The experimental materials chosen for this study consisted of three lines viz., C-152, GC-3, Pusa -do-phasali and the five testers viz., Konkan Safed, VCM-8, DFC-1, Pusa Falguni, Wali-4. These selected eight genotypes posses good amount of variation for earliness, pod length, number of seed, seed colour, seed size etc. along with yield.

The resulting 15 F_1 hybrids and their 8 parents were grown in a randomized block design with three replications. The variety VCM-8 was used as standard check for comparison. The hybrids along with check and parents were sown in adjacent separate blocks as suggested by Arunachalam (1974). Each treatment was randomized in each block and sown in rows of 5 m length at 45 cm x 15 cm spacing. The crop was raised with standard package of practices and plant protection measures. Observations were recorded for six quantitative traits viz., days to 50% flowering, pod length, number of seeds per pod, 100-seed weight, number of

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pods per plant and seed yield per plant in five randomly selected plants in each treatment and replication.

Results and Discussion

General combining ability effects: The estimates of GCA effects revealed that none of the parent was found to be consistently good general combiners for all the characters (Table 1). The female parent C-152 showed highest significant positive gca for pod length, number of seeds per pod, 100-seed weight and seed yield per plant, while GC-3 showed highest significant positive gca effects for number of pods per plant. Pusa Dophasali showed highest significant negative gca effect for days to 50% flowering. Among the male parent Wali 4 showed highest significant positive gca for pod length, 100 seed weight and seed yield per plant. However, DFC-1 was the best general combiner for number of seeds per pod (0.85), while Pusa Falguni was best for number of pods per plant (1.59). The parent VCM-8 was found best general combiner for days to 50% flowering.

Specific combining ability effects: The estimates of SCA effects revealed that none of the crosses was found to be consistently superior for all the characters (Table 2). The cross C-152 x VCM-8 (-8.02) was the best cross combination showing significant highest negative sca effect for days to 50% flowering. Out of 15 crosses, five crosses viz., C-152 x VCM-8, C-152 X Wali 4, GC-3 x Konkan safed, GC-3 x DFC-1 and Pusa-do-phasali x Konkan Safed exhibited sca effects in desirable direction for days to 50% flowering. For pod length, four crosses viz., C-152 x VCM-8, Pusa-do-phasali x Konkan Safed, Pusa–do-phasali x Pusa Falguni and GC-3 x VCM-8 exhibited significantly positive sca effects. Out of 15 crosses, six crosses showed significant positive sca effects for number of seeds per pod and cross Pusa-do-phasali x Wali 4 recorded highest significant sca effect followed by C-152 x VCM-8 (1.02). Five crosses viz. C-152 x VCM-8, GC-3 x Konkan Safed, GC-3 x Wali, Pusa-do-phasali x VCM-8, Pusa-do-phasali x DFC-1 showed significant positive sca effects for 100 seed weight. For number of pods per plant, five crosses viz., C-152 x Konkan Safed, GC-3 x DFC-1, GC-3 x Pusa Falguni, Pusa-do-phasali x Konkan Safed (1.02) and Pusa-do-phasali x Wali 4 recorded significant positive sca effect. Similarly, six crosses show significant positive sca effect for seed yield per plant, among them cross GC-3 x Wali 4 recorded highest significant positive sca effect followed by C-152 x VCM-8 and Pusa-do-phasali x Pusa Falguni.

Gene action and heritability: The magnitude of gca variances were greater than sca variances for two characters days to 50% flowering and pod length (Table 3). While gca variances were smaller than sca variances for the characters such as number of seeds per pod, 100-seed weight, number of pods per plant and seed yield per plant. Dominance variance was greater than additive variance for number of seeds per pod, 100-seed weight, number of pods per plant and seed yield per plant, where as for rest of the two characters the additive variance was greater than dominance variance. It was observed that A: D ratio was more than unity for the characters days to 50% flowering and pod length. The A: D ratio was less than unity for the remaining four characters. The narrow sense heritability estimate was above 50% for all the characters except number of seeds/pod.

Table 1: GCA effects of lines and testers yield contributing characters in cowpea

Sr. No.	Parents/ hybrids	Days to 50% flowering	Pod length (cm)	No. of seed/ pod	100 seed weight (g)	No. of pods/ plant	Seed yield/ plant
GCA Lines							
1	C-152	8.68*	0.51**	0.81**	1.84**	-1.69**	1.27**
2	GC-3	-3.24**	-038**	-0.28**	-2.19**	1.13**	-2.41**
3	Pusa- do-phasali	-5.44**	-0.13	-0.52**	0.35*	0.56**	1.14**
	SE±	0.48	0.09	0.06	0.13	0.05	0.17
	CD at 5%	0.99	0.19	0.13	0.28	0.12	0.36
	CD at 1%	1.33	0.25	0.18	0.38	0.16	0.49
GCA testers							
1	Konkan safed	-6.31**	-0.91**	-1.09**	0.30	-0.59**	-1.02**
2	VCM-8	-13.64**	-1.27**	-0.32**	-0.83**	1.58**	0.52*
3	DFC-1	-2.08**	-0.03	0.85**	0.32	-1.62**	-1.53**
4	Pusa Falguni	-6.88**	-0.99**	-0.09	-2.32**	1.59**	-0.86**
5	Wali 4	28.91**	3.21**	0.65**	2.53	-0.96**	2.91**
	SE±	0.62	0.12	0.08	0.17	0.07	0.23
	CD at 5%	1.28	0.24	0.17	0.36	0.15	0.47
	CD at 1%	1.72	0.33	0.23	0.49	0.21	0.64

Table 2: Specific combining ability effects of different yield contributing traits in cowpea

Sr. No.	Hybrids	Days to 50% flowering	Pod length (cm)	No. of seed/ pod	100 seed weight (g)	No. of pods/ plant	Seed yield/ plant
1	C-152 x Konkan Safed	6.64**	-0.61**	-0.39*	-0.89*	1.23*	0.94*
2	C-152 x VCM-8	-8.02**	1.08**	1.02**	0.93**	-0.09	2.67**
3	C-152x DFC-1	4.42**	-0.06	0.44**	0.32	0.23	0.60
4	C-152 x Pusa Falguni	2.53*	0.03	-0.46**	0.38	-1.07**	-1.86**
5	C-152 x Wali 4	-5.57**	-0.42	-0.61**	-0.74*	-0.30*	-2.36**
6	GC -3 x Konkan Safed	-2.42*	-0.35	-0.02	1.85**	-2.25**	-1.91**
7	GC -3 x VCM-8	7.24**	0.50**	0.40*	-3.11**	0.24	-2.75**
8	GC -3 x DFC-1	-3.97**	0.06	0.15	-1.42**	1.77**	1.76**
9	GC -3 x Pusa Falguni	-1.86	-0.55	0.57**	-0.98**	1.31**	-0.34
10	GC -3 x Wali 4	1.02	0.33	-1.11**	3.67**	-1.07**	3.25**
11	Pusa-do-phasali x Konkan Safed	-4.22**	0.97**	0.41	-0.95**	1.02**	0.97**
12	Pusa-do-phasali x VCM-8	0.77	-1.58**	-1.42**	2.18**	-0.15	0.07
13	Pusa-do-phasali x DFC-1	-0.44	-0.00	-0.60**	1.10**	-2.00**	-2.37**
14	Pusa-do-phasali x Pusa Falguni	-0.66	0.52*	-0.11	0.60	-0.23	2.20**
15	Pusa-do-phasali x Wali 4	4.55**	0.09	1.72**	-2.93**	1.38**	-0.88*
	SE±	1.08	0.20	0.14	0.30	0.13	0.40
	CD at 5%	2.21	0.42	0.30	0.63	0.27	0.82
	CD at 1%	2.99	0.57	0.41	0.85	0.36	1.11

Table 3: Components of variance of cowpea for yield contributing characters

Sr. No.	Components	Days to 50% flowering	Pod length (cm)	No. of seed/ pod	100 seed weight (g)	No. of pods/ plant	Seed yield/ plant
1	σ^2GCAσ	140.23	1.41	0.54	3.77	2.24	3.90
2	σ^2SCA	34.34	0.73	1.14	5.90	2.61	6.68
3	σ^2A	560.92	5.66	2.19	15.10	8.96	15.60
4	σ^2D	137.36	2.95	4.57	23.60	10.45	26.74
5	h^2(ns%)	88.76	78.33	48.51	55.74	63.02	53.26
6	A : D ratio	4.08	1.91	0.48	0.64	0.85	0.58

The magnitude of gca variances were greater than sca variances for two characters days to 50% flowering and pod length suggesting the feasibility of using different selection procedures for exploiting these characters. Similar findings were reported by Ponmariamma and Das (1997), Madhusudan *et al.* (1995), Sawant (1995), Patel *et al.* (1994) and Thiyagarajan (1992). While gca variances were smaller than sca variances for the characters such as number of seeds/pod, 100-seed weight, number of pods /plant and seed yield/plant. Dominance variance was greater than additive variance for number of seeds/pod, 100 seed weight, number of pods /plant and seed yield/plant, where as for rest of the two characters the additive variance was greater than dominance variance. It was observed that A:D ratio was more than unity for the characters days to 50% flowering and pod length. The A:D ratio was less than unity for the remaining four characters. The narrow sense heritability estimate was above 50% for all the characters except number of seeds/pod. The heritability (ns) estimates were of high magnitude for days to 50% flowering (88.76 %) and pod length (78.33 %) indicating major role of genotype in the inheritance of their character. Drabo *et al.* (1984), Patil and Shete (1986) and Zaveri *et al.* (1983) reported similar results earlier for quantitative characters.

Looking overall performance of all parents based on general combining ability effects, C-152 among the female parent was the best combiner for pod length, number of seeds per pod, 100-seed weight, seed yield per plant. Among males, Wali 4 was the best combiner for pod length, number of seeds per pod, 100-seed weight and seed yield per plant. Considering the *per se* performance, general combining ability effects of parents and specific combining ability of hybrids the cross GC-3 x Wali 4 was appeared to be the most promising for yield and its principal component.

सारांश

लोबिया के तीन लाइन एवं पाँच टेस्टर को समाहित कर पित्रों तथा संकरों की संयोजन क्षमता का मूल्यांकन किया गया। पित्रों तथा उनके उत्पन्न 15 संकरों का मूल्यांकन लाइनग टेस्टर प्रजनन पद्धति से किया गया तथा 6 मात्रात्मक गुणों का अवलोकन किया गया। पित्रों में, माता पितृ सी–152 व नर पितृ बाली–4 उपज घटकों के लिये अच्छे संयोजक थे। संयोजन जी सी–3xवाली–4 तथा सी–152xवी

सी एम–8 उपज घटकों के लिए सर्वाधिक विशिष्ट संयोजन क्षमता को प्रदर्शित किये। प्रसरण के कारण विशिष्ट संयोजन क्षमता, मूल्य सामान्य संयोजन क्षमता से कई प्रमुख घटकों के लिए ज्यादा था, जिससे स्पष्ट होता है कि इन गुणों के लिए अयोज्य जीन की पूर्व प्रभाविता है।

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