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Research Article

Combining ability analysis in the inter subspecific crosses of cowpea (*Vigna unguiculata* (L.) Walp.) and yard long bean (*Vigna unguiculata* (L.) Walp. spp. *sesquipedalis*)

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Abstract
The study was carried out to determine combining ability analysis among crosses derived from 11 selected cowpea genotypes. Six lines and five testers were crossed in L x T fashion and 30 hybrids were synthesized. Genotypes GC 3, Co 6, ACM 05-07, RC 101, Co(CP)7, and ACM 05-02 belonging to *Vigna unguiculata* were used as lines. Vellayani Local, Ettumanoor Local, Vyjayanthi and Vellayani jyothica belonging to *Vigna unguiculata* spp. *sesquipedalis* and VBN 2 belonging to *Vigna unguiculata* were used as testers. The results indicated the presence of both additive and non-additive genetic components for most of the traits. Based on the general combing ability, the parents GC 3, RC 101, Vyjayanthi and Vellayani jyothica were selected as good combiners. The most promising specific combiners for yield and yield components were GC 3 x Vellayani local, GC 3 x Vellayani jyothica, ACM 05-07 x VBN 2, ACM 05-07 x Vyjayanthi, RC 101 x Vellayani jyothica and ACM 05-02 x Vyjayanthi.

Key words Cowpea, combining ability, inter subspecific crosses, line x tester analysis

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp.) (2n=2x=22) is a member of the tribe Phaseoleae of Fabaceae family. Cowpea is a warm-season, annual, herbaceous legume. Yard long bean (*V. sesquipedalis*) is much more a trailing and climbing plant, often reaching 9 - 12 feet in height with pods 30 - 100 cm long and more or less inflated and flabby when young. *V. Sesquipedalis* has pods with sparse seed arrangement. *V. unguiculata* has bushy plant stature with short pod length upto 15 - 20 cm and dense seed arrangement. Hence, the crosses were made between the *V. unguiculata* and *V. sesquipedalis* types to get the higher pod length with dense seed arrangement. Combining these two characters can help to improve the yield potential of the progenies. Among the testers, Vyjayanthi (*V. sesquipedalis* type) has the pink coloured pod. The expectation was that pink colour from the Vyjayanthi should inherit to the progeny. Hence, analyzing of combining ability between *V.unguiculata and V.sesquipedalis* shall give new way for improving cowpea genotypes. Combining ability describes the breeding value of parental lines to produce hybrids. Hence the present study was undertaken.

Material and Methods

The experiment was carried out at Agricultural College and Research Institute, Madurai. The parents used for this experiment are given in Table 1. Crosses were made in a Line x Tester mating design using six genotypes as lines and five as testers and obtained hybrid seeds from 30 cross combinations. Thirty hybrids along with 11 parents were evaluated in randomized block design with three replications. The spacing adapted was 60 cm x 45 cm. Recommended package of practices for agronomic and pest management measures were followed. Observations were recorded on ten plants chosen randomly in each replication. The observations were taken for ten characters namely days to 50 percent flowering, plant height, number of branches per plant, number of clusters per plant, number of pods per clusters, pod length, number of seeds per pod, days to maturity, 100 grain weight and single plant yield. The line x tester analysis was carried out as suggested by Kempthrone (1957).

Results and Discussion

Estimation of *gca* of the 11 genotypes for the ten characters showed GC 3, RC 101, Vyjayanthi and Vellayani jyothica were the best combiners for grain yield (Table 2.). Among the female parents

GC3 was best general combiner for number of cluster per plant, number of pods per cluster, pod length, number of seeds per pod and 100 grain weight. RC101 and Vellyani local were best general combiners for the traits number of branches per plant, number of cluster per plant, pod length and 100 grain weight. Vyjayanthi was best general combiner for number of pods per clusters, pod length, number of seeds per pod and 100 grain weight. Similar results were reported by Sobha *et al*. (1998), Yadav *et al.* (2003), Patil and Navale (2006), Indra Singh *et al.* (2006), Pal *et al.* (2007) and Kwaye Romanus *et al*.(2008).

The estimates of *sca* of 30 crosses for the ten characters are presented in Table 3. Ten cross combinations namely GC 3 x Vellayani local, GC 3 x Vellayani jyothica, CO 6 x VBN 2, CO 6 x Ettumanoor local, ACM 05-07 x VBN 2, ACM 05-07 x Vyjayanthi, RC 101 x Vellayani jyothica, CO(CP) 7 x Ettumanoor local, ACM 05-07 x Vyjayanthi, ACM 05-02 x Ettumanoor local and ACM 05-02 x Vyjayanthi showed the best specific combining ability most of the yield contributing characters. The cross combination GC 3 x Vellayani local was the best specific combiner for number clusters per plant, number of pods per cluster, pod length, number of seeds per pod and days to maturity. GC 3 x Vellayani jyothica was the best specific combiner for number of clusters per plant and number of pods per clusters. CO 6 x VBN 2 was the good specific combiner for number of branches per plant, pod length and 100 seed weight. CO 6 x Ettumanoor local was the good specific combiner for days to 50% flowering, number of clusters per plant, pod length, number of seeds per pod and 100 grain weight. ACM 05-07 x VBN 2 was the good specific combiner for days to 50% flowering, number of clusters per plant and 100 seed weight. ACM 05-07 x Vyjayanthi was the good specific combiner for number of clusters per plant, number of pods per cluster and number of seeds per pod. RC 101 x Vellayani jyothica was the good specific combiner for days to 50% flowering, number of clusters per plant, number of pods per clusters, pod length, days to maturity and 100 grain weight. CO (CP) 7 x Ettumanoor local was the good specific combiner for plant height, number of branches per plant and number of pods per clusters. CO (CP) 7 x Vyjayanthi was the good specific combiner for number of clusters per plant and number of pods per clusters. ACM 05-02 x Ettumanoor local was the good specific combiner for number of branches per plant, number of pods per clusters and pod length. ACM 05-02 x Vyjayanthi was good specific combiner for days to 50% flowering, number of pods per clusters, pod length, number of seeds per plant, days to maturity and 100 grain weight. Apart from these, all F_1s involved with Vyjayanthi had pink coloured pods. The findings of Patil and Navale (2006), Indra Singh *et al.* (2006), Pal *et al.* (2007) and Kwaye Romanus *et al*.(2008) were similar to present findings.

The existence of high variability for different characters among cowpea varieties had been reported by Hazra *et al.* (1994). Presence of highly significant *gca* and *sca* variances for most of the characters indicated the importance of both additive and non-additive genes in the expression of the traits (Kheradnam and Niknejad, 1971). In this study, crosses made between vegetable type yard long bean (*V. sesquipedalis*) and *V.unguiculata*, *V.sesquipedalis* types are having climbing nature and lengthy pods (40cm to 60 cm) with dispersed seed arrangement. In contrast to *V. sesquipedalis* type, the seed types are mostly bushy plant type with shorter pod length and dense seed arrangement.

With the foregoing discussion, it may be concluded that both additive and non-additive genetic components are important for most of the traits. Parents viz., GC 3, RC 101, Vyjayanthi and Vellayani jyothica were found to be good general combiners for grain yield and yield components. These lines could be utilized in hybridization programs to exploit heterosis. The most promising specific combiners for yield and yield components were GC 3 x Vellayani local, GC 3 x Vellayani jyothica, ACM 05-07 x VBN 2, ACM 05-07 x Vyjayanthi, RC 101 x Vellayani jyothica and ACM 05-02 x Vyjayanthi.

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Table 1. Details of parental lines

S.No.	Genotype	Parentage	Usage
L_1	GC 3	Selection from forage cowpea CAZRI, Jodhpur	Grain
L_2	Co 6	MS 9804 x C 152	Grain
L_3	ACM 05-07	Sarika X CO6	Grain
L_4	RC 101	IT 82 D-652 X FS 68	Grain
L_5	Co(CP) 7	Gamma mutant of CO4	Grain
L_6	ACM 05-02	Selection from TC 49-1	Grain
T_1	VBN 2	Selection from IT 81-D-1228-10	Vegetable
T_2	Vellayani Local	Local variety of kerala	Vegetable
T_3	Ettumanoor Local	Local variety of kerala	Vegetable
T_4	Vyjayanthi	Local variety of kerala	Vegetable
T_5	Vellayani jyothica	Local variety of kerala	Vegetable

Table 2. General combining ability effects for different traits

	Parents	Days to 50 percent flowering	Plant height (cm)	No. of branches per plant	No. of clusters per plant	No. of pods per cluster	Pod length (cm)	No. of seeds per pod	Days to maturity	100 grain weight (g)	Single plant yield (g)
L_1	GC 3	1.16 **	12.97 **	0.02	2.91 **	0.08 **	1.99 **	0.78 **	1.68 *	0.97 **	58.34 **
L_2	Co 6	1.62 **	-7.99 *	0.06 **	-5.48 **	-0.67 **	-3.38 **	-0.32	0.81	-1.97 **	-82.94 **
L_3	ACM 05-07	-0.44	4.40	-0.29 **	1.08	0.61 **	0.10	-0.55 *	0.61	-2.31 **	1.34
L_4	RC 101	-1.98 **	-4.52	0.33 **	2.61 **	-0.23 **	1.99 **	-0.12	-1.46 *	0.81 **	18.10 **
L_5	Co(CP) 7	2.76 **	-5.00	0.51 **	0.98	-0.08 **	-1.77 **	0.37	2.21 **	0.18	-1.60
L_6	ACM 05-02	-3.11 **	0.14	-0.63 **	-2.10 **	0.29 **	1.08 *	-0.16	-3.86 **	2.33 **	6.76
T_1	VBN 2	-1.94 **	-14.54 **	-0.35 **	1.44 *	0.33 **	-4.86 **	-0.70 **	-1.36 *	-3.45 **	-24.49 **
T_2	Vellayani Local	1.94 **	-4.10	-0.13 **	-0.60	-0.24 **	-0.67	0.42 *	1.70 **	-0.49 *	-15.62 **
T_3	Ettumanoor Local	-3.56 **	13.95 **	0.05 **	-2.96 **	-0.09 **	-0.13	-0.77 **	-4.19 **	-0.71 **	-47.40 **
T_4	Vyjayanthi	2.11 **	2.00	-0.15 **	-0.52	0.06 *	1.80 **	0.80 **	2.09 **	1.36 **	23.31 **
T_5	Vellayani jyothica	1.44 **	2.69	0.58 **	2.64 **	-0.05	3.86 **	0.25	1.76 **	3.29 **	64.19 **

* Significant at 5% level, ** Significant at 1% level.

Table 3. Specific combining ability effects for different traits

Hybrids	Days to 50% of flowering	Plant height (cm)	No. of branches/Plant	No. of clusters/Plant	No. of pods/ clusters	Pod length(cm)	No. of Seeds/pod	Days to maturity	100 grain weight(g)	Single plant yield(g)
L_1 x T_1	3.34 **	-16.01 *	1.46 **	0.47	0.24 **	-1.30	0.03	0.82	-1.71 **	-22.24 *
L_1 x T_2	-2.21 **	2.95	-1.08 **	10.02 **	0.41 **	2.36 *	1.08 *	-4.23 **	0.54	116.52**
L_1 x T_3	-1.04	18.06 *	-0.04	-10.14 **	-1.10 **	0.86	-1.23 *	-1.34	1.35 **	-115.19 **
L_1 x T_4	-2.04 **	-5.76	-0.40 **	-6.53 **	-0.32 **	-0.18	-0.13	2.38	-0.27	-104.19 **
L_1 x T_5	1.96 **	0.75	0.06	6.17 **	0.77 **	-1.73	0.24	2.38	0.09	125.10 **
L_2 x T_1	1.21	11.52	1.43 **	-1.71	-0.06	4.86 **	0.14	1.02	3.21 **	29.94 **
L_2 x T_2	-0.34	-3.96	-1.17 **	-1.52	0.18 **	-2.19 *	-0.65	0.97	-0.40	-2.44
L_2 x T_3	-3.51 **	10.88	-1.41 **	10.44 **	0.03	7.97 **	1.70 **	-2.14	2.60 **	85.97 **
L_2 x T_4	0.16	-7.96	0.70 **	-2.94	-0.12 *	-4.70 **	-2.03 **	-0.42	-1.66 **	-41.76 **
L_2 x T_5	2.49 **	-10.49	0.45 **	-4.27 *	-0.02	-5.94 **	0.85	0.58	-3.75 **	-71.70 **
L_3 x T_1	-2.72 **	0.91	-1.20 **	5.84 **	-0.08	-3.51 **	-1.46 **	-0.11	1.09 *	24.30 *
L_3 x T_2	3.06 **	-2.11	3.76 **	-2.01	-0.47 **	-0.23	0.08	1.50	0.28	-28.84 **
L_3 x T_3	-0.44	0.86	-2.08 **	-4.00 *	-0.25 **	1.26	-0.56	-1.28	0.76	-20.68
L_3 x T_4	2.22 **	-2.53	-0.05	5.28 **	0.49 **	1.36	1.54 **	0.11	-1.23 *	70.12 **
L_3 x T_5	-2.11 **	2.88	-0.43 **	-5.11 **	0.32 **	1.12	0.41	-0.22	-0.90	-44.90 **
L_4 x T_1	2.48 **	1.35	0.61 **	4.00 *	0.10	-1.11	0.44	2.62	-0.86	13.22
L_4 x T_2	-3.41 **	19.72 **	-1.79 **	-4.72 **	-0.27 **	4.45 **	-0.18	-2.43	1.43 **	-58.68 **
L_4 x T_3	0.42	-23.47 **	1.82 **	-0.29	0.21 **	-8.04 **	-0.66	-0.88	-3.71 **	-31.29 **
L_4 x T_4	4.09 **	4.83	0.01	-10.90 **	-0.57 **	1.96 *	0.27	4.18 **	1.29 **	-106.95 **

L_4 x T_5	-3.58 **	-2.44	-0.64 **	11.91 **	0.53 **	2.75 **	0.15	-3.49 *	1.85 **	183.71 **
L_5 x T_1	-1.92 *	4.37	-0.95 **	-9.90 **	-0.03	1.26	0.04	-0.38	0.26	-49.68 **
L_5 x T_2	-0.48	0.95	0.17 **	-3.01	-0.42 **	2.74 **	1.00	-1.43	1.13 *	-28.29 **
L_5 x T_3	2.69 **	-28.68 **	1.08 **	2.24	0.79 **	-6.10 **	0.18	4.12 **	-1.76 **	36.62 **
L_5 x T_4	0.02	9.03	-0.30 **	15.80 **	0.28 **	-0.77	-0.89	-1.16	-0.03	130.84 **
L_5 x T_5	-0.31	14.34	-0.00	-5.13 **	-0.62 **	2.87 **	-0.34	-1.16	0.41	-89.49 **
L_6 x T_1	-2.39 **	-2.14	-1.35 **	1.29	-0.17 **	-0.20	0.81	-3.98 *	-2.00 **	4.46
L_6 x T_2	3.39 **	-17.55 *	0.12 **	1.23	0.57 **	-7.12 **	-1.32 *	5.63 **	-2.96 **	1.74
L_6 x T_3	1.89 *	22.35 **	0.64 **	1.75	0.33 **	4.05 **	0.57	1.52	0.77	44.57 **
L_6 x T_4	-4.44 **	2.39	0.04	-0.71	0.25 **	2.33 *	1.25 *	-5.09 **	1.89 **	51.94 **
L_6 x T_5	1.56 *	-5.05	0.56 **	-3.57 *	-0.98 **	0.94	-1.31 *	1.91	2.30 **	-102.71 **
SE	0.73	7.47	10.71	1.65	0.061	0.95	0.51	1.51	0.47	0.04

* Significant at 5% level, ** Significant at 1% level