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COMBINING ABILITY ANALYSIS IN DUAL PURPOSE IN COWPEA (*VIGNA UNGUICULATA* (L.) WALP)

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Abstract

An investigation was carried out to know the combining ability of dual purpose cowpea lines among the crosses developed from eight selected cowpea genotypes. Analysis of variance revealed that both *gca* and *sca* effets were significant for plant height, number of secondary branches per plant, days to first flowering, days to 50% flowering, days to maturity, number of pods per plant, seed yield per plant, green fodder yield per meter row length, stover yield per plant and crude protein content indicating both additive and non-additive gene involved in expression of these traits. Among the parents MFC-09-12 good general combiner for days to fifty per cent flowering, days to maturity, number of pods per plant, number of seeds per pod, seed yield per plant and crude protein content. UPC-9202 good general combiner for number of primary branches per plant, leaf to stem ratio, days to first flowering, days to fifty per cent flowering, days to maturity, number of pods per plant, seed yield per plant and green fodder yield per meter row length. Among crosses SWAD × UPC-9202 exhibited significant *sca* effect for yield and yield related components, while UPC-8705 × BL-2 showed desirable *sca* effect for maturity related traits.

Key words : *Vigna unguiculata*, combining ability analysis, traditional cropping systems, semiarid regions.

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp.) is diploid with a chromosome number of 2n=22 belonging to the tribe Phaseolae of family *Fabaceae*. It is an important *kharif* food legume and forms an integral part of traditional cropping systems for the semiarid regions of the tropics where other food legumes may not perform well. Worldwide area under cowpea is about 14 million ha. Africa is the largest producer of cowpea (90.1% of 3.7 million tons) followed by Asia, which produced 7.1% of the total production (Anon, 2002).

Farmers often grow a short-duration spreading variety for grain and a long- duration spreading variety for fodder, but the grain and fodder yields are poor due to low yield potential of the spreading varieties and also due to early cessation of rains. Since majority of cultivars derive their high productivity from an erect growth habit (Singh and Sharma, 1996). The use of cowpea as a dual-purpose crop, providing both grain and fodder, is attractive in mixed crop/livestock systems where land and feed are becoming increasingly scarce (Tarawali *et al.,* 1997) especially in the dry season. Despite the high grain and fodder yields, the haulms of improved dual- purpose varieties have crude protein content (17-18%) and dry matter digestibility (64-71%) compared to the local varieties.

Dual purpose cowpea has the potential to function as a key integrating factor in intensifying systems through supplying protein in human diets and fodder for livestock, as well as bringing N into the farming system through biological fixation (FAO, 2000; Giller, 2001). Efforts at global level (IITA and ILRI) focused a systematic programme to develop medium-maturing (85-95 days), semi-erect, dual-purpose varieties with higher grain and fodder yields and with enhanced fodder quality.

Materials and Methods

Parents are evaluated for dual purpose and based on their suitability of dual nature eight parents were selected and crossed in half diallel fashion excluding reciprocals. Twenty eight crosses along with their parents and check

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were evaluated in randomized block design with two replications. All recommended package of practice were followed. In each treatment fifteen plants were accommodated. Observation were recorded on five randomly selected and tagged plants for plant height (cm), days to first flowering, number of primary branches per plant and number of secondary branches per plant. At first flowering ten plants were cut leaving three nodes from base followed by fertilizer application and irrigation allowing for regeneration. From regenerated plant, observations *viz*., seed yield per plant (g), green fodder yield per meter row length (kg) at first flowering, leaf to stem ratio, dry matter content and crude protein content were recorded. Days to fifty per cent flowering were recorded from the five plants left uncut per replication. Diallel analysis of method 2 (model II), (p (n+1/2 diallel analysis) was carried out as suggested by Griffing (1956).

Results and Discussion

Mean sum of square for *gca* and *sca* effects among parents and their crosses revealed significant differences for most of the traits except number of primary branches per plant, number of seeds per pod, pod length and test weight (table 1). The significance of *gca* and *sca* variance for the character indicated that both additive as well as non- additive type of gene actions were involved in the expression of these traits (Mukati *et al.*, 2014). Daniel and Joseph, 2013 reported high *gca* and *sca* mean squares for grain yield, hundred seed weight, number of seeds per pod, pod length, days to flowering and plant height showed considerable genetic variability and importance of additive and non-additive gene effects among the parents and their respective crosses. The general combining ability effect (table 2) revealed that none of the parent showed significant *gca* effect for all the characters (Chaudhari *et al*. 2013). However, the parent MFC-09-12 was good general combiner for characters *viz*., days to fifty per cent flowering, days to maturity, number of pods per plant, number of seeds per pod, seed yield per plant and crude protein content similar findings were reported by Chaudhari *et al*. 2013 wherein significant and positive *gca* effects were observed for seed yield per plant, branches per plant, clusters per plant, pods per plant, pod length, seeds per plant and 100-seed weight. The parent UPC-8705 was good general combiner for the traits such as number of secondary branches per plant, green fodder yield per meter row length, dry matter

Table 1: Analysis of variance for parents and crosses for green fodder and seed yield related characters along with crude protein in cowpea.

Source of variation	d.f	Plant height (cm)	No. of primary branches	No. of secondary branches	Leaf to stem ratio	Days to first flowering	Days to 50% flowering	Days to maturity	No. of pods per plant
Replications	1	51.40	0.01	0.06	0.00	22.00	25.44	0.01	2.13
Diallel progenies	35	781.58**	16.46	14.75**	0.10*	109.50**	122.20**	81.49**	101.98**
Parents	7	641.23**	1.11	1.27	0.05	128.15**	154.50**	80.34**	244.20**
F_1's	27	816.74**	15.02*	13.25**	0.11**	95.02**	107.77**	70.91**	68.70**
Parents *vs*. F_1	1	814.75*	0.32	0.24	0.21*	369.75**	285.76**	375.15**	4.79
Error	35	178.64	10.08	2.90	0.05	21.74	25.53	1.44	9.71

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Source of variation	d.f	No. of seeds per pod	Pod length (cm)	Test weight (g)	Seed yield per plant (g)	Green fodder yield per meter row length (kg)	Dry matter content (%)	Stover yield (g)	Crude protein (%)
Replications	1	0.81	2.95	1.66	7.47	0.02	0.60	27.60	6.30
Diallel progenies	35	2.48	2.30	1.54	87.71**	0.26**	4.37*	671.01**	5.10**
Parents	7	2.35	1.37	1.20	101.40**	0.43**	2.70	981.00**	4.12**
F_1's	27	2.57	2.62	1.68	78.89**	0.23**	4.89*	587.90**	5.21**
Parents *vs*. F_1	1	0.82	0.06	0.001	230.13**	0.002	2.25	745.44	8.77**
Error	35	2.01	1.73	1.01	7.96**	0.04	2.17	232.00	1.17

*- significant at 5 per cent probability **- significant at 1 per cent probability

Table 2: General combining ability effects of parents for green fodder and seed yield related characters along with crude protein in cowpea.

Parents	Plant height (cm)	No. of primary branches	No. of secondary branches	Leaf to stem ratio	Days to first flowering	Days to 50% flowering	Days to maturity	No. of pods per plant
SWAD	-4.78	-0.01	0.29**	-0.002	1.05	0.69	0.16	-0.56
MFC-09-12	4.80	-0.05	0.03	0.01	-1.30	-2.33*	-2.95**	4.44**
UPC-8705	4.57	-0.08	0.18**	-0.02	2.63*	3.06**	0.29	-0.03
UPC-9202	-7.33*	0.31*	0.03	0.15**	-4.78**	-5.83**	-2.03**	5.63**
BL-2	-1.88	-0.10	-0.11	-0.02	-1.60	-1.66	-0.42	-0.46
UPC-622	0.67	-0.17	0.03	-0.01	0.83	1.25	0.10	-2.70**
EC-4216	6.85*	0.15	-0.15*	-0.11*	2.81**	4.13**	2.26**	-3.25**
UPC-5286	-2.90	-0.07	-0.30**	0.001	0.37	0.70	2.59**	-3.07**
SE $_{(gi)}$	2.79	0.11	0.06	0.05	0.98	1.06	0.25	0.65
C. D 5%	5.67	0.23	0.12	0.09	2.00	2.15	0.50	1.32

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Parents	No. of seeds per pod	Pod length (cm)	Test weight (g)	Seed yield per plant (g)	Green fodder yield per meter row length (kg)	Dry matter content (%)	Stover yield (g)	Crude protein (%)
SWAD	-0.13	-0.21	0.15	-0.16	0.03	0.23	0.48	0.46
MFC-09-12	0.71*	0.09	0.22	2.62**	0.01	0.50	5.11	0.89**
UPC-8705	0.06	0.34	0.15	-0.85	0.22**	0.63*	11.40**	-0.04
UPC-9202	0.48	0.02	-0.15	3.59**	0.13**	0.08	-9.90**	-0.83**
BL-2	0.002	0.14	0.08	1.15	-0.03	-0.64*	-1.56	-0.16
UPC-622	-0.46	-0.15	-0.28	-2.24**	-0.09	0.46	-5.74	0.10
EC-4216	-0.74*	-0.50	-0.13	-2.34**	-0.20**	-0.19	0.70	-0.69**
UPC-5286	0.08	0.27	-0.04	-1.78**	0.06	-1.06**	-0.49	0.27
SE $_{(gi)}$	0.30	0.28	0.21	0.59	0.05	0.31	3.19	0.23
C. D 5%	0.60	0.56	0.43	1.20	0.09	0.63	6.47	0.46

*- significant at 5 per cent probability **- significant at 1 per cent probability

content and stover yield per plant the crosses involving this parent would help in development of fodder type genotypes with quality since it had good amount of dry matter content. while, parent UPC-9202 was good general combiner for number of primary branches per plant, leaf to stem ratio, days to first flowering, days to fifty per cent flowering, days to maturity, number pods per plant, seed yield per plant and green fodder yield per matter row length the crosses involving this parent would help in development of early maturing fodder type genotypes.

Estimates of *sca* effect (Table 3) revealed that eight crosses *viz*., SWAD × UPC-9202, SWAD × UPC-622, SWAD × UPC-5286, MFC-09-12 × UPC-8705, UPC-8705 × EC-4216, UPC-9202 × UPC-622, UPC-9202 × UPC-5286 and UPC-622 × EC-4216 showed significant positive *sca* effect for seed yield per plant. These crosses could be exploited in future for the development of grain purpose genotypes. Crosses such as SWAD × UPC-622, SWAD × EC-4216, MFC-09-12 × UPC-8705, MFC-09-12 × UPC-5286, UPC-9202 × UPC-5286 and BL-2 × UPC-622 exhibited positive *sca* effect for green fodder yield meter row length indicated that these crosses may be used for development of fodder purpose genotypes while, three crosses namely SWAD × UPC-622, MFC-09-12 × UPC-8705 and UPC-9202 × UPC-5286 recorded positive significant *sca* effect both for seed yield per plant and green fodder yield per meter row length. These three crosses could be utilized for development of dual purposes genotypes suitable for grain and green fodder yield. None of the cross the cross recorded significant *sca* effect for all the characters (Mukati *et al.,* 2014*,* Ayo-Vaugan *et al.,* 2013, Daniel and Joseph. 2013 in cowpea). Some of the crosses along with seed yield they also possesses positive significant *sca* effect for number of pods per plant and test weight which indirectly contributes to the final yield of plant (Patel *et al.,* 2013) because these traits exhibit maximum heritability. The cross combination SWAD × UPC-9202 was best specific combiner for leaf to stem ratio days to first flowering days to fifty per cent

Table 3: Specific combining ability effect of crosses for green fodder and seed yield related characters along with crude protein in cowpea.

Crosses	Plant height (cm)	No. of primary bran-ches	No. of secon-dary bran-ches	Leaf to stem ratio	Days to first flower-ing	Days to 50% flower-ing	Days to mat-urity	No. of pods /plant	No. of seeds /pod	Pod length (cm)	Test weight (g)	Seed yield / plant (g)	Green fodder yield /meter row length (kg)	Dry matter content (%)	Stover yield (g)	Crude protein (%)
SWAD x MFC-09-12	-9.92	0.45	0.15	-0.05	6.21*	6.38	7.05**	-3.27	-1.87*	-0.95	-0.15	-11.26**	-0.24	-0.08	24.73*	-0.04
SWAD x UPC-8705	-17.19	-0.50	0.001	0.34*	-2.88	-2.01	-3.44**	-2.15	-1.12	-0.40	0.01	-5.93**	-0.26	-0.57	-26.50*	0.846
SWAD x UPC-9202	-25.88**	-0.08	-0.05	0.36*	-10.26**	-10.62**	-8.12**	10.17**	0.36	1.07	-0.71	6.85**	-0.43*	-0.18	23.02*	2.16*
SWAD x BL – 2	20.47	-0.58	-0.61**	-0.17	2.15	2.16	2.02*	-0.58	0.24	-0.20	-0.77	2.65	0.20	-1.02	-28.54*	-0.483
SWAD x UPC-622	8.96	-0.26	0.05	-0.18	-4.57	-4.05	-6.15**	-3.17	-0.70	-1.16	-0.84	4.19*	0.54**	2.21*	34.80**	-1.67*
SWAD x EC-4216	-9.16	0.28	0.43*	-0.13	-0.55	-1.68	0.69	-3.59	0.78	1.00	1.18	-2.70	0.30*	-2.77*	17.40	-0.91
SWAD x UPC-5286	33.18**	0.20	0.64**	0.02	10.89**	10.10**	2.86*	9.82**	0.96	1.63	2.53**	4.87*	0.03	0.97	16.24	-0.22
MFC-09-12 x UPC-8705	-21.27	0.95*	0.36	0.36*	-1.67	-2.64	-9.23**	7.29**	1.25	0.20	-0.29	12.79**	0.45*	0.84	0.57	-0.52
MFC-09-12 x UPC-9202	13.99	-0.14	0.51*	0.17	0.10	1.14	-1.26	-2.13	-1.98*	-1.48	-0.67	2.56	-0.31*	-0.39	-24.64*	0.31
MFC-09-12 x BL -2	21.19	-0.56	-0.65**	-0.12	0.71	-0.38	-0.42	-8.16**	1.00	-0.50	-0.49	2.61	0.03	0.74	-12.97	-1.34
MFC-09-12 x UPC-622	-34.27**	-0.07	-0.09	0.48**	-8.22*	-8.24*	-4.54**	-6.32*	0.97	-0.57	-0.35	-7.02**	-0.24	-1.37	-9.14	0.43
MFC-09-12 x EC-4216	-7.13	-0.41	0.39*	-0.29*	8.10*	5.68	3.95**	-6.47**	0.14	1.94*	1.12	-9.03**	0.21	0.67	10.07	-1.41*
MFC-09-12 x UPC-5286	5.42	-0.56	-0.26	-0.08	-1.66	-0.24	0.12	-5.16*	-1.12	-0.03	0.86	-3.51	0.52**	-1.57	1.36	0.11
UPC-8705 x UPC-9202	-28.87**	-0.21	0.56**	-0.11	5.61	4.86	4.41**	-5.11*	0.37	0.87	0.97	-5.60*	0.14	1.50	15.03	2.45**
UPC-8705 x BL -2	-1.23	1.04*	0.70**	0.01	-8.33*	-8.81*	5.73**	0.11	-2.25*	1.95*	0.70	-1.62	-0.54**	0.48	0.95	-2.04*

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flowering days to maturity number of pods per plant seed yield per plant stover yield per plant and crude protein content similar results were reported by patel *et al.,* (2013) who recorded significant *sca* effect for days to fifty per cent flowering, plant height, branches per plant, number of pods per plant, number of seeds per pod, 100- seed weight, seed yield per plant and protein content. UPC-8705 × BL-2 exhibited significant *sca* effect for number of primary branches per plant number of secondary branches per plant days to first flowering days to fifty per cent flowering and pod length. Patil and Navale (2006) also reported similar results for days to fifty per cent flowering, days to maturity, plant height, plant spread, number of branches per plant, number of pods per plant, pod length, number of seeds per pod, test weight and seed yield per plant. The cross SWAD × UPC-5286 was recorded good specific combining ability for plant height number of secondary branches per plant number of pods per plant test weight and seed yield per plant. MFC-09-12 × UPC-8705 showed significant *sca* effect for number of primary branches per plant, leaf to stem ratio, days to maturity, number of pods per plant seed yield per plant and green fodder per meter row length. The results of Kwaye *et al*., 2008 supports present findings wherein significant *sca* effect were noted for days to flowering, grain filling period, days to maturity, pod length, number of pods per plant, number of seeds per pod, number of nodules, 100- seed weight and grain yield. Bl-2 × UPC-5286 expressed desirable significant *sca* effect for number of secondary branches per plant, leaf to stem ratio, days to fifty per cent flowering, days to maturity, crude protein content. The cross combination UPC-622 x UPC-5286 was best specific combiner for leaf to stem ratio, days to first flowering, days to fifty per cent flowering, days to maturity and dry matter content this cross could be exploited for development of early maturing genotypes (Mukati *et al*., 2014) with high leaf to stem ratio. Earliness helps to fit into multiple cropping system whereas high leaf to stem ratio contributes to the quality of fodder.

The parents showing significant *gca* effect possesses additive component which is fixable can be utilized in future breeding programme for development of dual purpose varieties. The crosses showing significant

Table 3 : *continune....*

Crosses	Plant height (cm)	No. of primary bran-ches	No. of secon-dary bran-ches	Leaf to stem ratio	Days to first flower-ing	Days to 50% flower-ing	Days to mat-urity	No. of pods /plant	No. of seeds /pod	Pod length (cm)	Test weight (g)	Seed yield / plant (g)	Green fodder yield /meter row length (kg)	Dry matter content (%)	Stover yield (g)	Crude protein (%)
UPC-8705 x UPC-622	27.73**	0.16	0.26	0.03	-5.00	-4.17	-4.88**	2.75	0.39	-1.47	-0.44	0.45	-0.23	-0.20	8.58	0.06
UPC-8705 x EC-4216	11.79	-0.46	0.04	-0.05	3.97	2.50	8.55**	6.49**	0.79	-0.71	-0.64	6.84**	-0.02	0.56	2.43	2.20*
UPC-8705 x UPC-5286	-12.90	-0.74*	-0.31	-0.21	-3.59	-3.17	-6.38**	0.15	0.80	0.12	-0.33	1.87	-0.10	-1.20	11.17	-3.20**
UPC-9202 x BL -2	11.62	0.31	-0.45*	0.21	-4.11	-5.43	2.46*	1.45	0.63	0.82	-0.42	2.68	-0.27	0.88	6.89	-1.25
UPC-9202 x UPC-622	15.89	0.48	0.01	0.02	0.27	1.96	4.64**	2.97	0.19	0.01	0.01	9.78**	0.20	1.03	-7.03	-2.72**
UPC-9202 x EC-4216	-2.41	0.27	-0.31	-0.07	1.09	0.78	-12.12**	-4.28*	-0.33	-0.39	-0.79	-0.32	0.20	-2.04*	-3.98	0.36
UPC-9202 x UPC-5286	18.71*	-0.47	-0.26	-0.32*	2.13	2.01	0.48	-2.45	0.65	1.04	0.58	5.85*	0.52**	-1.08	0.76	-1.55*
BL -2 x UPC-622	-13.68	-0.42	0.05	-0.08	2.33	2.29	-7.67**	5.69*	-0.83	0.18	1.03	-1.64	0.28*	-0.07	0.84	0.82
BL -2 x EC-4216	-24.88*	-0.11	-0.37	0.08	-2.10	5.91	-0.34	-4.80*	0.05	-1.71*	-1.11	4.38*	-0.36*	0.08	-14.96	0.07
BL -2 x UPC-5286	-9.51	0.39	0.38*	0.33*	-6.06	-7.66*	-4.67**	3.21	0.53	-0.93	-0.80	1.32	-0.55**	-1.47	-9.92	2.81**
UPC-622 x EC-4216	30.71**	-0.22	0.29	-0.01	5.47	4.50	5.15**	10.58**	-1.19	-1.03	0.03	5.73*	0.13	-0.01	-3.88	-0.79
UPC-622 x UPC-5286	-31.17**	-0.40	-0.36	0.30*	-17.59**	-18.07**	-10.18**	-1.44	-0.10	0.91	0.93	3.60	-0.39*	2.63*	4.81	1.07
EC-4216 x UPC-5286	-20.54*	0.61	-0.18	-0.03	-6.37*	-2.95	-2.85*	2.25	-0.43	-0.64	-1.20	-3.65	0.13	-0.44	10.07	-0.78
$SE_{(sij)}$	8.57	0.34	0.18	0.14	2.99	3.24	0.76	2	0.91	0.84	0.65	1.81	0.14	0.95	9.77	0.69
C.D.5%	17.40	0.70	0.37	0.29	6.07	6.58	1.54	4.06	1.85	1.71	1.31	3.67	0.28	1.92	19.83	1.41

*- significant at 5 per cent probability **- significant at 1 per cent probability

sca effect can be utilized as hybrids since they possesses non additive component which is not fixable.

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