Minufiya J. Agric. Res. Vol. 33 No.2: 505 - 521 (2008)

USING LINE x TESTER ANALYSIS FOR PRODUCING NEW CULTIVARS OF COWPEA [*Vigna unguiculata* L.) Walp.]

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(Received: Jan. 28, 2008)

***ABSTRACT**: Five cowpea inbreed lines were top crossed with three testers (male parents) to produce (5 x 3)15 F_1 crosses in 2006 summer season. In the second season of 2007, all entries were evaluated to study the combining ability, heterosis, potence ratio and average degree of dominance for some traits.*

Significant differences were found between either parents or F_1 crosses in all traits. Both additive and non-additive gene actions were important to control most studied traits. There were significant to highly significant mean squares of entries, parents, crosses, heterosis, females, males, and female x male in all traits, excluding some ones. For all traits, except pod length, 100-seed weight and total dry seed yield, the estimated additive genetic variance values were higher, indicating that the total genetic variability were a result of additive and additive x additive types of gene. Average degree of dominance (ADD) which was found to be more than one for pod length, 100-seed weight and total dry seed yield, suggest that dominance or over-dominance influenced the expression of this character.

Both general (GCA) and specific (SCA) combining abilities were highly significant in the studied traits. The line 1-23 gave high positive significant GCA values for 6 traits; i.e., plant height, seed number per pod, pod filling, pod weight, seed index and total dry seed yield. While, the line 2-8 gave positive significant to high significant GCA values for 4 traits; i.e., number of branches, shell-out%, seed index and total dry seed yield. They can be considered as good donor and may be used through breeding program. The crosses"1-23 x Cream-7", and " 2-8 x Dokki-126" exhibited significant specific combining ability effects for 4 traits, and could be considered the best combinations

Significant positive or negative heterotic effects to better parents' value were detected for all studied traits. Estimate of heterosis relative to the better parent showed over- dominance in 2 crosses for plant height; in 10 crosses for branch number per plant; in 5 crosses for flowering time; 3 crosses for seed number per pod; 7 crosses for pod weight; 3 crosses for pod filling; 5 crosses for seed index and in 4 crosses for total dry seed yield. A pronounced heterosis over BP was observed in "1-49 x Dokki-126"(87.6%) and "1-41 x Dokki-126" (85.3%) for total dry seed yield.

Accordingly, these superior and prospective genotypes can be used in cowpea improvement through breeding programs.

***Key words:** Lines, Testers, Heterosis, Combining ability, Dominance and Cowpea.*

INTRODUCTION

Cowpea {*Vigna unguiculata* (L.) Walp.} is annual leguminous plant which is grown in many tropical and subtropical countries (Singh and Sharma, 1996). It is a key staple food in many developing countries, and forms an integral part of the diet of about 120 million people around the world (IITA, 1995).

The improvement of quantitative and qualitative traits of cowpea depends on the presence of genetic variability, which allows the breeders to select new genotypes. Significant differences among cowpea genotypes as regards plant growth, yield and yield components were recorded by Golasangi et al.(1995),Amanullah et al.(2000), Helal et al.(2000),Ismail and El-Ghareeb(2000), Kumar et al.(2000) ,Faris and El-Gizy(2001), Hussien et al.(2003) and Farag et al.(2005).

Highly significant general (GCA) and specific (SCA) combining abilities effect indicating both additive and non-additive gene effects were found for all studied traits by Sawant (1995), Sawarkar et al.(1999 a) Shashibhushan and Chaudhari(2000) and Gad et al. (2005 a& b). Highly significant variance for number of pods per plant, weight of 100-seeds and grain yield and its components(Singh and Dabas 1992), for number of pods per peduncle and pod length(Zhang et al.1994); for pod length (Mehta and Zaveri, 1997 and Umaharan et al.,1997)and for seed number per pod(Dobhal and Rana, 1997). Conversely, Sawant (1995) El-Sharkawy (1998) and Bastian et al.(2000) stated that the magnitudes of non-additive genetic variances including dominance were larger than that additive for most traits On the other hand, additive gene effects were more important in controlling studied traits by Roquib and Patnik (1990),Singh and Dabas(1992), Sawant et al.(1994), Umaharan et al.(1997), Sawarkar et al.(1999 b), Kumar et al.(2000) ,Rahman and Saad (2000), Shashibhushan and Chaudhari(2000), Tyagi et al.(2000), Subbiah et al.(2003) and Gad et al.(2005 a). Maximum progress for improving a character would be expected with a carefully designed pedigree selection programs when the additive gene effect is the main components of gene actions.

Over-dominance and heterosis was significantly positive for pod clusters per plant with an average degree of heterosis of 133% followed by pods per plant (89%) (Patil and Shete, 1987). Damarany (1994) found over-dominance for the genes of HP for number of pods per plant. Similarly Tyagi et al.(2000)

for pod diameter, and partial to over-dominance in the inheritance of pod length and seed number per pod. These differences may be due to genetic differences of the parents and /or non-allic interaction. Helal et al.(2000) stated that significant heterosis based on the high parent appeared in all characters, it ranged from1.87% (shell-out) to 15.64% (pod length).Gad et al.(2005 b)showed partial dominance for pod length, and complete dominance for pod diameter, pod filling and seed number per pod.

The objectives of this study were to estimate general and specific combining ability effects, average degree of heterosis, relative potence ratio of genes and average degree of dominance (ADD) to study the possibility concern improving some economical important traits in cowpea using line x tester mating design.

MATERIALS AND METHODS

The genetic materials used in this study consisted of 3 male parents (testers) each crossed to 5 parents (females) to develop 15 F_1'S (Table, 1). The 5 inbred lines namely: (P_1) 1-4, (P_2) 1-23, (P_3)1-41, (P_4)1-49 and (P_5)2-8.These lines were obtained from the previous study of Farag et al. (2005) using a pedigree selection program. On April 15th, 2006 season; the selected lines of cowpea were crossed by the male parents (P_6) Dokki-126, (P_7) Cream-7 and (P_8) GAS 80 A, to produce 15 F1 crosses, at the Experimental Farm of El-Gemmeza Agriculture Research Station, Gharbia Governorate. On April 17th, 2007 season, the15 F_1 crosses were evaluated together with 8 parents in a randomized complete block design with three replicates and the data were recorded. In each replicate, three rows were allocated to each of populations. Each row on one side comprised of fifteen hills spaced at 30 cm apart within row of sixty five-centimeter widths. Recommended agronomic practices were carried out as usual for the ordinary cowpea fields in the area.

Observations and measurements were recorded on 20 guarded plants per plot for each of parents, and F_1'S .The following characters were recorded: plant height, number of branches per plant, earliness to flower, pod length, number of seeds per pod, dry pod weight, seed pod weight, pod filling (according to method described by Remison,1978),100-dry seed weight (seed index), shell-out percentage(% of seed weight/pod weight) and total dry seed yield per plant.

Table (1) : Growth habit, seed coat and eye color of the parental genotypes

genotypes	Growth habit	Seed coat	Eye color

		color	
Female(Lines):			
1-4	leaves with elongated shape	Cream	Brown
1-23	leaves with common wide shape	White	Black
1-41	leaves with common wide shape	Cream	Pale eye
1-49	leaves with common wide shape	Cream	Black
2-8	leaves with common wide shape	cream	Pale eye
Male cultivars			
Dokki-126	leaves with common wide shape	Cream	Brown
Cream-7	leaves with common wide shape	Cream	White
GAS-80A	leaves with common wide shape	cream	Black

Statistical And Genetic Analysis:

Analysis of variance was performed according to Snedecor and Cochran (1982). Mean values representing the various investigated genotypes were compared by the Duncan multiple range test (Duncan, 1955). The analyses of general(GCA) and specific(SCA) combining abilities were computed using the line x tester procedure suggested by Kempthorne (1957).The measures of the analysis of variances and average degree of dominance (ADD) were worked out as given by Comstock and Robinson (1952). Average degree of heterosis(ADH%) was expressed as the percentage increase or decrease of the F_1 performance from the mid (MP) and high (HP) or better parent (BP)values.

RESULTS AND DISCUSSION

Mean Performance of The F_1 Crosses And Their Parents

Data in Table (2) showed the mean values of the parents and their F_1 crosses for all studied characters. Significant differences were found between either parents or F_1 crosses in all traits. Look upon to plant height, and number of branches per plant, the line 1-23 gave the tallest plant (145.7 cm), and the cross" 5 x 6" gave largely number of branches per plant (6.4), respectively. The cross "3 x 8" and the cultivar Dokki-126 surpass all other genotypes in early flowering and number of seeds per pod recording values

as 40.33 days and 13.76 seeds per pod, respectively. Concerning pod length, pod filling and average pod weight, the cv.Dokki-126 , line 1-4 and the cross

"1 x7" gave the largely values. They recorded 19.24 cm. for pod length, 0.84 for pods filling and 2.766 g. pod weight. Whereas for shell-out%, 100 dry-seeds weight and total dry seed yield, the crosses"5 x 6", ," 2 x 8" and " 3 x8, gave the highest values as 84.80%, 19.57 g and 89.64 g, respectively. They were significantly superior in this respect. On the contrary, the cultivar Cream-7 gave the shortest plant height as 58.86 cm; the cv. GAS80A gave the fewer number of branches per plant as 4.08 (Table 2). With regard to seed number per pod, the line 1-49 gave the less number (10.69).The cross "3 x 7" gave the lowest shell-out%(71.39%) and the line 1-41 gave the lightest pod weight(1.220 g),100-seed weight(8.19 g) and lowest total dry seed yield(41.27g). These results are in agreement with those of Amanullah et al.(2000), Helal et al.,(2000),Ismail and El-Ghareeb(2000), Kumar et al.,(2000) , Hussien et al.,(2003)and Farag et al.,(2005) who stated significant varietals differences among cowpea genotypes.

Highly significant mean squares of female x male parent's interaction were obtained for all traits, except for days to flowering and seeds number per pod, indicating that females did not express identical orders of ranking for the performance of their crosses with each tester. Significant to highly significant differences for both general and specific combining abilities for all characters (Table 3), indicating that both additive and non-additive gene effects were involved in the genetic control. These results agree with those obtained by Sawarkar et al.(1999 a) Shashibhushan and Chaudhari(2000) and Gad et al. (2005 b).Significant advancement could be achieved in the segregating generations through conventional breeding methods such as pedigree and bulk selection methods. Estimates of total genetic variability associated with all traits which were results of additive type of gene effects, showed values more than one for all traits, except pod length, 100-seed weight and total dry seed yield, suggesting additive and additive x additive types of gene action for these traits. The remaining traits showed values below unity. The same results were obtained by Kumar et al.,(2000) ,Rahman and Saad (2000), Shashibhushan and Chaudhari(2000), Tyagi et al. (2000), Subbiah et al. (2003) and Gad et al. (2005 a & b).Since there was predominance of additive gene effect for all above traits, significant advancement could be achieved in the segregating generation through conventional breeding method's such as pedigree and bulk selection method. Average of dominance (ADD) ($(\sigma^2 D / \sigma^2 A)^{1/2}$ which was found to be more than one for pod length, total dry seed yield (1.483 and1.920, respectively) (Table 3) suggest that dominance influenced the expression of these characters. Average degree of dominance revealed predominance of non-additive type of gene effect for these traits. Therefore, recurrent selection could be useful for the development of this character. The

remaining traits showed ADD values less than one, except 100-seed weight, which gave value just about one (Table 3).

The improvement of quantitative and qualitative traits of cowpea depends on the presence of genetic variability, which allows the breeders to select new genotypes. After that, test these lines under wide range of environmental conditions to estimate average yield stability. Since the farmers prefer cultivars that can perform predictably over a wide range of environmental conditions, with acceptable high quality.

Combining Ability:

Data in Table (3) showed Highly significant mean square values in all source of variations; i.e., entries, parents, crosses, heterosis, females, males, and female x male for most traits. Mean squares of entries, parents, and female's parents were highly significant. The hybrid vigor (parent vs. crosses) comparison was significant for all traits, except seed number per pod and pod length, indicating the expression of heterosis effects for all traits. Mean squares of the male parents were significant to high significant for all traits, except pod weight, days to flowering and seeds number per pod.

Table (3): Analysis of variance for combining ability, genetic components of variance and average degree of dominance (ADD) for plant and pod characteristics of cowpea.

S.O.V.	df	Plant height	Branch number /plant	Days to flowering	Seeds number/ pod	Pod length	Pod filling	Pod weight	Shell-out %	100-Seed Weight	Dry seed yield
Entries	22	1475.5**	1.004**	35.99**	1.292**	4.45**	0.0070**	0.514**	39.75**	21.41**	890.8**
Parents(P)	7	2416.2**	0.993**	41.73**	2.673**	9.14***	0.0074**	0.511**	24.67**	32.70**	776.9**
Crosses(C)	14	1105.3**	0.428**	10.36	0.682**	2.38**	0.0071**	0.458**	39.69**	16.40**	541.2**
Heterosis (P vs.C)	1	74.2**	9.133**	354.6**8	0.158	0.59	0.0034*	1.317**	146.13**	12.66**	6581.9**
Lines (L)	4	2958.1**	0.586**	21.41**	1.412**	3.17**	0.0176**	1.325**	79.66**	28.62**	620.5**
Testers (T)	2	609.2**	0.940**	3.09	0.309	1.53*	0.003*	0.031	27.76**	20.50**	214.5**
Line x tester (LXT)	8	302.9**	0.222**	6.64	0.410	2.187**	0.003**	0.131**	22.68**	9.26**	583.3**
Error	44	2.63	0.063	5.97	0.210	0.307	0.001	0.028	1.80	0.30	6.57
σ^2GCA	7	148.10**	0.030*	1.023**	0.068*	0.143*	0.001*	0.066*	3.874**	1.411**	26.07**
σ^2SCA	14	100.09**	0.053*	0.225**	0.066*	0.627*	0.001*	0.034*	6.961**	2.986**	192.23**
(σ^2A/ σ^2D)		2.959	1.141	9.094	2.049	0.455	2.286	3.846	1.113	0.945	0.271
ADD		0.581	0.936	0.332	0.699	1.483	0.661	0.510	0.948	1.029	1.920

*,** Significant at 0.05 and 0.01 levels of probability, respectively

In relation to general combining ability (GCA) effects, there were significant

differences for all traits under study (Table 4).The lines 1-23 and 2-8 can be considered as good donor and may be used through breeding program, since it gave high positive significant GCA values for 6 traits; i.e., plant height, seed number per pod, pod filling, pod weight, seed index and total dry seed yield. While, the line 2-8 gave positive significant to high significant GCA values for 4 traits; i.e., number of branches, shell-out%, seed index and total dry seed yield. On the other side, the cultivar Dokki-126 (tester) showed high significant GCA effect in 3 traits.

Table (4): General combining ability (GCA) effects for yield and yield components of the studied cowpea characters.

Character / Cultivar	Plant height	Branch number	Days to flowering	Seeds number /pod	Pod length	Pod filling	Pod weight	Shell-out	100-Seed Weight	Dry seed yield/ plant
(1) Female parents(lines)										
Line 1-4	-2.97**	-0.27**	-1.53	0.09	-0.91**	0.054**	0.40**	3.04**	0.30	-6.28**
Line 1-23	28.29**	0.14	-0.31	0.61**	0.29	0.024**	0.16**	0.80	2.30**	3.42**
Line 1-41	0.01	-0.29**	-1.09	-0.02	-0.27	0.011	-0.50**	-4.92**	-2.56**	6.27**
Line 1-49	-3.05**	0.19*	2.36**	-0.43**	0.57**	-0.056**	0.25**	-0.08	-0.64**	-11.18**
Line 2-8	-22.28**	0.22*	0.58	-0.25	0.33	-0.033**	-0.31**	1.16*	0.59**	7.77**
(2) Male parents (Tester)										
Dokki-126	3.01**	0.258**	0.51	0.09	-0.28*	0.016	0.05	1.54**	-1.12**	1.15
Creem-7	-7.32**	-0.02	-0.16	0.07	0.35*	-0.010	-0.01	-0.49	-0.09	3.07**
GAS 80 A	4.31**	-0.24**	-0.36	-0.17	-0.07	-0.006	-0.04	-1.05**	1.21**	-4.22**

*,** Significant at 0.05 and 0.01 levels of probability, respectively

In general, the cultivars Dokki-126, GAS80A and the lines 2-8 and 1-23 showed highly significant desirable GCA effects in 3, 2,4 and 6 traits, respectively (Table 4). Therefore, these parental genotypes could be considered as good combiners and could be used as donors for breeding to these traits.

Estimates of specific combining ability effects (SCA) showed that the highest positive significant values(15.504, 0.214,4.044,2.720 and 21.05) were given by the F_1 combinations “2 x 6”, “4 x 7”, “2 x 7 “, " 3 x 8" and “4 x 6”,for plant height, pod weight, shell-out%, seed index and total dry seed yield, respectively(Table 5). These combinations could be considered the most desirable for these traits. Conversely, the crosses, which showed negative or low positive SCA effects, were the poorest in these traits. Also, one, four, two, and three crosses exhibited significant specific combining ability effects for number of branches per plant, seeds number per pod, pod length and seed index, respectively. Generally, each of the crosses”2 x 7”, and” 5 x 6” exhibited significant specific combining ability effects for 4 traits. Also, the crosses”1 x 7”, “2 x 6”,” 3 x 8” and "4 x 8 " showed positive significant SCA effects in different three traits, therefore, they could be considered the best

combinations. The crosses "2 x 8", "4 x 7"and "5 x 8" showed significant desirable SCA effect values for 2 traits.

Table(5): Estimates of specific combining ability (SCA) effects of the different crosses for the studied cowpea characters .

Character / Cross	Plant height	Branch number	Days to flowering	Seeds number /pod	Pod length	Pod filling	Pod weight	Shell-out	Seed index	Dry seed yield/ plant
1 x 6	-8.607**	0.087	-0.733	0.182	0.405	-0.006	-0.107	-1.292*	0.658*	-3.67**
1 x 7	5.320**	0.160	-0.733	0.102	0.066	0.000	0.099	0.107	1.750**	14.45**
1 x 8	3.287**	-0.247*	1.467	-0.284	-0.471	0.006	0.008	1.185	-2.408**	-10.78**
2 x 6	15.504**	-0.158	-0.289	0.031	0.530*	-0.026*	0.166*	-0.456	0.314	-13.34**
2 x 7	-10.202**	0.282*	1.044	-0.386	-1.288**	0.040**	-0.013	4.044**	0.172	4.66**
2 x 8	-5.302**	-0.124	-0.756	0.354	0.758**	-0.014	-0.153	-3.588**	-0.486	8.68**
3 x 6	6.715**	0.042	1.489	0.094	0.464	-0.013	0.088	0.265	-0.558*	-4.50**
3 x 7	2.809**	-0.151	0.156	0.321	-0.188	0.023	-0.092	-3.176**	-2.162**	-5.56**
3 x 8	-9.524**	0.109	-1.644	-0.416	-0.275	-0.011	0.003	2.912**	2.720**	10.06**
4 x 6	-6.649**	-0.202	1.044	-0.393	-0.680*	0.004	-0.341**	-0.652	-0.991**	21.05**
4 x 7	-1.092	0.138	-1.622	0.280	1.092**	-0.030*	0.214**	0.880	0.101	-6.52**
4 x 8	7.741**	0.064	0.578	0.113	-0.412	0.026*	0.128	-0.228	0.890**	-14.53**
5x 6	-6.963**	0.231	-1.511	0.086	-0.719**	0.041**	0.195*	2.135**	0.577*	0.46
5 x 7	3.165**	-0.429**	1.156	-0.318	0.319	-0.033**	-0.208*	-1.855**	0.139	-7.03**
5 x 8	3.798**	0.198	0.356	0.232	0.399	-0.007	0.014	-0.280	-0.716**	6.57**

***,** Significant at 0.05 and 0.01 levels of probability, respectively**

(1) =1--4; (2)= 1-23; (3)=1-41; (4)=1-49; (5)=2-8; (6)=Dokki-126; (7) Creem-7 and (8)=GAS80A.

Heterosis And Potence Ratio

Average degree of heterosis (ADH %) for the studied characters are presented in Table (6). The average degree of heterosis was only estimated for the crosses that their parents are differed significantly in the trait. Degree of dominance for each studied trait was also determined by estimating the potence ratio value.

Relating to plant height, 11F_1 crosses showed significant positive heterosis values ranging from 2.89 in the cross "3 x 7" to 28.08 in the cross"2 x 6", based on their respective MP, suggesting dominance towards the taller parent. Estimates HP-heterosis revealed that the crosses "1 x 8"(12.66%) and

"4 x 8"(8.23%) showed significant positive heterosis values indicating hybrid vigor for this trait. Also, 3 of them gave negative significant HP-heterosis values. The over- dominance hypothesis in this cross was also supported by the obtained high potence ratio value, which was more than one. The cross "1 x 7" gave insignificant HP-heterosis values (1.04), suggesting complete dominance. As regards to branch number per plant, obtained ADH% values (Table 6), showed that 13 F_1crosses significantly exceeded their respective MP, suggesting dominance towards the high number of branches per plant. Also, 10 ones significantly exceeded their respective HP in their branch number, indicating hybrid vigor. Only the cross" 1 x 7","1 x 8" and "5 x 7" showed partial dominance towards the high parent, since HP- heterosis values were negative and significant. With view to number of days to flowering, of 13 crosses showed significant negative ADH% values based on MP, suggesting dominance towards the better parent, only 5 F_1 showed over-dominance for the short period to flowering(Table 6), since they gave significant negative BP-heterosis ranging from-5.98 to-11.23.The obtained potence ratio values were more than one, supported the postulated hypothesis. Data also revealed complete, partial and no-dominance for few number of days to flowering in the remaining crosses. The over all means for plant height, number of branches per plant and days to flowering, in relation to high parents were -10.74, 7.04 and -4.16, respectively.

Concerning the number of seeds per pod, over-dominance relative to HP was detected in 5 crosses, while the crosses "1 x 7", "2 x 8" and "3 x 7" surpass their HP for seed number per pod. Only the cross" 4 x 7" showed partial dominance (Table 6).Similar results were obtained by Tyagi et al.(2000) and Gad et al.(2005 b).For pod length, in relation to Mp-heterosis,5 F_1 crosses gave significant values and 10 ones gave negative.

significant values supporting over-dominance toward the high and low parents, respectively(Table 6). Relating to HP-heterosis, the crosses "2 x 8" and" 4 x 7" gave positive significant values, supporting over-dominance. On the other hand, the cross "4 x 8"," 5 x 7" showed partial dominance and the cross" 5 x 8" showed complete dominance with HP. For pod filling, in relation to MP-heterosis, 10 F_1 crosses showed over-dominance towards their high parents (Table, 7).Only the cross"4 x 7 "showed over-dominance toward the low parent. While in relation to HP, the crosses "2x7"," 3 x 6", "3x7" and 5x6 showed hybrid vigor. Also 6 F_1 crosses showed partial dominance for their HP. The cross" 3x8" showed complete dominance for their high parents. Our findings are agree with those obtained by Helal et al. (2000) and Gad et al.(2005 b). For pod weight, in relation to Mp-heterosis, 9 F_1 crosses gave positive significant values ranged from 2.89(3x8) to 41.35(2x6), supporting hybrid vigor (Table 7). Of them, 7 ones showed positive significant Hp-heterosis values. The crosses "3x7","3x8" and" 5x6" showed partial

dominance in relation to their high parents. The over all means for number of seeds per pod, pod length, pod filling and pod weight, in relation to high parents were -4.08,-10.02, -0.97 and 4.26, respectively. These results agree with that obtained by Helal et al., (2000).

Table (6): Average degree of heterosis (ADH %) based on mid-parents (MP) and better- parent (HP),as well as, potence ratio(PR) for plants and pod characteristics in cowpea.

Character / Cross	Plant height (cm)			Branch number			Days to flowering			Seeds number /pod			Pod length (Cm)		
	ADH%		P.R	ADH%		P.R	ADH%		P.R	ADH%		P.R	ADH%		PR
	MP	HP		MP	HP		MP	HP		MP	HP		MP	HP	
1 x 6	7.89**	-3.31*	0.68				-8.16**	-1.50	-1.21	-2.22**			-9.24**		
1 x 7	18.04**	1.04	1.07	0.36*	-6.20**	0.05	-6.37**	-3.07	-1.87	4.43**	2.03**	1.88	-0.94*		
1 x 8	27.35**	12.66**	2.10	7.16**	-4.30**	0.60	-1.12						-4.30**		
2 x 6	28.08**	-7.18**	0.74	15.52**	11.74**	4.58	-13.86*	-10.54**	-3.74	-3.78**			-7.06**		
2 x 7	-2.98*			11.92**	2.74**	1.33	-9.70**	-2.83	-1.37	-0.30			-8.20**		
2 x 8	10.62**	-20.56**	0.27	21.28**	10.22**	2.12	-13.26**	-5.98**	-1.71	6.06**	1.22**	1.27	4.71**	2.87**	2.63
3 x 6	15.62**	-5.92**	0.68	11.11**	7.37**	3.19				-3.81**			-9.43**		
3 x 7	2.89*	-19.56**	0.10	-3.81**			-10.68**	-6.51**	-2.39	5.34**	2.92**	2.27	-3.50**		
3 x 8	-0.84	-20.23**	-0.03	17.00**	6.43**	1.71	-14.35**	-9.71**	-2.79				-3.89**		
4 x 6	5.15**	-9.20**	0.33	21.15**	11.74**	2.51	-4.47*	-2.28	-2.00	-8.30**			-9.21**		
4 x 7	3.44**	-14.49**	0.16	15.14**	1.06**	1.09	-8.28**	-2.83	-1.48	4.74**	-0.86*	0.84	12.28**	3.38**	1.43
4 x 8	26.89**	8.23**	1.56	33.49**	27.12**	6.69	-3.49*	2.98	-0.56	3.57**	0.17	1.05	3.08**	-2.66**	0.52
5x 6	-14.22**			29.44**	20.47**	3.95	-14.75**	-11.23**	-3.72	-5.85**			-14.17**		
5 x 7	-10.40**			4.07**	-7.87**	0.31	-7.90**	-0.62	-1.08	-2.25**			1.67**	-2.56**	0.38
5 x 8	3.77**	-6.71**	0.34	35.94**	28.26**	6.00	-9.38**	-1.50	-1.17				2.48**	0.87	1.55
Over all mean	8.09	-10.74		15.33	7.04		-9.02	-4.16		0.06	-4.08		-3.05	-10.02	

*,** Significant at 0.05 and 0.01 levels of probability, respectively.
(1)= 1--4; (2) =1- 23; (3)= 1-41; (4)= 1-49; (5)= 2-8; (6)= Dokki-126; (7) Cream-7 and (8)=GAS 80A

For shell-out% and seed index, significant ADH% relative to MP, was detected in 9 F_1 for shell-out%, and 11 ones cross surpass their MP for seed index %(Table 7). Data also revealed over-dominance relative to HP in 7 and 5 F_1 crosses for these traits, respectively. The crosses "3 x 8", 4x7 and 5x7 gave not significant Hp-heterosis values for shell-out%, suggesting complete dominance for the high parent. In seed index, 4 F_1 crosses showed significant negative MP-heterosis Values, supporting over-dominance

towards the low parents. 3 crosses showed partial dominance towards the high parent, since HP-heterosis values were negative and significant. Also the crosses "2x7", "3x8" and" 5x8" showed complete dominance for their HP.

Table (7): Average degree of heterosis (ADH %) based on mid-parents (MP) and better- parent (HP) ,as well as, potence ratio(PR) for yield and its components in cowpea.

Character / Cross	Pod filling			Pod weight			Shell-out			Seed index			Dry seed yield/plant		
	ADH%		P.R	ADH%		P.R	ADH%		P.R	ADH%		P.R	ADH%		P.R
	MP	HP		MP	HP		MP	HP		MP	HP		MP	HP	
1 x 6	6.4**	-1.2**	0.8	24.4**	2.9**	1.2				2.9**	5.7**	-1.2**	0.8	24.4**	2.9**
1 x 7	5.2**	-3.6**	0.6	17.8**	8.9**	2.2				7.1**	4.9**	3.5	25.8**	-0.2	0.9
1 x 8	5.8**	-2.4**	0.7	12.6**	3.9**	1.5	7.4**	6.0**	5.6	-10.7**			-21.7**		
2 x 6	2.0**	-3.7**	0.3	41.4**	27.2**	3.7	3.4**	2.8*	5.7	8.8**	-4.2**	0.7	38.5**	22.9**	3.1
2 x 7	8.6**	1.2**	1.2				6.5**	5.9**	11.7	5.9**	0.6	1.1	63.9**	58.6**	18.9
2 x 8	1.3**	-4.9**	0.2				-2.4*			7.0**	4.0**	2.4			
3 x 6	5.4**	2.6**	2.0	32.5**	14.9**	2.1	-1.9*			9.2**	-14.3**	0.3	90.0**	85.3**	35.5
3 x 7	8.2**	3.9**	2.0	-0.9**	-22.4**	-0.3	-8.9**			-6.6**			73.9**	55.6**	6.3
3 x 8	3.4**	0.0	1.0	2.9**	-19.3**	0.1	-0.4	-1.5	-0.4	38.1**	0.9	1.0	86.6**	63.6**	6.2
4 x 6	0.0		0.0				5.9**	2.7**	1.9	-9.8**			95.4**	87.6**	22.8
4 x 7	-6.9**			38.8**	26.2**	3.9	5.2**	1.9	1.6	-3.9**			26.5**	20.4**	5.2
4 x 8	0.7**	-1.4**	0.3	32.9**	21.1**	3.4	4.6**	2.9*	2.8	6.0**	1.4**	1.3	-6.7**		
5x 6				12.2**	-2.9**	0.8	13.1**	7.8**	2.7	10.7**	6.2**	2.5	50.0**	19.9**	2.0
5 x 7				-21.1**			4.9**	0.3	1.0	5.6**	1.6**	1.4	30.5**	12.3**	1.9
5 x 8				-12.5**			8.0**	4.5**	2.4	5.6**	-0.7	0.9	37.8**	20.9**	2.7
Over all mean	3.34	-0.97	0.8	15.35	4.26		3.75	1.84		5.04	-4.67		43.25	28.49	

*,** Significant at 0.05 and 0.01 levels of probability, respectively.

(1) = 1--4 ; (2) = 1- 23 ; (3) = 1-41 ; (4) = 1-49 ; (5) = 2-8 ; (6) = Dokki-126; (7) Cream-7 and (8)=GAS 80A.

Obtained MP-heterosis values for total dry seed yield (Table 7) showed that 12 F_1 crosses significantly out-yielded their respective high parents indicating, hybrid vigor for the high total yield. Obtained potence ratio values (more than one) recommended the postulated hypothesis. While in relation to

Hp-heterosis, 10 F_1 showed over-dominance, the cross "1x 6" showed partial dominance and the cross "1 x 7" showed complete dominance. Similar results were obtained by Helal et al.,(2000). The over all means for shell-out, 100-seed weight, and dry seed yield, in relation to high parents were 1.84, -4.67 and 28.49, respectively.

In wide-ranging, estimate of heterosis relative to the better parent (Tables 6 &7) showed over- dominance in 2 crosses for plant height; in 10 crosses for branch number per plant; in 5 crosses for flowering; in 3 crosses for seeds number per pod; in 7 crosses for pod weight; in 2 crosses for pod length; in 3 crosses for pod filling; in 5 crosses for seed index and in 4 crosses for total dry seed yield. Degree of dominance was determined by estimating the potence ratio as shown in Tables (6 & 7). Obtained high potence ratio values were more than one (P>1) supported the suggested over- dominance hypothesis. Also, all types of dominance; i.e., complete, partial and no-dominance were obtained for all studied traits. The estimated potence ratio values were in accordance with the estimated heterosis values in the studied traits. Our results are in agreement with those of Helal et al., (2000), Tyagi et al., (2000) and Gad et al., (20005 a& b).

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اِستخدام تحليلْ السلالةُ فى الكشافْ لإنتاج أصناف جديدةٌ من اللوبيا

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الملخص العربى :

بإجراء التهجين القمى بين خمسه سلالات لوبيا ناتجه من التربيه الذاتية والسابق استنباطها بالمزرعة البحثية بمحطة البحوث الزراعية بالجميزة– محافظه الغربية ،حيث استخدمت كامهات، مع ثلاث أصناف كشافه ، وذلك فى الموسم الصيفي 2006.وفى الموسم التالي 2007 ،قيمت الخمسة عشر هجينا الناتجة مع الآباء فى تجارب حقليه مصممة بنظام القطاعات الكاملة العشوائية ، وتم تقدير ألقدره العامة والخاصة على الائتلاف وقوه الهجين ودرجه السيادة لعشرة صفات محصوليه هامة.

اوضحت النتائج ما يلى:

١ –وجود اختلافات معنويه بين الاباء و الهجن القميه لكل الصفات تحت الدراسة.

٢ –أوضحت حسابات القدرة العامة والخاصة على الائتلاف أن التأثير الجينى المضيف والغير مضيف كان معنويا فى وراثة معظم الصفات التي درست ، مشيرا إلى أهمية كل من الفعل الجينى المضيف والغير مضيف للجينات الخاصة بوراثة هذه الصفات .

٣ –كما أشارت النتائج الى إن الدور الذى تلعبه الجينات المضيفة (التجميعية) كان هام فى وراثة جميع الصفات ما عدا صفات طول القرن ، وزن 100بذرة، المحصول الكلى من البذور الجافة ، بالمقارنه بتأثير الجينات الغير مضيف مما يتيح التحسين لمعظم هذه الصفات بالتربية عن طريق الانتخاب .

٤ –بحساب متوسط درجه السيادة ADD وجدت بقيم أكثر من الواحد الصحيح لصفه طول القرن ، وزن 100 بذرة، المحصول الكلى من البذور الجافة مما يوضح إن كلاهما يتأثر بالفعل السيادي.

٥ –اظهرت حسابات كل من القدره العامه والخاصه على التالف معنوية عالية فى الصفات التى درست . والاباء التى اظهرت قدره عامة على التالف بدرجة معنويه لعديد من الصفات هى:

السلاله**1-23** بالنسبه لستة صفات هى :طول النبات و وزن القرن ودرجة امتلاء القرن و دليل البذرة و عدد البذور بالقرن و المحصول الكلى من البذور الجافه ، والسلاله٢-٨ بالنسبه لأربعة صفات هى : عدد ألافرع و نسبة التصافى و دليل البذرة و المحصول الكلى من البذور الجافه.

٦-أوضحت قياسات القدرة الخاصة على الائتلاف أن أفضل الهجن" **1-23 x** كريم-**7** "، " **8-2 X** دقى-**126**" حيث اظهرت قيم معنويه مرغوبة لاربعة صفات ، لذلك تعتبر من افضل الهجن.

٧-أظهرت النتائج وجود معظم أو كل نظم السيادة فى الهجن تحت الدراسة للصفات المختلفة . وكانت قيم الـ **potence ratio** المقدرة متوافقة مع متوسط درجات قوة الهجين المحسوبة لهذه الصفات.

٨-وبقياس قوه الهجين بالنسبة للأب الأفضل أو الأعلى نجدها قد ظهرت بوضوح في**2**و**10**و**15**هجن لصفات طول النبات، عدد الافرع،عدد الايام اللازمه للتزهير،على التوالي.كما ظهرت في عدد**3**و**7** و**3**لصفات عدد البذور بالقرن، وزن القرن،درجة امتلاء القرن،وفى **5, 4** هجين لصفه دليل البذره و المحصول الكلى من البذور الجافة، على التوالي.

٩-أظهر سلوك الهجن"**1-49 X** دقى-**126**" و " **1-41 X** دقى-**126**" تفوقا على الاب الافضل قدره **87.6**% و**85.3** % ، على التوالى ، من حيث المحصول الكلى من البذور الجافة.

١٠-مما سبق تشير النتائج الى أهمية استخدام هذه التراكيب المتفوقة فى زيادة الإنتاج التجارى وتحسين جودة قرون اللوبيا من خلال برامج التربية .

Table (2): Mean performances of the studied cowpea genotypes with regard to yield components, as well as, some pod characteristics

Character Genotype	Plant height (cm)		Branch number		Days to flowering		Seeds number /pod		Pod length (Cm)		Pod filling		Pod weight (g)		Shell-out %		100-seed weight (g)		Dry seed yield/plant (g)	
1	82.67	jk	5.19	h	42.30	jk	11.42	ij	13.52	k	0.84	a	2.539	de	78.45	f	17.26	f	88.91	ab
2	145.77	a	4.99	i	52.17	a	12.59	bc	15.60	fg	0.81	c	2.075	h	79.64	e	18.81	bc	55.92	i
3	104.42	d	4.98	i	49.51	bc	11.42	ij	15.12	hi	0.76	f	1.220	k	78.11	f	8.19	q	41.27	m
4	90.09	h	4.51	j	50.66	b	10.69	k	14.37	j	0.74	g	1.764	j	73.90	h	16.21	jk	47.21	k
5	79.68	l	4.60	j	52.44	a	11.47	ij	15.66	f	0.73	gh	2.273	ef	71.40	i	15.62	l	72.44	f
6	65.50	o	5.34	h	48.44	cd	13.76	a	19.24	a	0.72	hi	1.660	j	78.69	f	14.34	m	43.42	l
7	58.86	r	5.97	c	45.28	fg	11.97	efg	17.08	c	0.70	jk	2.158	gh	78.76	f	16.91	gh	52.25	j
8	63.59	p	4.08	k	44.67	fgh	11.44	ij	16.17	e	0.71	ij	2.146	gh	76.39	g	17.75	de	54.79	i
1 x 6	79.93	l	5.80	de	41.67	jkl	12.31	cd	14.87	i	0.83	ab	2.613	c	83.26	b	16.37	ij	68.73	g
1 x 7	83.53	ij	5.60	fg	41.00	kl	12.21	de	15.16	hi	0.81	c	2.766	a	82.63	bc	18.50	c	88.77	ab
1 x 8	93.13	g	4.97	i	43.00	ij	11.59	hi	14.21	j	0.82	bc	2.637	bc	83.15	b	15.64	l	56.24	i
2 x 6	135.30	b	5.97	c	43.33	hij	12.68	b	16.19	e	0.78	de	2.640	bc	81.85	c	18.03	d	68.77	g
2 x 7	99.27	e	6.13	b	44.00	ghi	12.24	de	15.00	hi	0.82	bc	2.408	d	84.32	a	18.92	b	88.68	ab
2 x 8	115.80	c	5.50	g	42.00	jk	12.74	b	16.63	d	0.77	ef	2.231	fg	76.14	g	19.57	a	85.41	d
3 x 6	98.23	f	5.73	ef	44.33	ghi	12.11	def	15.56	fg	0.78	de	1.908	i	76.86	g	12.30	o	80.46	e
3 x 7	84.00	i	5.27	h	42.33	jk	12.32	cd	15.54	fg	0.79	d	1.674	j	71.39	i	11.72	p	81.32	e
3 x 8	83.30	ij	5.30	h	40.33	l	11.34	ij	15.04	hi	0.76	f	1.732	j	76.92	g	17.91	de	89.64	a
4 x 6	81.80	k	5.97	c	47.33	de	11.21	j	15.26	gh	0.73	gh	2.221	fg	80.77	d	13.79	n	88.56	ab
4 x 7	77.03	m	6.03	bc	44.00	ghi	11.87	fgh	17.66	b	0.67	l	2.723	ab	80.28	de	15.91	kl	62.91	h
4 x 8	97.50	f	5.73	ef	46.00	ef	11.46	ij	15.74	f	0.73	gh	2.600	c	78.61	f	18.00	d	47.60	k
5x 6	62.27	q	6.43	a	43.00	ij	11.88	fgh	14.98	hi	0.79	d	2.205	fg	84.80	a	16.59	hi	86.91	cd
5 x 7	62.07	q	5.50	g	45.00	fg	11.46	ij	16.64	d	0.69	k	1.749	j	78.78	f	17.18	fg	81.33	e
5 x 8	74.33	n	5.90	cd	43.33	hij	11.77	gh	16.31	de	0.72	hi	1.934	i	79.80	e	17.63	e	87.65	bc
Mean	87.74		5.46		45.05		11.91		15.72		0.76		2.168		78.91		16.22		70.40	

* Mean within a column followed by different letters is significantly different at 0.05 levels.
(1) = 1-4 ,(2) = 1-23 ; (3) = 1-41 ; (4) = 1-49 ; (5) = 2-8 ; (6) =Dokki-126 ; (7) = Cream-7 ; and (8) = GAS 80A.