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GENETIC COMPONENTS OF SOME ECONOMIC TRAITS IN COWPEA *Vigna unguiculata*.

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ABSTRACT

A half diallel crosses involving eight divergent genetically and morphologically genotypes was used to estimate genetic components of some economic traits in Cowpea. The analyses of the F_1 generations and parents revealed that the additive - dominance model of gene action was operating for all studied traits except pod diameter and number of seeds/pod. Both additive and dominance gene effects were important in controlling the variation of all studied traits. The "D" parameter denoring additive variance was larger than the dominance (H_1) for flowering, weight of pods, weight of seeds, pod length and number of branches traits. This result confirming the presence of partial dominance, while the "D" parameter was smaller than dominance (H_1) for number pods/plant and weight of 100- seeds indicated the presence of over dominance. Narrow sense heritability was high for flowering (0.87), weight of pods/plant (0.80), weight of seeds (0.78) and for weight of 100 seeds(0.76).

INTRODUCTION

Cowpea (*Vigna unguiculata*) is one of the most important leguminous crops in several parts of the world. In Egypt, Cowpea is a popular vegetables crop. Cowpea is well adopted to stress and has excellent nutritional qualities. The Partitioning of the genetic variances are of great importance to the breeder to choice the appropriate breeding program. Breeding procedures for improving cowpea is mainly dependent on the type of gene action and relative amount of the genetic variance component in the population. For effective and rapid improvement of yield and its components in cowpea, through conventional breeding method, availability of variation among eight parents in the initial crosses is essential. Much work has been done towards understanding the inheritance of yield and yield components in cowpea, Tahany *et al.* (1991), Damarany (1994a and 1994b), Golasangi *et al.* (1995), Modhusudan *et al.* (1995), Zhang *et al.* (1995), Aravindhan and Das (1996) and Abd-El hady (1998). The diallel analysis of variance for some agroeconomic characteristics in cowpea was studied by Rashwan (2002). He found that the additive gene effects were greater in magnitude than non-additive gene effects for number of seeds/pod, pod length, number of branches, weight of pods/plant, weight of seeds/ plant and Days to flowering. Both additive and non-additive gene effects were highly significant. The wr/vr graph showed that the partial dominance was operating for pod length, number of seeds, number of pods, number of branches and weight of seeds. The heterosis averaged from –3.4 for days to flowering to 15.81% for weight of pods.

Genetic analyses showed the involvement of non-allelic gene interaction in the regulation of the large seeds in cowpea. Furthermore, the additive and (additive x dominance) gene effects were the most important factors in determining seed size in cowpea. A narrow sense heritability of 44.21 was estimated for seeds size (Ishiyaku and Singh 2004).

Pal *et al.* (2004) studied the genetic variability, heritability and genetic advances in cowpea. They obtaned high heritability with moderate to high genetic advance for plant height, number of branches and number of pods/plants.They reveald that these traits could be improved by single selection in early generation. Days to first flowering, pod diameter, number of seeds and 100- seed weight manifested high heritability with low genotypic coefficient of variation and genetic advance.

Gad *et al.* (2005 a) crossed and evaluated five cowpea cultivars viz., IT86F, IT93K, Kafr El-Sheikh-1, Dokki 331 and Kaha –1 in a half diallel crosses system in the summer season of 2003 for green pods morphological. They cleared that partial dominanc controlled the inheritance of pod length while complete dominance was important for pod diameter, pod filling and seed number/pod traits.

Both additive and non-additive gene action were involved in the inheritance of these traits. High heritability estimates were 75% and 87.52% for pod length (and pod filling . For heterosis over better parent, few cases showed positive values.

In another study, Gad *et al.* (2005 b) found that the (GCA) and (SCA) showed highly significant for all studied traits. Some crosses showed heterosis over better parent in Bp in growth traits viz. IT93KX Doki –331 (39%) or with Kaha (38.4) for plant height. Additive and non-additive showed significant effect for studied traits, while D for early pod number and H_2 for pod weight were significant.

Diallel analyses were adequate for morphological traits except the number of days to 50% flowering at the F_1 generations, which showed a complementary gene interaction. However, diallel analyses were non adequate for yield and yield components, which showed two types of non-allelic gene interaction (Duplicate or complementary types). The additive gene effects "D" was larger than the dominance gene effects (H_1) for number of seeds/pod, while the dominance gene effects (H_1) was larger than the additive gene effects "D" for number of days to flowering and number of branches/plant. (Nashwa 2006).

The present investigation was planned to:

1-Estimate the type of gene action and heritablility controlling the inheritance of yield and its components traits.

2-Identification of the parents which carry the dominance and recessive alleles for the studied traits.

MATERIALS AND METHODS

The genetic material used in this study consisted of eight parental genotypes of cowpea and their F_1 hybrids. The name and source of the eight genotypes of cowpea used in this study are given in Table1.

Genotypes	Source
Balady.	Local, EAO*, Egypt
Cream –7.	
Azmerly.	
Dokki –331.	
Black eye –H_5.	Dr, Miller, Texas, USA, ITTA**,
ITB2D –79.	Ibadan, Nigeria.
IT82C –9.	
IT82D –716	

*** EAO, Egyptian agricultural organization, Egypt.**

**** ITTA, International Institute of Tropical, Agriculture, Ibadan, Nigeria. Experiment was carried out at the experimental farm of the faculty of agriculture, South Valley University.**

In the summer season of 2007,10 July, the seeds of 36 entries, i.e, the eight parents and 28 F_1 hybrids were planted in the field.Arandomized complete block,design with three replications was used.

Each of the parents and their F_1 hybrids were represented by a single row. Each row was 3.0 m long, spaced 60 cm apart and plants spaced by 25 cm. The analysis of data was done according toArandomized c the methods of Hayman (1954) and Jinks (1954).

Data were recorded on the following traits:

1-Days to opening the first flower/plant.

2-Pod diameters, in cm., recorded for the mean of 10 dry pods/plant at the harvesting time.

3-Number of seeds/pod: recorded for the mean of 10 pods/plant at the harvesting time.

4-Weight of pods/plant, in gram: estimating after harvesting.

5-Pod length, in Cm. recorded for mean of 10 dry pods at the harvesting time.

6-Number of pods/plant: estimated for mean of 10 plants at the harvesting time.

7-Weight of seeds/plants, in grams: recorded after harvesting.

8-Weight of 100 seeds, in gram: recorded after harvesting.

9-Number of branches per plant estimated for mean of 10 plants at harvesting time.

RESULTS AND DISCUSSION

I: F_1 performance:

The analyses of variance among the different entries of the F_1 diallel crosses of studied traits revealed highly significant differences among genotypes as shown in Table 2. The results in Table 3 showed that the average number of days to the first flower appearance for the parents ranged from 58 days for P_4 (Dooki 331) to 74 days for P_8 (IT82D –716). The average of F_1 hybrids ranged from 59 days for the cross P_4XP_5 (Dokki 3331X Black eye –H_5) to 72 days for the cross P1xP8 (Balady x IT82D-716). Meanwhile, mean pod diameter of the parents ranged from 0.72 cm for P_6 (IT82D-79) to 0.88 cm for P_4 (Dokki –331) and from 0.73 cm for (P_1xP_3) to 0.85 for (P_7xP_8). As for number of seeds/pod, the mean of the parents ranged from 9(N) for P_3 (Azmerly) to 11(N) for P_8 (IT82D –716) and her too from 9 /(N)for P_3xP_5 (Azmerly X Black eye H_5) to 11(N) for P_1xP_8. The mean weight of pods/plant ranged from 50.57 (g) for P_1 to 86.63 (g) for P_5 (Black eye –H_5) and ranged from 57.2(g) for $P_{1x}P_6$ to 90.83(g) for P_3xP_5 (Table) 6.The results in table 7 showed that the mean pod length of the parents ranged from 12.73 for P_1 (Balady) to 17.80 cm for P_8 (IT82D –716) and from 12.6 for P_1xP_3 (Baldy Azmerly) to 16 cm for P_6xP_8 (IT82D –79x IT82D –716). While, mean number of pods/plant of the parents ranged from 39.6 for P_8 to 65.3 for P_5 and ranged from 50.7 for P_1xP_8 to 66.3 for P_5xP_7. Regard of weight of seeds, the mean ranged from 40.8 (g) to 65.3(g) for parents and ranged from 52.2(g) to 65.43(g) for hybrids. As for weight of 100-seed the mean of the parents ranged from 11.57(g) for P_1 to 18.8(g) for P_3 and 12.4(g) for P_1xP_5 to 20.4(g) for P_3xP_4 (table 10). The mean number of branches as shown in Table 11 ranged from 4/(N) for P_4 to 7/(N) for P_8, but ranged from 4(N) to 6(N) for F_1 hybrids.

II: The diallel analysis:

Highly significant additive and non-additive gene effects were indicated by the significance of “a” and “b” items (Table 12) for all studied traits. The results illustrated additive gene effects were greater in magnitudes than those dominance gene effects for all studied traits in accordance with results of Rashwan (2002), Gad *et al.* (2005 a and b) and Nashwa (2006). The significance of “b_1” item showed that the F_1 hybrids exhibited directional dominance for all studied traits except pod length and number of branches/plant. The average of F_1 hybrids exceeded that of the parents by 1.28% for pod diameter, 11.09% for weight of pods, 11.88% for number of pods, 8.48% for weight of seed and 2.36% for weight of 100-seed. In the reverse, the mean of F_1 was lower than the mean of parents for flowering, pod length and number of branches indicated that the direction of dominance towards earliness, short pod and lower branches. Similar results were obtained by Abd-Elhady (1998), Rashwan (2002) and Gad *et al.* (2005 and 6). The significance of “b_2” item for all studied traits except number of seeds/plant indicated asymaterical gene distribution of genes effecting at loci showing dominance, while the significant of “b_3” item indicated further dominance effects due to specific combinations. These results were in agreement with those obtained by Tahany *et al.* (1991), Damarany (1994 a and b), Zhang *et al.* (1995), Rashwan (2002), Gad *et al.* (2005 a and b) and Nashwa (2006).

III: The w_r/v_r relationship:

The analyses of variance of w_r+v_r and w_r-v_r are shown in Table 13 .The results revealed highly significant differences in w_r+v_r and w_r-v_r for all studied traits indicatied the presence of non-additive genetic effect and that non-allelic gene interaction was operating. The slope of the $^{wr/vr}$ regression line was significantly deviated from Zero, but not from unity for all studied traits except pod diameter and number of seeds/pod confirming the adequacy of the additive dominance gene model as cleared in fig. 1, 2 and

3.For pod diameter and number of seed/pod where the regression was non-significantly different from zero resulted in a w_r/v_r line suggested that at non allelic gene interaction is involved. Array No. 8 having IT82D –716 as common parent represented the extreme recessive genotype which was located at the end of the regression line for pod length, number of pods and flowering time. Meanwhile, array No. 6 represented the extreme recessive genotype for weight seeds, weight of pods, array No. 3 for number of branches and array No. 4 for seed index. In contrast, array No. 2 Cream –7 as common parent represented dominant genotype which was located near the point of origin for weight of seed and weight of 100- seeds. Here too, to flowering time, and weight of pods represented dominant genotype see Fig 1,2 and 3.

IV: Genetic parameters:

The estimates of the variance components of the genetic variation are given in Table 14 .The "D" parameter estimating the additive variance was larger than those dominance (H_1) confirmed that partial dominance was operating, which was also indicated by the average degree of dominance being less than one for flowering time, weight of pods, pod length, weight of seeds and number of branches. These results were in a greement with those obtained by Tahany *et al.* (1991, Abd-Elhady (1998), Rashwan(2002), Gad *et al.* (2005 a and b), and Nashwa (2006). Meanwhile the "D" parameter estimated the additive variance was smaller than dominance (H_1) this finding confirmed the presence of over dominance for number of pods/plant, and weight of 100-seeds. These results are in agreement with that obtained by Rashwan (2002), while Nashwa (2006) obtained similar results. In this study, the "F" value was positive for pod length, number of pods and number of branches indicating an excess of dominant alleles than recessive alleles. Morever, the 'F" value was negative for flowering, weight of pods, weight of seeds and weight of 100-seeds indicating an excess of recessive than dominant alleles. Rashwan (2002) reported that the "F" value was negative for weight of seeds, weight of pods, number of pods and number of branches, but the reverse was true for weight of 100-seeds.

The (UV) values were less than 0.25 indicated unequal distribution of the dominant and recessive alleles among the eight parents analyzed which has been indicated before from the significant "b_2" item. Similar results were obtained by Tahany *et al.* (1991), Damarany (1994 a and b), Rashwan (2002) and Nashwa (2006). Narrow sense heritability estimates were high for flowering (0.87), weight of pods (0.80), weight of seeds (0.78) and weight of 100-seeds (0.76). High estimates of heritability for these traits suggested the genetic improvement could be achieved through single plant and recurrent selection method. Uniformly , high heritability estimates of broad sense were for weight of pods (0.98), weight of seeds (0.97) and number of branches (0.89). These results are in harmony with those obtained by Damarany (1994 a and b), Abd-Elhady (1998), Rashwan (2002), Pal *et al.* (2004), Gad *et al.* (2005 a and b) and Nashwa (2006).

2-3-4

5-6-7

8-9-10

11-12

13-14

(Fig 1): The w_r/w_r graph of F_1 diallel cross for flowering, weight of pods and pod length.

(Fig 2): The w_r/w_r graph of F_1 diallel cross for number of pods, weight of seed and weight of 100-seeds.

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المكونات الوراثية لبعض الصفات الاقتصادية فى اللوبي

ثروت محمد الأمين عبد الرحيم
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استخدم في هذه الدراسة ثمانية أصناف من اللوبيا بالإضافة إلى بذور ٢٨ هجين فى الجيل الأول ناتجة من التهجين بين هذه الأصناف فى اتجاه واحد والأصناف المستخدمة فى الدراسة هي: البلدي، كريم – ٧، أزميرلى، دقى ٣٣١، Black eye H_5، IT82D-79، IT82C-9، IT82D-716.

وفى موسم ٢٠٠٧ تم زراعة الأباء وهجن الجيل الأول فى مزرعة كلية الزراعة – جامعة جنوب الوادي فى تجربة قطاعات كاملة العشوائية في ثلاث مكررات٠ تم تحليل بيانات الأباء والجيل الأول لصفات التزهير، قطر القرن، طول القرن، عدد بذور القرن، عدد قرون النبات، وزن قرون النبات، وزن بذور النبات، وزن الـ ١٠٠ بذرة، عدد الأفرع الثمرية على النبات باستخدام موديل هايمن ١٩٥٤، وأظهرت الدراسة النتائج التالية:

١- النموذج الوراثي البسيط هو الملائم لدراسة السلوك الوراثى لجميع الصفات محل الدراسة ما عدا صفتي قطر القرن وعدد بذور القرن.
٢- جميع الصفات محل الدراسة كانت محكومة وراثياً بالطراز السيادى والمضيف.
٣- الفعل الجينى المضيف كان أكثر أهمية من طراز الفعل الجينى السيادي لجميع الصفات محل الدراسة.
٤- لعبت السيادة الجزئية دور هام فى توارث صفات التزهير، وزن قرون النبات، وزن بذور النبات، طول القرن، عدد الأفرع الثمرية، بينما كان للسيادة الفائقة دور هام فى وراثة صفات عدد قرون النبات ووزن الـ١٠٠ بذرة.
٥- درجة التوريث بمعناها الضيق والواسع كانت عالية لصفات التزهير، وزن قرون النبات، وزن بذور النبات، وزن الـ١٠٠ بذرة.

Table 2: The analyses of variance of all studied traits among the different entries of diallel in the growing season of 2007

S.V.	d. F	Flowering	Pod diameter	Number of seeds/pod	Weight of pods	Pod length	Number of pods/plant	Weight of seeds	Seed index	Number of branches
Rep.	2	0.09	0.00005	0.003	1.81	0.009	1.34	2.21	0.19	0.19
Genotypes	35	49.97**	0.004**	1.23**	237.11**	3.12**	64.06**	94.25**	18.27**	0.82**
Error	70	0.84	0.0001	0.19	1.58	0.081	1.12	1.05	0.007	0.03

Table 3: The means of days to opening the first flower of the F_1 diallel cross in the growing season of 2007

Parents	1	2	3	4	5	6	7	8	Array mean
P_1-Balady	71.00	70.33	70.00	61.33	70.00	69.00	71.33	72.00	69.37
P_2-cream7		67.33	69.00	61.67	65.67	67.00	67.00	68.33	67.04
P_3-Azmerly			74.00	63.67	71.00	70.33	70.67	72.00	70.08
P_4-Dokki-331				58.33	59.33	59.67	61.33	62.00	60.92
P_5-Black eye-H5					65.67	65.33	64.00	69.33	66.29
P_6-IT82D-79						69.00	67.33	67.33	66.87
P_7- IT82C- 9							71.00	68.33	67.62
P_8- IT82D-716								74.00	69.16

P= 69.04 , F_1= 66.94

Table 4: The means of Pod diameter plant of the F_1 diallel cross in the growing season of 2007.

Parents	1	2	3	4	5	6	7	8	Array mean
P_1-Balady	0.72	0.80	0.73	0.77	0.74	0.82	0.74	0.70	0.75
P_2-cream7		0.78	0.77	0.79	0.76	0.79	0.80	0.79	0.78
P_3-Azmerly			0.86	0.80	0.86	0.80	0.84	0.84	0.81
P_4-Dokki-331				0.88	0.81	0.79	0.77	0.82	0.80
P_5-Black eye-H5					0.80	0.82	0.77	0.79	0.79
P_6-IT82D-79						0.72	0.74	0.74	0.77
P_7- IT82C- 9							0.83	0.85	0.79
P_8- IT82D-716								0.85	0.79

P= 0.78 , F_1= 0.79

Table 5: The means of number of seeds/pod of the F_1 diallel cross in the growing season of 2007.

Parents	1	2	3	4	5	6	7	8	Array mean
P_1-Balady	10.00	10.00	9.33	10.67	10.69	10.67	10.67	11.00	10.37
P_2-cream7		10.33	10.33	9.67	10.00	11.00	10.67	11.00	10.37
P_3-Azmerly			9.00	9.33	9.00	9.33	9.33	9.33	9.37
P_4-Dokki-331				9.33	10.67	10.33	10.00	9.00	9.87
P_5-Black eye-H5					10.00	10.67	10.00	10.33	10.17
P_6-IT82D-79						10.33	11.00	10.33	10.45
P_7- IT82C- 9							11.00	10.67	10.41
P_8- IT82D-716								11.00	10.33

P= 10.12 , F_1= 10.16

Table 6: The means of weight of pods/plant of the F_1 diallel cross in the growing season of 2007

Parents		1	2	3	4	5	6	7	8	Array mean
P_1-Balady	1	50.57	66.30	74.37	74.30	79.23	57.20	71.33	73.26	68.32
P_2-cream7	2		65.73	73.37	77.80	82.0	67.07	74.50	76.63	72.92
P_3-Azmerly	3			73.37	87.44	90.83	71.57	82.20	82.4	79.44
P_4-Dokki-331	4				76.6	89.63	81.00	87.07	87.90	82.71
P_5-Black eye-H5	5					86.63	75.40	88.17	83.93	84.47
P_6-IT82D-79	6						60.47	70.80	81.80	70.66
P_7- IT82C- 9	7							76.43	89.73	80.02
P_8- IT82D-716	8								75.33	81.37

P= 70.64 , F_1= 78.48

Table 7: The means of pod length/ plant of the F_1 diallel cross in the growing season of 2007

Parents	1	2	3	4	5	6	7	8	Array mean
P_1-Balady	12.73	13.37	12.60	13.03	13.00	13.70	12.93	13.23	13.07
P_2-cream7		14.53	14.80	14.80	14.43	15.43	15.23	15.37	14.74
P_3-Azmerly			13.30	14.10	14.47	13.90	14.13	13.97	13.90
P_4-Dokki-331				15.07	14.40	15.63	14.67	15.03	14.59
P_5-Black eye-H5					12.87	14.07	12.83	13.50	13.69
P_6-IT82D-79						15.47	14.47	16.00	14.83
P_7- IT82C- 9							13.63	14.27	14.02
P_8- IT82D-716								17.80	14.87

P= 14.42 , F_1= 14.19

Table 8: The means of number of pods/plant of the F_1 diallel cross in the growing season of 2007

Parents	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	Array mean
P_1-Balady	51.33	60.67	58.67	61.00	63.33	55.33	56.67	50.67	57.20
P_2-cream7		56.00	59.67	60.33	63.67	58.67	59.33	56.67	59.37
P_3-Azmerly			59.00	65.33	61.67	62.33	67.33	60.00	61.75
P_4-Dokki-331				55.33	63.33	62.00	64.00	61.33	61.58
P_5-Black eye-H5					65.33	63.33	66.33	63.33	63.79
P_6-IT82D-79						53.00	64.33	60.00	59.87
P_7- IT82C- 9							56.67	59.33	61.74
P_8- IT82D-716								39.67	56.37

P= 54.54 , F_1= 61.02

Table 9: The means of weight of seeds/plant of the F_1 diallel ~~cr~~oss in the grow~~in~~g season of 2007

Parents	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	Array mean
P_1-Balady	40.80	52.20	55.90	54.57	56.77	43.23	53.13	50.13	50.84
P_2-cream7		51.07	55.50	56.57	58.97	50.33	55.47	52.07	54.02
P_3-Azmerly			57.27	64.27	65.43	54.53	60.93	55.70	58.69
P_4-Dokki-331				55.57	64.63	60.93	64.53	59.43	60.06
P_5-Black eye-H5					62.57	57.33	65.30	56.67	60.95
P_6-IT82D-79						45.53	52.43	55.30	52.45
P_7- IT82C- 9							56.60	60.63	58.62
P_8- IT82D-716								50.10	55.00

P= 52.43 , F_1= 56.88

Table 10: The means of weight of 100-seeds of the F_1 diallel ~~cr~~oss in the grow~~in~~g season of 2007

Parents	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	Array mean
P_1-Balady	11.57	13.57	14.63	12.73	12.90	13.30	12.40	13.53	13.07
P_2-cream7		15.13	14.57	13.50	14.73	14.97	14.43	14.97	14.48
P_3-Azmerly			18.80	20.43	18.53	17.97	19.77	18.73	17.92
P_4-Dokki-331				19.58	19.23	18.03	19.33	19.93	15.33
P_5-Black eye-H5					15.27	16.93	16.60	16.43	16.32
P_6-IT82D-79						13.17	14.97	15.03	15.54
P_7- IT82C- 9							14.47	16.33	16.03
P_8- IT82D-716								17.27	16.52

P= 15.65 , F_1= 16.02

Table 11: The means of number of branches/plant of the F_1 diallel cross in the growing season of 2007

Parents	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	Array mean
P_1-Balady	5.83	5.73	5.90	4.23	5.23	5.50	5.60	5.83	5.48
P_2-cream7		6.13	5.83	4.47	5.07	5.47	5.63	5.90	5.52
P_3-Azmerly			6.30	4.30	5.20	5.50	5.53	5.90	5.55
P_4-Dokki-331				4.03	4.97	5.37	5.43	5.73	4.81
P_5-Black eye-H5					5.03	5.40	5.50	5.80	5.27
P_6-IT82D-79						5.73	5.60	5.73	5.53
P_7- IT82C- 9							5.93	5.87	4.90
P_8- IT82D-716								6.80	5.90

P= 5.72 , F_1= 5.44

Table 12: The results of the analyses of variance of diallel analysis for all studied traits in the season of 2007

Item	d. F	Flowering	Pod diameter	Number of seeds	Weight of pods	Pod length	Number of pods	Weight of seeds	Weight of 100- seeds	Number of branches
A	7	402.35**	0.02**	6.47**	1731.74**	20.37**	301.67**	675.08**	127.08**	5.04**
b	28	11.85**	0.007**	1.16**	100.58**	1.92**	68.75**	43.29**	9.33**	0.58**
b_1	1	92.71**	0.003**	0.001Ns	1292.18**	1.14**	882.38**	416.19**	2.84**	1.74**
b_2	7	6.80**	0.003**	0.49**	39.71**	3.45**	51.47**	18.04**	8.80**	0.30**
b_3	20	9.57	0.008**	1.45**	62.30**	1.42**	34.11**	33.49**	9.83**	0.62**
B×a	14	1.11	0.0004	0.32	3.19	0.12	1.43	1.03	0.129	0.05
B×b	56	1.63	0.0003	0.35	2.76	0.15	2.16	2.11	0.134	0.06
B× b_1	2	0.85	0.0002	0.36	0.82	0.53	0.21	4.82	0.365	0.05
B× b_2	14	0.59	0.001	0.12	1.19	0.12	2.54	1.36	0.287	0.07
B× b_3	40	2.02	0.0003	0.44	3.41	0.14	2.13	2.48	0.006	0.06
Block interaction	70	0.84	0.0001	0.19	1.58	0.08	1.12	1.05	0.007	0.03

All items tested against Block interaction

Table 13: Analyses of variance of (wr+vr) and (wr-vr) for all studied traits.

S.V.	d. F	Flowering		Pod diameter		Number of seeds		Weight of pods		Pod length	
		wr+vr	wr-vr	wr+vr	wr-vr	wr+vr	wr-vr	wr+vr	wr-vr	wr+vr	wr-vr
Reps.	2	0.17	8.01	0.00001	0.00007	0.27	0.001	75.39	111.86	0.04	0.02
Genotypes	7	162.13**	2.18	0.0001	0.00008	0.13	0.004	6317.19**	135.50**	5.63**	0.17**
Error	14	17.18	1.22	0.000004	0.000008	0.004	0.001	185.12	24.05	0.17	0.002

Continue Table 13: Analyses of variance of (wr+vr) and (wr-vr) for all studied traits.

S.V.	d. F	Number of pods		Weight of seeds		Seed India		Number of branches	
		wr+vr	wr-vr	wr+vr	wr-vr	wr+vr	wr-vr	wr+vr	wr-vr
Reps.	2	21.55	0.56	20.75	27.62	0.78	1.93	0.08	0.02
Genotypes	7	3547.45**	80.42**	680.40**	33.52	68.69**	6.74**	0.26	0.03
Error	14	56.96	15.86	37.57	8.13	0.34	0.13	1.94	0.02

Table 14: Components of the genetic variation for seven traits studied of 2007 season.

character	Flowering		Weight of pods		Pod length		Number of pods		Weight of seeds		Weight of 100-Seeds		Number of branches	
Item	×	± S.E	×	± S.E	×	± S.E	×	± S.E	×	± S.E	×	± S.E	×	± S.E
D	27.39	0.67	124.82	6.01	2.78	0.09	52.81	2.43	48.01	1.70	7.39	0.22	0.68	0.03
F	-4.86	1.59	-10.36	7.09	1.91	0.22	39.98	5.76	-4.26	4.12	-1.03	0.53	0.33	0.07
H_1	7.27	1.55	72.60	6.90	1.92	0.22	55.61	5.60	30.47	4.01	8.21	0.52	0.37	0.07
H_2	6.23	1.35	63.91	6.01	1.12	0.19	43.62	4.27	26.79	3.49	6.07	0.45	0.32	0.06
E	0.84	0.22	1.58	1.01	0.08	0.03	1.12	0.81	1.05	0.58	7.41	0.07	3.43	0.01
$(H_1/D)^{½}$	0.51		0.76		0.83		1.02		0.79		1.05		0.73	
Uv	0.21		0.22		0.14		0.19		0.21		0.18		0.21	
Broad sense H^2	0.95		0.98		0.93		0.95		0.97		0.98		0.89	
Narrow sense H^2	0.87		0.80		0.69		0.50		0.78		0.76		0.64	