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# Genetic study for some pod characters in vegetable cowpea (*Vigna unguiculata* (L.) Walp.)

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**Abstract:** Pod characters like pod length, pod weight, number of pods per cluster and number of pods per plant are very important yield component which determines the marketable green pod yield in vegetable cowpea. Line x Tester (6x4) analysis of in cowpea exhibited significant differences among parents and their crosses for all these characters. ICP-38 x Arka Garima, ICP-45 x Pusa Komal and ICP-42 x Indira Hari exhibited maximum positive magnitude for relative heterosis, heterobeltiosis and standard heterosis respectively for pod length. Crosses ICP-42 x Arka Garima and ICP-54 x Indira Hari showed maximum positive magnitude for relative heterosis, heterobeltiosis and standard heterosis for pod weight and number of pods per plant, respectively. Additive genetic variance was predominant for pod length and pod weight whereas, non-additive gene action for number of pods per cluster and number of pods per plant. ICP-42, ICP-45, Pusa Komal, Arka Garima and Indira Hari were good general combiners for pod length and pod weight. ICP-42, Arka Garima and Khalleshwari were good general combiners for number of pods per cluster whereas, ICP-38 and ICP-54 for number of pods per plant. The crosses ICP-42 x Indira Hari, ICP-26 x Khalleshwari, ICP-42 x Indira Hari and ICP-42 x Arka Garima were identified as best specific combiners for yield contributing characters.

**Keywords:** *Vigna unguiculata*, cowpea, heterosis, combining ability

## Introduction

Yield in vegetable cowpea (*Vigna unguiculata* L.) can be thought of as a function of components such as the number of pods per cluster, number of pods per plant, pod length and pod weight (Pathmanathan *et al.,*1997). Little information is available on genetics of these components of pod yield in cowpea and earlier studies suggested that long pod length is dominant over short pod length (Hazra *et al.,* 1993), light pod weight is partially dominant over heavy pod weight (Roy and Richharia, 1948) and both were governed by additive gene action (Pathmanathan *et al.,*1997) whereas, number of pods per cluster and number of pods per plant were governed by non-additive gene action (Zaveri *et al.,* 1980; Pathmanathan *et al.,*1997) in cowpea. Contradictory results were also reported for pod length (Brittingham, 1950). Exact nature of genetics of these traits are not confirmed. Therefore, the present study was undertaken to know the heterosis, combining ability and gene action for pod length, pod weight, number of pods per cluster and number of pods per plant in cowpea.

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## Material and Methods

The experiment was conducted during *Kharif* season of 2007 and 2008 at Department of Horticulture, IGKV, Raipur (C.G.). The experiment comprises of different phenotypic genotypes like six lines *viz*., ICP-26 ($L_1$), ICP-38 ($L_2$), ICP-42 ($L_3$), ICP-45 ($L_4$), ICP-49 ($L_5$) and ICP-54 ($L_6$) and four testers *viz*., Pusa Komal ($T_1$), Arka Garima ($T_2$), Indira Hari ($T_3$) and Khalleshwari ($T_4$) along with their 24 $F_1$s produced by utilizing line x teater matting design as given by Kempthorne (1957). The experiment was laid out in randomized block design with three replications. Each genotype consisted of three rows of 3.15 m long and 7 plants in each row. The spacing given was 60 cm between rows and 45 cm within a row. Observations were recorded on ten randomly tagged competitive plants from each genotype for pod length, pod weight, number of pods per cluster and number of pods per plant. Statistical analysis was done as methods suggested by Hayes *et al*. (1955) and Kempthorne (1957).

## Results and Discussion

Analysis of variance revealed that the mean sum of squares due to genotypes were highly significant for parents and crosses for all the characters suggesting existence of considerable amount of genetic variability in the materials under investigation. Generally, long pod, higher pod weight, more number of pods per cluster and maximum number of pods per plant are desired in high yielding variety along with positive magnitude of heterosis and positive values of specific combining ability (sca), that is desirable for breeding high green pod yielding varieties in cowpea. The magnitude of different heterosis viz., relative heterosis (RH), heterobeltiosis (HB) and standard heterosis (SH) represented in Table 1.

For pod length cross combinations viz; ICP-38 x Arka Garima (23.82%), ICP-45 x Pusa Komal (10.37%) and ICP-42 x Indira Hari (86.45%) exhibited maximum positive magnitude for relative heterosis, heterobeltiosis and standard heterosis, respectively. Among rest of the crosses significant positive magnitude of relative heterosis was showed by ICP-38 x Pusa Komal (20.78%) ICP-45 x Pusa Komal (19.97%), ICP-45 x Arka Garima (14.87%) and ICP-42 x Arka Garima (10.29%), significant positive magnitude of heterobeltiosis only by ICP-45 x Pusa Komal (10.37%) and significant positive magnitude of standard heterosis by ICP-42 x Arka Garima (65.73%), ICP-54 x Indira Hari (65.30%), ICP-54 x Pusa Komal (57.96%), ICP-42 x Pusa Komal (55.80%), ICP-54 x Arka Garima (53.78%), ICP-38 x Pusa Komal (46.74%), ICP-38 x Arka Garima (45.45%) for this trait.

Pod weight is also one of the important quantitative trait, which directly influence the green pod yield the cross, ICP-42 x Arka Garima showed maximum positive magnitude for relative heterosis (36.14%), heterobeltiosis (5.61%) and standard heterosis (89.00%). The other promising crosses were ICP-42 x Indira Hari (35.66%) and ICP-54 x Arka Garima (14.00%) for relative heterosis and ICP-42 x Indira Hari (81.74%), ICP42 x Pusa Komal (40.63%), ICP-54 x Arka Garima (36.28%), ICP-54 x Pusa Komal (23.94%), ICP-38 x Arka Garima (23.70%), ICP-49 x Arka Garima (16.20%), ICP-49 x Pusa Komal (14.27%), ICP-38 x Pusa Komal (13.30 %) for standard heterosis for pod weight.

For number of pods per cluster, the crosses ICP-26 x Khalleshwari (46.15%), ICP-45 x Indira Hari (32.39%) and ICP-38 x Arka Garima (56.54%) recorded highest significant positive magnitude for relative heterosis, heterobeltiosis and standard heterosis respectively for number of pods per cluster. The top ranking crosses were ICP-26 x Khalleshwari (46.15%), ICP-45 x Indira Hari (46.03%), ICP-26 x Arka Garima (42.50%), ICP-42 x Indira Hari (40.60%), ICP-45 x Khalleshwari (37.18%), ICP- 49 x Arka Garima (36.47%) and ICP-38 x Indira Hari (34.38%) etc. for relative heterosis, ICP-45 x Indira Hari (32.39%), ICP-26 x Indira Hari (32.39%), ICP-26 x Indira Hari (27.17%), ICP-49 x Indira Hari (15.50%), ICP-42 x Indira Hari (15.05%) etc. for heterobeltiosis and ICP-38 x Arka Garima (56.54%) showed highest standard heterosis followed by ICP-45 x Khalleshwari (49.62%), ICP-45 x Arka Garima (49.23%), ICP-49 x Arka Garima (48.85%),

**Table 1:** Magnitude of relative heterosis, heterobeltiosis and standard heterosis in vegetable cowpea

| Hybrids | Pod length (cm) | | Pod weight (g) | | Number of pods per cluster | | Number of pods per plant | |
|---|---|---|---|---|---|---|---|---|
| | RH | HB | RH | HB | RH | HB | RH | HB |
| ICP- 26 x Pusa Komal | 10.24 | 6.89 | -6.36 | -25.88** | 21.88** | 0.38 | 1.59 | -13.62* |
| ICP- 26 x Arka Garima | 11.68 | 4.05 | -14.41* | -31.95** | 42.50** | 3.54 | 2.51 | -11.85 |
| ICP- 26 x Indira Hari | 0.18 | -9.41 | -17.03* | -31.25** | 29.41** | 27.17** | 21.81* | 14.83* |
| ICP- 26 x Khalleshwari | -20.87* | -38.51** | -12.50 | -27.54** | 46.15** | 7.65* | 20.18* | 8.66 |
| ICP- 38 x Pusa Komal | 20.78** | 2.63 | -3.80 | -16.41** | 9.09* | 7.69 | 35.41** | 13.18 |
| ICP- 38 x Arka Garima | 23.82** | 1.72 | 5.64 | -8.74* | 31.18** | 10.90** | 33.88** | 13.13 |
| ICP- 38 x Indira Hari | -0.79 | -4.71 | -11.29* | -26.49** | 34.38** | 13.44** | 43.60** | 32.73** |
| ICP- 38 x Khalleshwari | -36.61** | -55.24** | -37.38** | -59.86** | 20.88** | 3.97 | 17.17* | 4.01 |
| ICP- 42 x Pusa Komal | 0.98 | -25.31** | 0.87 | -21.42** | 13.75** | 10.99* | 34.83** | 9.46 |
| ICP- 42 x Arka Garima | 10.29* | -20.55** | 36.14** | 5.61 | 16.67** | 1.63 | 50.78** | 23.71** |
| ICP- 42 x Indira Hari | 9.60* | -10.61** | 35.66** | 1.55 | 40.60** | 15.02** | 27.85** | 14.27* |
| ICP- 42 x Khalleshwari | -47.42** | -66.27** | -44.34** | -66.22** | 17.02** | 3.97 | 26.44** | 8.71 |
| ICP- 45 x Pusa Komal | 19.97** | 10.37* | -3.05 | -7.93 | 23.94** | 12.69** | 27.74** | 2.08 |
| ICP- 45 x Arka Garima | 14.87* | 1.81 | -1.11 | -6.63 | 33.91** | 5.72 | 20.54* | -2.71 |
| ICP- 45 x Indira Hari | 2.07 | -2.85 | 0.70 | -9.35* | 46.03** | 32.39** | 41.79** | 24.41** |
| ICP- 45 x Khalleshwari | -31.93** | -49.11** | -38.01** | -58.37** | 37.18** | 10.20** | 19.19* | 0.69 |
| ICP- 49 x Pusa Komal | 1.37 | -7.39 | 4.63 | -3.57 | 28.99** | 14.23** | 17.05 | -11.58 |
| ICP- 49 x Arka Garima | 2.77 | -9.54 | 6.96 | -1.94 | 36.47** | 5.45 | 14.53 | -12.72 |
| ICP- 49 x Indira Hari | -6.55 | -10.39* | -0.82 | -13.16** | 23.75** | 15.50** | 39.68** | 14.88* |
| ICP- 49 x Khalleshwari | -29.44** | -47.50** | -35.75** | -57.45** | 32.53** | 3.97 | 27.20** | 1.06 |
| ICP- 54 x Pusa Komal | 7.28 | -18.79** | 3.22 | -11.64** | 5.00 | 2.56 | 37.76** | 15.14* |
| ICP- 54 x Arka Garima | 7.38 | -20.95** | 14.00** | -2.84 | 18.75** | 3.54 | 39.35** | 17.72* |
| ICP- 54 x Indira Hari | 1.37 | -15.02** | -5.78 | -23.02** | 32.84** | 8.79* | 74.20** | 60.92** |
| ICP- 54 x Khalleshwari | -45.97** | -64.79** | -42.21** | -63.19** | 22.77** | 9.07** | 20.62** | 7.00 |

" and ** Significant at 5 and 1 percent level; RH - Relative Heterosis, HB - Heterobeltiosis, SH - Standard Heterosis

ICP-54 x Khalleshwari (48.08%), etc. for standard heterosis.

For number of pods per plant, the cross ICP-54 x Indira Hari showed maximum significant relative heterosis (74.20%), heterobeltiosis (60.92%) and standard heterosis (27.44%) for number of pods per plant. The top ranking crosses were ICP-42 x Arka Garima (50.78%), ICP-38 x Indira Hari (43.60%), ICP-45 x Indira Hari (41.79%), ICP-49 x Indira Hari (39.68%), ICP-54 x Arka Garima (39.35%), ICP-38 x Pusa Komal (35.41%), ICP-42 x Pusa Komal (34.83%), ICP-38 x Arka Garima (33.88%), ICP-42 x Indira Hari (27.85%), ICP-45 x Pusa Komal (27.74%), ICP-49 x Khalleshwari (27.20%), ICP-42 x Khalleshwari (26.44%) etc. for relative heterosis, ICP-38 x Indira Hari (32.73), ICP-45 x Indira Hari (24.41%), ICP-42 x Arka Garima (23.71), ICP-54 x Arka Garima (17.72%), ICP-54 x Pusa Komal (15.14%) ICP-49 x Indira Hari (14.88%), ICP-26 x Indira Hari (14.83%) and ICP-42 x Indira Hari (14.27) for heterobeltiosis and only two crosses showed significant positive standard heterosis i.e., ICP-54 x Indira Hari (27.44%) and ICP-42 x Arka Garima (20.45%) for standard heterosis. In present investigation positive heterosis for yield and its contributing characters was also reported by Mak and Yap (1977), Sangwan and Lodhi (1995), Kumar *et al.* (1999) and Bhusana *et al.* (2000) in cowpea.

The estimates of GCA of parents and SCA of crosses for pod length, pod weight, number of pods per cluster and number of pods per plant revealed that among parents ICP-42, ICP-45, Pusa Komal, Arka Garima and Indira Hari were good general combiner for pod length and pod weight. ICP-42, Arka Garima and Khalleshwari were good general combiners for number of pods per cluster whereas, ICP-38 and ICP-54 for number of pods per plant. Thus, it is suggested that these parents may be exploited in breeding programme for development of high yielding varieties. The crosses ICP-42 x Indira Hari (4.46), ICP-26 x Khalleshwari (2.37), ICP-42 x Indira Hari (0.33) and ICP-42 x Arka Garima (3.49) showed maximum SCA effect for pod length, pod weight, number of pods per cluster and number of pods per plant respectively. The cross ICP- 26 x Khalleshwari exhibited significant and positive SCA effects commonly for all the four traits and ICP-42 x Indira Hari also showed significant and positive SCA effects except for number of pods per plant. The crosses ICP-42 x Arka Garima, ICP-49 x Pusa Komal, ICP-49 x Khalleshwari and ICP-54 x Indira Hari proved significant and positive SCA effects for pod weight and number of pods per plant, pod weight and number of pods per cluster, pod length and number of pods per plant and number of pods per cluster and number of pods per plant, respectively. In these crosses at least one parent possessed higher GCA effects. These results are similar to the findings of Yadav *et al.* (2004) and Kumar and Sangwan (2005) in cowpea.

**Table 2:** Analysis of variance for combining ability for pod characters in vegetable cowpea

| Source of variation | d.f. | Mean sum of square | | | |
|---|---|---|---|---|---|
| | | Pod length | Pod weight | No. of pods per cluster | No. of pods per plant |
| Replication | 02 | 12.15 | 0.93 | 0.35 | 20.22 |
| Lines | 05 | 295.14** | 32.45** | 0.57** | 8.96** |
| Testers | 03 | 143.45** | 17.52** | 2.11** | 17.53** |
| Line x Tester | 15 | 221.92** | 36.70** | 0.77** | 37.99** |
| Error | 46 | 5.11 | 0.33 | 0.02 | 5.34 |
| $\sigma^2 g$ | | 37.93 | 5.80 | 0.2 | 2.39 |
| $\sigma^2 s$ | | 6.13 | 1.95 | 0.5 | 3.44 |
| $\sigma^2 g/\sigma^2 s$ | | 7.82 | 2.97 | 0. 4 | 0.69 |
| Average degree of dominance $(\sigma^2 g/\sigma^2 s)^{1/2}$ | | 2.79 | 1.72 | 0.63 | 0.83 |

* Significant at 5% level

For pod length, high GCA performance shown by one of the parent of the crosses that attributed to importance of additive gene action and possibility of getting better transgressive segereagants for early generation testing. These findings are similar to the reports of Chaudhary *et al.* (1998), Singh *et al.* (2004), Yadav *et al.* (2004) and Kumar and Sangwan (2005).

The gene action admitted the additivity for pod weight as at least one parent of these crosses recorded high positive GCA effect with or without high SCA effects, whereas one of the parents of some crosses had positive GCA effects but some of them had negative GCA effects also thereby, confirming also the involvement of non-additive gene action in the form of over dominance and epistasis for crosses with high SCA effects. These findings are in agreement with finding of Patel *et al.* (1994) and Yadav *et al.* (2004) in cowpea.

For the number of pods per cluster and number of pods per plant, among the crosses, any one parent of crosses recorded high positive GCA effect with high SCA effects while, remaining some crosses had high SCA without involving high GCA of parents. One of the parent of the crosses mentioned above had positive GCA effects but most of them had negative or lower GCA effects thereby, confirming the presence of non additive gene action in the form of over dominance and epistasis for crosses with high SCA effects. These results are in confirmation with finding Hazara *et al.* (1996), Bushana *et al.* (1998), Chaudhary *et al.* (1998), Kumar and Sangwan (2005) and Singh *et al.* (2006) in cowpea.

**Table 3:** Estimate values of GCA of parents for pod characters in vegetable cowpea

| Parents | Pod length | Pod weight | No. of pods per cluster | No. of pods per plant |
|---|---|---|---|---|
| Lines | | | | |
| ICP-26 ($L_1$) | -3.99* | -3.09* | -0.20* | -2.41* |
| ICP-38 ($L_2$) | 0.82 | -0.07 | 0.05 | 1.42* |
| ICP-42 ($L_3$) | 5.80* | 3.68* | 0.10* | 1.18 |
| ICP-45 ($L_4$) | -2.16* | -0.84* | 0.08 | -0.83 |
| ICP-49 ($L_5$) | -4.38* | -0.21 | -0.09 | -2.75* |
| ICP-54 ($L_6$) | 3.90* | 0.53* | 0.06 | 3.39* |
| Testers | | | | |
| Pusa Komal ($T_1$) | 3.87* | 1.07* | -0.44* | 0.87 |
| Arka Garima ($T_2$) | 3.43* | 2.00* | 0.56* | 0.71 |
| Indira Hari ($T_3$) | 5.24* | 0.87* | -0.58* | 0.41 |
| Khalleshwari ($T_4$) | -12.55* | -3.94* | 0.46* | -1.99* |
| SE (Lines) | 0.50 | 0.10 | 0.04 | 0.47 |
| SE (Testers) | 0.39 | 0.08 | 0.03 | 0.37 |

The ratio of GCA variance to SCA variance (Table 2) was found more than unity for pod length and pod weight whereas, less than unity for number of pods per cluster and number of pods per plant, this indicated the preponderance of additive gene action for former two characters and non-additive gene action for later two characters. These results are in accordance with the findings of Chaudhary *et al.* (1998) for pod length, Patel *et al.* (1994) for pod weight, Thiagarajan and Rajshekharan (1989) for number of pods per cluster and Mak and Yap (1977) and Hazara *et al.* (1996) for number of pods per plant in cowpea.

The average degree of dominance indicated over dominance for pod length and pod weight and were predominantly controlled by additive gene action. For these character improvement can be done through selection in variable populations of segregating generation. Whereas, number of pods per cluster and number of pods per plant had lower average degree of dominance. Based on heterosis and gene action studies it can be suggested that intermitting of superior segregates in advance generations followed by recurrent selection or multiple crossing is a judicious approach to harness both additive and non-additive types of gene actions in present set of biological material. The transgressive segregates produced as a result of this will lead to development of high yielding genotypes having desirable pod characters in cowpea.

## References


Bhushana HO, Viswanatha KP, Arunachalam P and Halesh GK (2000) Heterosis in cowpea (*Vigna unguiculata* (L.) Walp.) for seed yield and its attributes. Crop Research 19(2): 277-280.

Bhushana HO, Viswanatha KP, Manjuatha A, Kulkarni RS and Kyhad PR (1998) Combining ability for seed yield and its components in cowpea (*Vigna unguiculata* L. Walp). Crop Improvement 25 : 116-118.

Brittingham WH (1950) Inheritance of date of pod maturity, pod length, seed shape and seed size in southern pea (*Vigna sinensis*). Proc Amer Soc Hort Sci 56: 381-388.

Chaudhary FP, Thaker DN, Tikka SBS and Patel ID (1998) Genetic architecture of yield and its components in cowpea (*Vigna unguiculata* L. Walp), Guj Agric Uni Res J 24: 30-35.

Hazra P, Som MG and Das PK (1993) Inheritance of pod length in cowpea. Indian J Hort 50(4): 358-363

Hayes HK, Immer KC and Smith DC (1955) *Methods of Plant Breeding*, McGraw Hill Book Company Inc., New York.

Hazra P, Som MG and Das PK (1996) Combining ability for pod yield and seed protein in cowpea (*Vigna unguiculata* (L.) Walp.). Indian J Genet 56(4): 553-555.

Kempthorne O (1957) *An Introduction to Genetic Statistics*, John Wiley and Sons, Inc., New York, pp.468-471.

Kumar D and Sangwan VP (2005) Combining ability studies for yield and architectural traits in cowpea [*Vigna unguiculata* (L.) Walp.]. Annals of Biology 21(1): 47-49.

Kumar R, Singh SP and Joshi AK (1999) Heterosis in cowpea (*Vigna unguiculata* [L.] Walp.). Vegetable Science 26 (1): 22-26.

Mak C and Yap TC (1977) Heterosis and combining ability of seed protein yield and yield component in long bean. Crop Sci 17: 339-341.

Pathmanathan U, Ariyanayagam RP and Haque SQ (1997) Genetic analysis of yield and its components in vegetable cowpea. Euphytica 96: 207-213.

Patel RN, Godhani PR and Fougat RS (1994) Combining ability in cowpea, (*Vigna unguiculata* L. Walp). Gujarat Agri Univ Res J 20: 70-74.

Roy RS and Rachharia RH (1948) Breeding and inheritance studies in cowpea (*Vigna sinensis*). J Amer Agron 40: 479-489.

Sangwan RS and Lodhi GP (1995) Heterosis for grain characters in cowpea (*Vigna unguiculata* L. Walp). Lagume Research 18: 75-80.

Singh I, Badaya SN and Tikka SBS (2006) Combining ability for yield over environments in cowpea (*Vigna unguiculata* (L.) Walp.). Indian J Crop Science 1(1-2):205-206.

Singh SP, Kumar R, Joshi AK and Singh B (2004) Genetic architecture of yield traits in cowpea [*Vigna unguiculata* (L.) Walp.]. Advances in Plant Sciences 17(2): 495-502.

Thiagarajan K and Rajasekaran S (1989) Genotypes x environment interaction for grain yield in cowpea. Madras Agric J 74: 15-17.

Yadav KS, Yadava HS and Naik ML (2004) Gene action governing the inheritance of pod yield in cowpea. Legume Research 27(1): 66-69.

Zaveri PP, Patel PK and Yadvendra JP (1980) Diallel analysis of flowering and maturity in cowpea. Indian J Agric Sci 50: 807-810.