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# Combining Ability Studies in CGMS Based Hybrids of Pigeonpea [*Cajanus cajan* (L.) Millsp]

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## ABSTRACT

*Four cytoplasmic genetic male sterile lines were crossed with six restorer lines in Line x Tester design. The resultant 24 hybrids were evaluated along with their parents during Kharif 2017-18. Combining ability analysis revealed predominance of non-additive gene action. The lines ICPB 2043, ICPB 2047 and ICPL 87119 were good general combiners for seed yield and its components. Six out of 28 hybrids showed significant positive sca effects for seed yield and its two or more component traits.*

***Key words:*** *Pigeonpea, CGMS lines, General combining ability, Specific combining ability.*

## INTRODUCTION

Combining ability analysis helps to choose suitable parents for hybridization and provides valuable information regarding cross combinations to be exploited commercially. The identification of genetic male sterility in pigeon pea[5,11] has opened new vistas for commercial exploitation of hybrid vigour in this crop. Further, by the use of cytoplasmic genetic male sterility[9], hybrid seed production has become feasible. The environment plays an important role in the expression of a trait and greatly influences combining ability estimates and thus the study in single environment may not provide reliable information. Therefore, present study was undertaken to estimate combining ability for seed yield and other traits in pigeon pea over three different environments.

## MATERIAL AND METHODS

The experiment was carried out in Randomized Block Design with three replications during *Kharif*, 2017-18 with four lines *viz.*, ICPA 2043, ICPA 2047, ICPA 2078 and ICPA 2092 and six testers viz., ICPL 87119, ICPL 20096, ICPL 20098, ICPL 20103, ICPL 20108 and ICPL 20116 and their 24 $F_1$'s of pigeonpea obtained by L x T mating design[2]. Five plants in each plot in each replications were randomly selected to record the observations for quantitative traits *viz.*, days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of seeds per pod, 100-seed weight, harvest index, seed protein content, pollen fertility and seed yield per plant.

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## RESULTS AND DISCUSSION

Pooled analysis of variance for combining ability over three environments is presented in Table 1. The variance components due to environments, hybrids, lines × testers and environments × hybrids showed highly significant difference for all the characters. The lines were found to be significant for days to 50 per cent flowering, days to maturity, plant height (cm) and number of seeds per pod. The testers were non-significant for all the characters except days to maturity. The interaction of environment and lines exhibited significant difference for days to maturity, plant height and 100-seed weight. The interaction of environment and testers is significant for days to maturity, number of pods for plant and seed yield per plant.

In the present study the estimates of components of variance and their ratio (σ2gca / σ2 sca) indicated the preponderance of non-additive gene action for all the characters and in all three environments. Predominance of non- additive gene action has also been reported by Reddy *et. al.*[7,6] and Narladkar and Khapre[3] for days to 50% flowering and maturity, pods per plant and seed yield per plant; Reddy *et. al.*[6] and Patel *et. al.*[4] for branches per plant, plant height and 100-seed weight; Reddy *et al.* and Patel *et al.*[4] for seeds per pod.

Based on gca effects and per se performance, the parental lines ICPB 2043, ICPB 2047 and ICPL 87119 were recognized as the best parental lines for most of the traits under study (Table 2). Crosses involving these parents might produce heterotic hybrids with high mean performance. ICPB 2043 was good for six traits *viz.*, days to 50 per cent flowering, days to maturity, number of pods per plant, number of seeds per pod, harvest index and seed yield per plant, whereas ICPB 2047 was good for five traits *viz.*, number of primary branches per plant, number of secondary branches per plant, seed protein content, pollen fertility and seed yield per plant and ICPL 87119 showed well per se performance along with good gca effect for four characters i.e. number of pods per plant, harvest index, seed yield per plant and pollen fertility. The parents viz., ICPB 2043, ICPB 2078 and ICPL 20116 were identified best parent for days to 50 per cent flowering and days to maturity based on good per se along with good gca effects. Hence, selection of these parents in hybridization programmes would result in early maturing hybrids with high yield.

The estimates of *sca* effects revealed that six out of 24 hybrids showed significant positive *sca* effects for seed yield per plant on pooled basis (Table 3). Best specific combiners with mean performance, *gca* status and their significant response of *sca* effects to other traits are presented in Table 3. ICPA 2043 × ICPL 20103 for days to 50% flowering, days to maturity, number of pods per plant and harvest index; ICPA 2078 × ICPL 87119 for number of pods per plant, 100-seed weight, harvest index and pollen fertility; ICPA 2047 × ICPL 87119 for days to 50% flowering, days to maturity, plant height, number of pods per plant, 100-seed weight and seed protein content; ICPA 2047 × ICPL 20098 for days to 50 per cent flowering, number of secondary branches per plant, number of pods per plant, harvest index and pollen fertility; ICPA 2043 × ICPL 20096 for days to 50 per cent flowering, days to maturity, number of primary branches per plant and number of secondary branches per plant and ICPA 2092 × ICPL 20116 for number of pods per plant, harvest index and pollen fertility.

The hybrids *viz*, ICPA 2043 × ICPL 20096 (good × poor), ICPA 2043 × ICPL 20103 (good × poor), ICPA 2047 × ICPL 87119 (good × good), ICPA 2047 × ICPL 20098 (good × poor), ICPA 2092 × ICPL 20116 (poor × good) and ICPA 2078 × ICPL 87119 (poor × good). The crosses showing high *sca* effects involving one good general combiner indicated additive x dominance type gene interaction which could produce desirable transgressive segregants in subsequent generations[8,1].

**Table 1: Pooled ANOVA for combining ability in Line × Tester design for yield and yield components in pigeon pea over environments**

| Source of variation | D. F | Days to 50% flowering | Days to maturity | Plant height (cm) | Number of primary branches per plant | Number of secondary branches per plant | Number of pods per plant | Number of seeds per pod | 100-seed weight (g) | Harvest index (%) | Seed protein content (%) | Seed yield per plant (g) | Pollen Fertility (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Environment | 2 | 2952.05** | 9646.17** | 302280.80** | 140.45** | 4717.92** | 498870.00** | 3.26** | 21.86** | 265.84** | 27.20** | 6664.24** | 1268.69** |
| Hybrids | 23 | 261.61** | 816.35** | 712.97** | 36.68** | 166.90** | 155615.00** | 0.40** | 7.05** | 151.16** | 71.40** | 1934.22** | 1424.16** |
| Lines (Females) | 3 | 763.61** | 5167.83** | 991.09** | 31.18 | 195.30 | 88999.19 | 1.04* | 9.77 | 159.37 | 183.90 | 1523.97 | 724.51 |
| Testers (Males) | 5 | 76.03 | 136.88** | 201.44 | 29.31 | 115.11 | 309379.20 | 0.43 | 9.24 | 162.38 | 25.83 | 3366.94 | 2245.49 |
| Environments × Hybrids | 46 | 133.80** | 363.40** | 1034.11** | 31.67** | 122.01** | 118945.80** | 0.17** | 2.18** | 50.11** | 0.61** | 1370.10** | 32.89** |
| Environments × Lines | 6 | 63.91 | 1083.51** | 1947.76** | 39.23 | 177.60 | 65406.52 | 0.29 | 4.92* | 43.78 | 1.33 | 394.88 | 22.73 |
| Environments × Testers | 10 | 50.82 | 307.36** | 1114.44 | 18.65 | 122.66 | 276420.00** | 0.23 | 2.34 | 67.72 | 0.32 | 3241.90** | 10.99 |
| Error | 138 | 1.55 | 1.85 | 24.30 | 1.88 | 4.33 | 466.51 | 0.06 | 0.59 | 6.25 | 0.07 | 52.21 | 5.43 |
| $\sigma^2 gca$ | - | 9.29 | 18.90 | 12.71 | 0.63 | 3.35 | 4416.05 | 0.01 | 0.19 | 3.43 | 2.32 | 53.18 | 32.87 |
| $\sigma^2 sca$ | - | 24.51 | 58.96 | 89.28 | 4.26 | 19.34 | 13024.10 | 0.02 | 0.57 | 15.50 | 7.11 | 165.16 | 142.76 |
| $\sigma^2 gca/\sigma^2 sca$ | - | 0.37 | 0.32 | 0.14 | 0.14 | 0.17 | 0.33 | 0.63 | 0.34 | 0.22 | 0.32 | 0.32 | 0.23 |

** Significant at 1% level; * Significant at 5% level

**Table 2: Estimates of general combing ability (*gca*) effects of parents for yield and yield components in pigeon pea over environments**

| Parents | Days to 50% flowering | Days to maturity | Plant height (cm) | Number of primary branches per plant | Number of secondary branches per plant | Number of pods per plant | Number of seeds per pod | 100-seed weight (g) | Harvest index (%) | Seed protein content (%) | Seed yield per plant (g) | Pollen Fertility (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ICPB 2043 | -2.81** | -9.24** | -5.43** | -0.60** | -0.12 | 57.35** | 0.08* | -0.09 | 2.65** | -2.56** | 5.60** | -0.28 |
| ICPB 2047 | 0.44** | 3.78** | -0.78 | 0.58** | 0.83** | -12.05** | -0.04 | 0.12 | -0.79* | 1.75** | 3.47** | 4.07** |
| ICPB 2078 | -3.37** | -6.55** | 1.44* | -0.70** | -2.58** | -38.20** | 0.13** | 0.49** | -0.22 | 0.08* | -4.80** | -4.76** |
| ICPB 2092 | 5.10** | 12.01** | 4.77** | 0.72** | 1.86** | -7.09* | -0.17** | -0.52** | -1.45** | 0.73** | -4.26** | 0.96** |
| ICPL 87119 | -1.37** | -1.41** | -2.99** | 0.34 | 2.72** | 58.01** | -0.06 | 0.91** | 2.11** | 1.60** | 6.44** | 12.12** |
| ICPL 20096 | 1.47** | 0.57* | 1.61 | -0.37 | -1.91** | -69.50** | -0.03 | -0.31* | 0.15 | -0.57** | -8.69** | -8.52** |
| ICPL 20098 | 1.01** | 3.60** | 3.44** | 1.64** | 0.58 | -94.48** | 0.10* | 0.24** | -2.73** | -0.67** | -8.13** | -0.55 |
| ICPL 20103 | 1.25** | -0.36 | -2.09* | -0.94** | 1.08** | 145.49** | 0.04 | -0.45** | 2.79** | -0.07 | 15.88** | -8.69** |
| ICPL 20108 | -1.93** | -1.78** | 0.26** | -0.40 | -1.63** | -63.89** | 0.11** | -0.24 | -1.03* | -0.44** | -5.67** | 3.23** |
| ICPL 20116 | -0.43* | -0.61** | -0.24 | -0.26 | -0.84* | 24.38** | -0.16** | -0.14 | -1.30** | 0.16** | 0.17 | 2.41** |

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

**Table 3: Estimates of specific combing ability (*sca*) effects in hybrids for yield and yield components in pigeon pea over environments**

| Hybrids | Mean seed yield per plant | SCA effects | GCA status | Significant response in other trait for sca effects |
|---|---|---|---|---|
| ICPA 2043 × ICPL 20096 | 73.49 | 5.97* | good × poor | DF, DM, NPB and NSB |
| ICPA 2043 × ICPL 20103 | 94.06 | 21.50** | good × poor | DF, DM, NPP and HI |
| ICPA 2047 × ICPL 87119 | 85.68 | 5.16* | good × good | DF, DM, PH, NPP, TW and Pro. |
| ICPA 2047 × ICPL 20098 | 73.84 | 7.89** | good × poor | DF, NSB, NPP, HI and PF |
| ICPA 2078 × ICPL 87119 | 95.25 | 23.00** | poor × good | NPP, HI, TW and PF |
| ICPA 2092 × ICPL 20116 | 85.39 | 18.87** | poor × good | NPP, HI and PF |

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

DF = Days to 50% flowering
DM = Days to maturity
PH = Plant height (cm)
NPB = Number of primary branches per plant
NSB = Number of secondary branches per plant
NPP = Number of pods per plant
NSP = Number of seeds per pod
TW = 100-seed weight (g)
HI = Harvest index (%)
Pro. = Seed protein content (%)
PF = Pollen fertility (%)

## CONCLUSION

Combining ability analysis over environments revealed that among the parents viz., ICPB 2047, ICPB 2043 and ICPL 87119 were identified as the best parents with significant positive gca effects and per se performance and based on mean and sca effects, the hybrids viz., ICPA 2043 × ICPL 20096, ICPA 2043 × ICPL 20103, ICPA 2047 × ICPL 87119, ICPA 2047 × ICPL 20098, ICPA 2078 × ICPL 87119 and ICPA 2092 × ICPL 20116 were identified as promising hybrids for yield and yield components. Hence, the above good specific combiners could be recommended for heterosis breeding.

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