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# Studies on combining ability for fruit yield and quality attributing characters in Yardlong bean (*Vigna unguiculata* (L.) Walp. Ssp. *sesquipedalis* Verdc.)

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**Abstract**
The present investigation was taken up at College of Horticulture, Venkataramannagudem, Andhra Pradesh, India during 2018-2019, to study the combining ability of seven different lines of yardlong bean. They were mated diallel fashion excluding reciprocals and their twenty one crosses were evaluated along with seven parents and one commercial check in Randomized block design (RBD) for fruit yield and quality attributing traits. The analysis of variance for combining ability revealed significant differences due to parents and crosses for all the characters except for days to first picking whereas the significant differences due to parents *vs* hybrids were observed for fourteen of the seventeen characters studied indicating the existence of wide variability in the material studied and greater scope for identifying promising parents and hybrid combinations. The lines Babli, Bobbili Local, Lola and Trivendrum Local recorded significant positive *gca* effects were found to be promising general combiners for yield and quality traits. In respect of *sca* effects, six crosses *viz*., Babli x Bobbli Local, Babli x Lola, Babli x Trivendrum Local, Bobbili Local x Lola, Bobbili Local x Trivendrum Local and Lola x Trivendrum Local were identified as promising specific combiners for yield and quality traits in yardlong bean. The knowledge of combining ability helps in identifying good combiners for hybridization.

**Keywords:** Yardlong bean, randomized block design, gene action, fruit yield per vine

## Introduction
Yardlong bean (*Vigna unguiculata* (L.) Walp. ssp. *Sesquipedalis* Verdc.) belongs to the family Fabaceae with chromosome number 2n=2x=22. It is a distinct form of cowpea grown as a vegetable crop throughout Asia especially in South and South East Asian countries including India. It is also known as asparagus bean, Chinese long bean, pea bean, string bean, snake bean, snake pea, snap pea, borbati *etc*., in different parts of the world.
During recent years, the commercial exploitation of hybrid vigour and selection of parents on the basis of combining ability have expanded a new alley in crop improvement. The concept of combining ability for the evaluation of parents in a crossing programme is of immense importance. Hybridization is one of the most important technique for breaking yield barriers and evolving varieties having high yielding potential. The selection of suitable parents is one of the most important steps in heterosis breeding. Selection of parents on the basis of phenotypic performance alone is not a sound procedure, since phenotypically superior lines may not lead to expected degree of heterosis. Thus, one of the potential tool for identifying prospective parents for hybridization and shifting productive hybrids from a set of crosses in $F_1$ generation is the analysis of combining ability (Griffing, 1956) [4].

## Materials and Methods
The experimental material consisted of seven parental lines *viz.*, Geethika, Babli, Vizianagaram Local, Bobbili Local, Lola, Trivendum Local and Bhuvaneswar Local and these were crossed in diallel fashion excluding reciprocals during *Rabi*, 2018. The resultant 21 $F_1$ hybrids along with seven parents and one commercial check were evaluated in randomized block design with three replications with spacing of 2.0 x 1.0 m during *Summer*, 2019. Observations were recorded on five randomly selected plants from each plot for fruit yield and quality characters *viz.*, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length (cm), pod girth (mm), pod weight (gm), number of seeds per pod,

100 seed weight (g), pod yield per plant (kg), TSS ($^{O}$Brix), protein (%).

**Results and Discussion**

The analysis of variances for general combining ability are highly significant for the traits like number of clusters per plant, number of pods per cluster, number of pods per plant, pod length (cm), pod girth (mm), pod weight (gm), number of seeds per pod, 100 seed weight (g), pod yield per plant (kg), TSS ($^{O}$Brix), protein (%). The variance for specific combining ability is highly significant for all the traits, studied indicating the importance of both additive and non-additive genetic components for most of the traits. Further, the estimates of *gca* and *sca* variances and their ratios are presented in (Table-1). General combining ability is associated with additive gene action, while specific combining ability is due to dominance and epistasis. In the present investigation, it was observed that *sca* variances were higher than *gca* variances for all the characters which indicated that predominance of non-additive gene action.

The *gca* effects of parents were significant for most of the characters studied which indicated the existence of variability among the parents selected for hybridization (Table-2). The parents Babli, Bobbili Local, Lola and Trivendrum Local recorded significant positive *gca* effects were found to be promising general combiners for yield and quality traits. The parents with good *gca* for the characters also exhibited good *per se* performance. Similar results for some of the characters were reported by Anitha *et al*. (2017) [2] and Owusu *et al*. (2018) [7] in cowpea.

Estimation of *sca* effects for 21 crosses has resulted in identification of good specific combiner for various characters as given in (Table-3). Among these 21 cross combinations, the six cross combinations, *viz.*, Babli x Bobbli Local, Babli x Lola, Babli x Trivendrum Local, Bobbili Local x Lola, Bobbili Local x Trivendrum Local and Lola x Trivendrum Local were identified as promising specific combiners for yield and quality traits in yardlong bean in the present investigation. These results are in agreement with the earlier reports of Ushakumari *et al*. (2010) [9] in cowpea, Selvam and Elangaimannan (2010) [8], Kachave *et al*. (2015) [5] in black gram, Latha *et al*. (2018) [6] in mung bean, Aksander and Osman (2018) [1] in pea, Chinapolaiah *et al*. (2019) [3] in velvet bean.

**Table 1:** Analysis of variance and gene action of combining ability analysis for fruit yield and quality attributing traits in 7 x 7 half diallel of yard long bean

| Source of variation | Mean sum of squares | | | σ2gca | σ2sca | gca/sca |
|---|---|---|---|---|---|---|
| | GCA | SCA | Error | | | |
| Degrees of freedom | 06.00 | 21.00 | 54.00 | | | |
| Characters | | | | | | |
| **Yield parameters** | | | | | | |
| Number of clusters per plant | 10.177** | 1.777** | 0.236 | 0.933 | 1.541 | 0.606 |
| Number of pods per cluster | 0.452 ** | 0.090 ** | 0.027 | 0.040 | 0.063 | 0.635 |
| Number of pods per plant | 745.552 ** | 158.629 ** | 5.623 | 65.214 | 153.006 | 0.426 |
| Pod length | 193.156** | 32.645** | 0.685 | 17.835 | 31.960 | 0.558 |
| Pod girth | 0.123 ** | 0.037 ** | 0.002 | 0.010 | 0.036 | 0.267 |
| Pod weight | 13.934 ** | 6.519 ** | 0.467 | 0.824 | 6.052 | 0.136 |
| Number of seeds per pod | 7.042** | 1.276** | 0.094 | 0.641 | 1.182 | 0.542 |
| 100 seed weight | 10.946** | 3.780** | 0.068 | 0.796 | 3.711 | 0.215 |
| Pod yield per plant | 0.552** | 0.310** | 0.007 | 0.027 | 0.302 | 0.090 |
| **Quality parameters** | | | | | | |
| TSS | 0.127 ** | 0.133 ** | 0.002 | -0.001 | 0.131 | -0.005 |
| Protein | 0.215 ** | 0.071** | 0.003 | 0.016 | -0.005 | 0.235 |

** 1% level of significance, * 5% level of significance

GCA = General combining ability, SCA = Specific combining ability, $\sigma^2$gca = Variance due to GCA, $\sigma^2$sca = Variance due to SCA

**Table 2:** Estimates of general combining ability effects for fruit yield and quality attributing traits in 7 x 7 half diallel of yard long bean

| Parent | Yield parameters | | | | | | | | | Quality parameters | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NCP | NPC | NPP | PL | PG | PW | NSP | 100 SW | PYP | TSS | P |
| Geethika | -0.794** | -0.253** | -11.911** | -1.625** | -0.111** | -0.843** | -0.040 | -1.115** | -0.224** | -0.107** | -0.106** |
| Babli | 1.339** | 0.310** | 11.259** | 6.387** | 0.138** | 1.560** | 0.982** | 1.587** | 0.359** | 0.117** | 0.168** |
| Vizianagaram Local | -1.176** | -0.216** | -9.993** | -7.416** | -0.142** | -1.799** | -1.611** | -0.152 | -0.262** | -0.212** | -0.196** |
| Bobbili Local | 0.987** | 0.066 | 7.126** | 4.051** | 0.073** | 1.068** | 0.197* | 0.211* | 0.208** | 0.065** | 0.074** |
| Lola | 0.787** | 0.125* | 4.874** | 1.306** | 0.112** | 0.724** | 0.871** | 0.527** | 0.138** | 0.022 | 0.118** |
| Trivendram Local | 0.032 | 0.177** | 4.474** | 0.717** | 0.037** | 0.349 | 0.160 | 0.618** | 0.021 | 0.099** | 0.119** |
| Bhuvaneswar Local | -1.176** | -0.208** | -5.830** | -3.422** | -0.106** | -1.059** | -0.559** | -1.676** | -0.240** | 0.016 | -0.178** |
| SE (gi) | 0.367 | 0.124 | 1.791 | 0.625 | 0.030 | 0.516 | 0.231 | 0.197 | 0.064 | 0.033 | 0.039 |

** 1% level of significance, * 5% level of significance

NCP = Number of clusters per plant, NPC = Number of pods per cluster, NPP = Number of pods per plant, PL = Pod length, PG = Pod girth, PW = Pod weight, NSP = Number of seeds per pod, 100 SW = 100 Seed weight, PYP = Pod yield per plant, TSS = Total soluble solids, P = Protein

**Table 3:** Estimates of specific combining ability effects for fruit yield and quality attributing traits in 7 x 7 half diallel of yard long bean

| Parent | Yield parameters | | | | | | | | | Quality parameters | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NCP | NPC | NPP | PL | PG | PW | NSP | 100 SW | PYP | TSS | P |
| Geethika x Babli | -0.143 | 0.033 | 3.369 | -3.385 ** | -0.255** | 1.363* | -0.654* | 0.202 | -0.042 | -0.149 ** | -0.262** |
| Geethika x Vizianagaram Local | 1.139* | 0.426** | 10.620** | 14.268 ** | 0.345** | 3.252** | 2.272** | 2.981** | 0.442** | 0.056 | 0.382** |
| Geethika x Bobbili Local | -0.891 | -0.056 | -8.498** | -4.598 ** | -0.223** | -0.458 | -1.469** | -0.022 | 0.018 | -0.341 ** | -0.368** |
| Geethika x Lola | -1.824** | -0.181 | -6.913** | 2.296 ** | -0.059 | 0.012 | -0.276 | 2.418** | 0.038 | -0.150 ** | -0.019 |
| Geethika x Trivendrum Local | -0.869 | -0.167 | -5.513* | 1.329 | -0.151** | -0.373 | -0.631* | -1.190** | 0.188 | -0.464 ** | -0.270** |
| Geethika x Bhuvaneswar Local | -0.261 | -0.048 | 1.591 | 1.935 * | -0.144** | 1.158 | -1.713** | 1.025** | 0.403** | -0.141 ** | -0.099* |
| Babli x Vizianagaram Local | -0.794 | -0.670** | -14.483** | -0.587 | -0.120** | -0.655 | -0.817** | 0.102 | -0.124 | -0.231 ** | -0.075 |
| Babli x Bobbili Local | 1.843** | 0.248 | 16.665** | 2.439 ** | 0.169** | 0.195 | 1.043** | 0.587* | 0.542** | -0.184 ** | 0.062 |
| Babli x Lola | 2.243** | 0.389* | 17.583** | 5.884 ** | 0.139** | 2.339** | 0.635* | 0.390 | 0.805** | -0.081 | 0.060 |
| Babli x Trivendrum Local | 1.198* | 0.070 | 12.517** | 4.277 ** | 0.191** | 2.587** | 0.680* | 0.969** | 0.606** | 0.342 ** | 0.166** |
| Babli x Bhuvaneswar Local | -0.328 | -0.344* | 1.287 | -6.994 ** | -0.133** | 0.468 | -0.335 | 1.450** | -0.023 | -0.265 ** | -0.170** |
| Vizianagaram Local x Bobbili Local | -0.643 | 0.174 | 8.317** | -9.128 ** | -0.325** | 0.947 | -1.831** | -0.395 | 0.160* | -0.016 | -0.381** |
| Vizianagaram Local x Lola | -0.709 | -0.085 | 2.569 | 0.127 | -0.051 | 0.911 | -0.439 | -0.165 | -0.030 | -0.642 ** | -0.305** |
| Vizianagaram Local x Trivendrum Local | -1.620** | 0.130 | -1.165 | -5.364 ** | -0.262** | 1.253 | -1.661** | -1.632** | 0.050 | -0.370 ** | -0.500** |
| Vizianagaram Local x Bhuvaneswar Local | -0.546 | 0.448** | 2.339 | 3.225 ** | 0.198** | 3.664** | 1.457** | 2.852** | 0.401** | 0.000 | 0.041 |
| Bobbili local x Lola | 0.461 | 0.167 | 10.783** | 4.517 ** | 0.134** | 2.244** | 0.487 | 2.066** | 0.549** | 0.437 ** | 0.222** |
| Bobbili local x Trivendrum Local | 0.217 | 0.048 | 5.917* | 2.120 ** | 0.139** | 2.459** | 0.598* | 1.775** | 0.553** | 0.283 ** | -0.013 |
| Bobbili local x Bhuvaneswar Local | -1.909** | 0.167 | 5.620* | 4.399 ** | 0.039 | 1.007 | 0.850** | -2.024** | -0.116 | 0.133 ** | 0.238** |
| Lola x Trivendrum Local | 0.550 | 0.122 | 13.369** | 5.728 ** | 0.110** | 1.876** | 0.057 | 1.098** | 0.326** | -0.183 ** | 0.046 |
| Lola x Bhuvaneswar Local | -0.176 | 0.307* | 6.406** | -5.917 ** | -0.064 | -1.106 | 0.309 | -2.187** | 0.240** | -0.250 ** | 0.010 |
| Trivendrum Local x Bhuvaneswar Local | -0.354 | 0.056 | 5.472* | -1.277 | -0.125** | -0.664 | 0.754* | -3.088** | -0.042 | -0.107 * | 0.195** |
| SEij | 0.910 | 0.307 | 4.440 | 1.550 | 0.074 | 1.279 | 0.573 | 0.489 | 0.159 | 0.082 | 0.097 |

** 1% level of significance, * 5% level of significance

NCP = Number of clusters per plant, NPC = Number of pods per cluster, NPP = Number of pods per plant, PL = Pod length, PG = Pod girth, PW = Pod weight, NSP = Number of seeds per pod, 100 SW = 100 Seed weight, PYP = Pod yield per plant, TSS = Total soluble solids, P = Protein

## Conclusion

The study reveals that combining ability helps in identifying good combiners and cross combinations for hybridization and to exploit heterosis. Among seven parents studied Babli is identified as good general combiner followed by Bobbili local, Lola and Trivendram Local as it made significant contribution towards fruit yield and quality attributing traits. Among the 21 crosses the best performed six crosses anyone of them can be used for further breeding programmes.

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