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# Correlation studies in $f_2$ populations of three superior crosses viz., ML 267 × LGG 528, MGG 390 × LM 95, LM 95 × EC 362096 in mungbean

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**Abstract**
The simple correlation coefficients were calculated in $F_2$ populations of three superior crosses *viz.*, ML 267×LGG 528, MGG 390×LM 95 and LM 95×EC 362096 for fourteen quantitative characters. Correlation studies among the fourteen characters indicated different degrees of association between characters. Both positive and negative correlations were found between different pairs of characters. Knowledge on inter-relationship among yield components, water use efficiency and heat stress tolerance related traits may facilitate breeder to decide upon the intensity and direction of selection pressure to be given on related traits for the simultaneous improvement of these traits. Correlation studies in $F_2$ populations of three identified superior crosses revealed that improvement in seed yield coupled with drought and heat stress tolerance could be brought through component characters like number of pods per plant, number of clusters per plant, number of pods per cluster, plant height, branches per plant, SLA, SCMR, SLW and relative injury.

**Keywords:** Mungbean, correlation coefficient, water use efficiency

## Introduction
Mungbean (*Vigna radiata* (L.) Wilczek) (2n=2x=22) popularly known as green gram, is one of the important pulse crops of India. It belongs to the family Fabaceae. India is the largest producer (25% of global production), consumer (27% of world consumption) and importer (14%) of pulses in the world (www.Indiastat.com, 2016-17). Our national production and productivity levels of mungbean are low, which indirectly affects the nutrient availability of people resulting in malnutrition. Among several reasons for low productivity, various biotic and abiotic factors play a major role. Among the abiotic stresses, drought stress and heat stress are prominent, which seriously influences the mungbean productivity. Water deficits and high temperature occur together in many environments and both stresses can interact to reduce yields. Although intensive research work has been done on genetic architecture of yield and yield attributes of mungbean but limited work was done on yield attributes along with water use efficiency (WUE) and heat stress tolerance related traits. Realizing the significance of drought and heat stress on yield components there is an immediate need to enhance the genetic potential of mungbean genotypes with high yield and drought and heat stress tolerance. Combination of different water use efficiency and high temperature tolerance traits is relevant, rather than a single trait used as a selection criteria. However, breeding for drought and high temperature tolerance has unfortunately remained neglected in mungbean. Due to complex nature of these stresses and lack of appropriate screening techniques, outcomes achieved have been less. Keeping in view the importance of these stresses, development of mungbean genotypes, which can retain maximum number of flowers and produce productive pods during high temperature (>40 ºC) and tolerate drought are essential to increase mungbean production in the country. To exploit the existing genetic variability for seed yield as efficiently as possible, the breeder would need a comprehensive knowledge regarding the association of component traits with yield. This would facilitate effective selection for simultaneous improvement of one or more yield influencing components. Correlation studies provide reliable information on nature and extent of relationship between different characters and is of great value to plant breeders as it will help in assessing the scope of simultaneous improvement of two or more characters at a time.

It is known as the best method of measuring the association between variables of interest. It elaborates the degree and extent of relationship among important plant characters and it provides basic criteria for selection and leads to directional model based on yield and its components in the field experiments. Correlation coefficient is one of the important biometric tools for formulating the selection index. Seed yield is considered to be complex in nature and hence the knowledge of association of yield with its related traits plays an important role in developing an efficient breeding programme which can be achieved through the use of correlation coefficients.

## Materials and Methods

The present experiment was carried out at dry land farm of Sri Venkateswara Agricultural College, Tirupati, situated at an altitude of 182.9 m. above mean sea level, 32.27°N latitude and 79.36°E longitude, situated geographically in Southern Agro Climatic Zone of Andhra Pradesh, India. The $F_1$s of three superior crosses selected based on their yield, WUE and heat stress tolerance related attributes *viz*., ML 267 × LGG 528, MGG 390×LM 95 and LM 95× EC 362096 and their five parents *viz*., ML 267, LGG 528, MGG 390, LM 95 and EC 362096 were sown at dry land farm, S.V.Agricultural College, Tirupati during *kharif*, 2017. The $F_2$ seed was harvested from selfed $F_1$ population. The experimental material comprising of $F_2$ populations of three crosses *viz.*, ML 267×LGG 528, MGG 390×LM 95 and LM 95×EC 362096 were grown at the dry land farm, S.V. Agricultural College, Tirupati during *rabi*, 2017 in compact family block design with two replications. $F_2$ populations were raised in 10 rows of three-meter length following a spacing of 30 cm between the rows and 10 cm between the plants within a row. As a basal dressing, fertilizers *viz.*, urea and single super phosphate to supply 20 kg N and 40 kg $P_2O_5ha^{-1}$ were applied respectively to experimental plots. Thinning was done to leave single seedling per hill after 15 days of sowing. Irrigation, weeding and plant protection measures were taken up as and when needed during the crop growth period, as per the standard recommended package of practices to raise a good and healthy crop. Observations were recorded on 80 randomly chosen competitive plants from each genotype in each replication for all the characters. The values of 80 competitive plants were averaged and expressed as mean of the respective characters. The simple correlation coefficients were calculated in $F_2$ populations of three crosses *viz.*, ML 267×LGG 528, MGG 390×LM 95 and LM 95×EC 362096 as per the method suggested by Panse and Sukhatme (1985) [10]. The significance of correlation coefficients were tested by referring r table value (Fisher and Yates, 1967) [3]. at (n – 2) degrees of freedom.

## Results and Discussion

In the present investigation, the correlation coefficients of $F_2$ populations of three crosses *viz.*, ML 267 × LGG 528, MGG 390 × LM 95, LM 95 × EC 362096 for yield attributes, water use efficiency and heat stress tolerance related traits and their relationship with yield as well as among themselves were represented in the Table 1 to 3. In the present study, seed yield per plant recorded positive and significant correlation with number of pods per cluster (0.719**, 0.438*, 0.253*), number of pods per plant (0.917**,0.907**,0.945**) in all the three $F_2$ populations *viz.*, ML 267 × LGG 528, MGG 390 × LM 95, LM 95 × EC 362096. Similarly, it has also showed significant association with plant height (0.201**, 0.612**), branches per plant (0.221**, 0.683**), clusters per plant (0.240**,0.754**) in two crosses namely MGG 390 × LM 95, LM 95 × EC 362096; with 100 seed weight (0.176*, 0.165*) in two crosses namely ML 267 × LGG 528, MGG 390 × LM 95; with harvest index (0.192**) in ML 267 × LGG 528; SLA (0.157*) in MGG 390 × LM 95; days to maturity (0.219**) and SCMR(0.197**) in LM 95 × EC 362096. Hence, simultaneous selection based on these characters could be suggested for improvement of yield in segregating populations. These results were in close agreement with earlier workers Khajudparn and Tantasawat (2011) [7], Kumar *et al.*, (2010b) [8], Tabasum *et al*, (2010) [15], Srivastava and Singh (2012), Gadakh *et al.*, (2013) [4]. Prasanna *et al.*, (2013) [11]. and Javed *et al.*, (2014) [6]. Correlation studies among the fourteen characters indicated different degrees of association between characters. Both positive and negative correlations were found between different pairs of characters. Knowledge on inter-relationship among yield components, water use efficiency and heat stress tolerance related traits may facilitate breeder to decide upon the intensity and direction of selection pressure to be given on related traits for the simultaneous improvement of these traits. In the present study, the results obtained in the $F_2$ populations of the cross ML 267 × LGG 528 revealed that seed yield had significant and positive association with pods per plant, pods per cluster, harvest index and 100 seed weight in the decreasing order of magnitude. Similarly in the cross MGG 390 × LM 95 pods per plant, pods per cluster, clusters per plant, branches per plant, plant height, 100 seed weight and SLA had significant and positive correlation with seed yield in decreasing order of magnitude. Likewise, Seed yield exhibited significant and positive correlation with pods per plant, clusters per plant, branches per plant, plant height, pods per cluster, days to maturity and SCMR in decreasing order of magnitude in the cross LM 95 × EC 362096. This indicates that selection based on these characters may result in improved yield. Similar results were also reported by Narasimhulu *et al*., (2013) [9]. Srikanth *et al*., (2013) [13]. Govardhan *et al*., (2015) [5]. Chandra *et al*., (2016) [2]. Rupal *et al*., (2017) [12]. and Anil kumar *et al*., (2018) [1]. Therefore, the positively correlated yield attributes should be considered as crucial parameters for selection in breeding programme targeted for high yield in green gram. In general, the yield component traits which showed significant and positive association with seed yield are of prime importance in determining the ultimate yield. Hence, such a situation is favourable to a plant breeder as it helps in simultaneous improvement of these characters along with seed yield *per se*. Hence, the emphasis should be given on pods per plant, clusters per plant in all the crosses for obtaining higher yield. The inter-se correlations among yield, water use efficiency and heat stress tolerance related traits revealed that days to flowering showed positive and significant association with days to maturity in all the three crosses which is of an important component in identifying and deciding the duration of the crop. Thus, it indicated that flowering time was an important indicator of maturity. Plant height had highly significant positive association with branches per plant, clusters per plant and pods per plant in all the three crosses. Hence, selection for plant height is a worthwhile step to improve the associated characters.

Number of branches per plant displayed significant and positive association with clusters per plant and pods per plant in all the three crosses studied which indicates that selection for more number of branches leads to more number of clusters and pods per plant. Likewise, selection for number of clusters

per plant and number of pods per cluster increased the number of pods per plant in all the three crosses. In case of water use efficiency and heat stress tolerance related traits, negative association was observed between SLA and specific leaf weight which indicated that SLA decreases with increased specific leaf weight which in turn reduces the transpiration. Hence low SLA and high SLW are the indicators of high-water use efficiency. SCMR had significant negative association with relative injury which in turn makes the plants thermo stable and results in more productivity.

**Table 1:** Simple Correlation Coefficients among fourteen traits in the $F_2$ population of the cross ML 267 × LGG 528 in mungbean

| | DM | PH | NBP | NCP | NPC | NPP | 100-SW | HI | SCMR | SLA | SLW | RI | SYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DF | 0.295** | -0.003 | 0.109 | 0.139* | -0.226** | -0.122 | -0.039 | 0.055 | 0.086 | -0.063 | 0.062 | -0.012 | -0.052 |
| DM | | -0.093 | 0.050 | 0.038 | -0.045 | 0.009 | -0.018 | 0.052 | 0.103 | -0.068 | 0.027 | -0.004 | 0.024 |
| PH | | | 0.764** | 0.647** | -0.316** | 0.144* | 0.117 | -0.016 | 0.096 | -0.213** | 0.226** | -0.112 | 0.088 |
| NBP | | | | 0.864** | -0.456** | 0.138* | 0.065 | -0.025 | 0.106 | -0.213** | 0.223** | -0.101 | 0.059 |
| NCP | | | | | -0.512** | 0.170* | 0.059 | 0.023 | 0.070 | -0.223** | 0.244** | -0.063 | 0.080 |
| NPC | | | | | | 0.716** | 0.081 | 0.048 | 0.067 | 0.184* | -0.186** | 0.090 | 0.719** |
| NPP | | | | | | | 0.050 | 0.051 | 0.138* | 0.016 | -0.006 | 0.038 | 0.917** |
| 100-SW | | | | | | | | 0.206** | -0.033 | 0.019 | -0.045 | -0.003 | 0.176* |
| HI | | | | | | | | | -0.110 | -0.142* | 0.155* | -0.035 | 0.192** |
| SCMR | | | | | | | | | | 0.158* | -0.141* | 0.104 | 0.076 |
| SLA | | | | | | | | | | | -0.976** | 0.051 | 0.015 |
| SLW | | | | | | | | | | | | -0.087 | -0.013 |
| RI | | | | | | | | | | | | | 0.055 |

* Significant at 5% level, ** Significant at 1% level DF : Days to 50% Flowering; DM : Days to Maturity; PH : Plant Height; NBP : Number of Branches per Plant; NCP : Number of Clusters per Plant; NPC : Number of Pods per Cluster; NPP : Number of Pods per Plant; 100-SW : 100-Seed Weight; HI : Harvest Index; SCMR : Spad Chlorophyll Meter Reading; SLA : Specific Leaf Area; SLW : Specific Leaf Weight; RI : Relative Injury; SYP : Seed Yield per Plant

**Table 2:** Simple Correlation Coefficients among fourteen traits in the $F_2$ population of the cross MGG 390 × LM 95 in mungbean

| | DM | PH | NBP | NCP | NPC | NPP | 100-SW | HI | SCMR | SLA | SLW | RI | SYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DF | 0.219** | -0.001 | 0.019 | 0.002 | 0.021 | -0.050 | -0.034 | -0.031 | 0.026 | -0.054 | 0.062 | 0.030 | -0.033 |
| DM | | -0.120 | -0.143* | -0.234** | 0.210** | -0.041 | 0.018 | 0.002 | 0.025 | 0.020 | -0.042 | 0.016 | -0.121 |
| PH | | | 0.882** | 0.793** | -0.507** | 0.178* | 0.093 | -0.122 | -0.256** | -0.132* | 0.125 | 0.133* | 0.201** |
| NBP | | | | 0.865** | -0.508** | 0.202** | 0.076 | -0.077 | -0.169* | -0.147* | 0.133* | 0.160* | 0.221** |
| NCP | | | | | -0.627** | 0.256** | 0.071 | -0.087 | -0.210** | -0.114 | 0.109 | 0.142* | 0.240** |
| NPC | | | | | | 0.474** | -0.037 | 0.012 | 0.150* | 0.205** | -0.217** | -0.158* | 0.438** |
| NPP | | | | | | | 0.027 | -0.137* | -0.091 | 0.193** | -0.214** | -0.087 | 0.907** |
| HSW | | | | | | | | 0.202** | -0.140* | -0.012 | 0.029 | 0.115 | 0.165* |
| HI | | | | | | | | | 0.075 | -0.045 | 0.068 | -0.126 | -0.045 |
| SCMR | | | | | | | | | | 0.071 | -0.087 | -0.052 | -0.122 |
| SLA | | | | | | | | | | | -0.988** | -0.029 | 0.157* |
| SLW | | | | | | | | | | | | 0.020 | -0.165* |
| RI | | | | | | | | | | | | | -0.131 |

*Significant at 5% level, ** Significant at 1% level DF: Days to 50% Flowering; DM : Days to Maturity; PH: Plant Height; NBP: Number of Branches per Plant; NCP: Number of Clusters per Plant; NPC: Number of Pods per Cluster; NPP: Number of Pods per Plant; 100-SW: 100-Seed Weight; HI: Harvest Index; SCMR: Spad Chlorophyll Meter Reading; SLA: Specific Leaf Area; SLW: Specific Leaf Weight; RI: Relative Injury; SYP: Seed Yield per Plant

**Table 3:** Simple Correlation Coefficients among fourteen traits in the $F_2$ population of the cross LM 95 × EC 362096 in mungbean

| | DM | PH | NBP | NCP | NPC | NPP | 100-SW | HI | SCMR | SLA | SLW | RI | SYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DF | 0.268** | 0.105 | 0.010 | 0.028 | -0.030 | 0.025 | -0.055 | 0.030 | -0.099 | 0.029 | -0.031 | -0.024 | 0.035 |
| DM | | 0.111 | 0.095 | 0.131 | 0.058 | 0.183* | 0.132* | 0.008 | 0.101 | 0.034 | -0.041 | -0.014 | 0.219** |
| PH | | | 0.718** | 0.665** | -0.031 | 0.641** | -0.010 | -0.015 | 0.126 | -0.034 | 0.043 | 0.031 | 0.612** |
| NBP | | | | 0.897** | -0.265** | 0.729** | -0.037 | 0.043 | 0.198** | -0.042 | 0.051 | -0.044 | 0.683** |
| NCP | | | | | -0.336** | 0.800** | 0.020 | -0.044 | 0.179* | -0.008 | 0.022 | -0.008 | 0.754** |
| NPC | | | | | | 0.275** | 0.040 | -0.066 | -0.017 | -0.054 | 0.044 | 0.093 | 0.253** |
| NPP | | | | | | | 0.044 | -0.080 | 0.157* | -0.055 | 0.064 | 0.042 | 0.945** |
| 100-SW | | | | | | | | -0.183* | 0.045 | -0.063 | 0.067 | 0.017 | 0.038 |
| HI | | | | | | | | | 0.010 | 0.066 | -0.057 | -0.104 | -0.097 |
| SCMR | | | | | | | | | | 0.157* | -0.140* | -0.140* | 0.197** |
| SLA | | | | | | | | | | | -0.994** | -0.154* | -0.013 |
| SLW | | | | | | | | | | | | 0.147* | 0.023 |
| RI | | | | | | | | | | | | | -0.001 |

* Significant at 5% level, ** Significant at 1% level DF : Days to 50% Flowering; DM: Days to Maturity; PH : Plant Height; NBP : Number of Branches per Plant; NCP: Number of Clusters per Plant; NPC: Number of Pods per Cluster; NPP: Number of Pods per Plant; 100-SW: 100-Seed Weight; HI: Harvest Index; SCMR: Spad Chlorophyll Meter Reading; SLA: Specific Leaf Area; SLW: Specific Leaf Weight; RI: Relative Injury; SYP: Seed Yield per Plant

## Conclusions

Correlation studies in $F_2$ populations of three superior crosses *viz.*, LM 95 × EC 362096, MGG 390 × LM 95 and ML 267 × LGG 528 among fourteen characters indicated different degrees of association between characters. In conclusion, from the present study it is evident that improvement in seed yield coupled with drought and heat stress tolerance in mungbean could be brought through component characters like number of pods per plant, number of clusters per plant, plant height, number of branches per plant, SLA, SCMR, SLW and relative injury.

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