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*Research Article*

# CORRELATION AND PATH ANALYSIS OF SEED YIELD AND YIELD CONTRIBUTING COMPONENTS OF BLACKGRAM (*VIGNA MUNGO* L. HEPPER) UNDER RAINFED CONDITION FROM ANDHRA PRADESH, INDIA

G. Vijay Kumar*, M. Vanaja, P. Sathish, P. Vagheera, S.S. Shishodia, Abdul Razak

Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad-500 059, India.
Author for Correspondence:vijay.genetics@gmail.com

**ABSTRACT:** Correlation coefficient and path analysis studies were carried out with seventeen parents (fourteen lines and three testers) resulting 42 $F_1$ crosses for fifteen yield contributing component characters. The phenotypic and genotypic correlation analysis revealed that seed yield was highly significantly and positively correlated with number of branches, number of clusters, number of pods per plant, number of seeds per plant pod weight, total biomass and also highly significantly and positively correlated among themselves. Path coefficient analysis for seed yield revealed that significant phenotypic and genotypic direct effect with seeds per plant, 100 seed weight, harvest index, pod weight and number of clusters per plant. Hence selection for these characters may be carried out in the field and lab for overall yield improvement in blackgram.

**Key words:** Blackgram, Correlation coefficient, Path analysis, Yield components.

## INTRODUCTION

Pulses, popularly known as “poor man’s meat”, form the major source of dietary protein of the large section of vegetarian population of India and also the world. India is world’s largest producer of pulses with its total pulse production of 18.45 million tonnes (Business Today 2014). Among pulses, blackgram (*Vigna mungo* L. Hepper, 2n=22) is an important short duration crop widely cultivated in India which give us an excellent source of easily digestible good quality protein and ability to restore the fertility of soil through symbiotic nitrogen fixation. The major constraints in achieving higher yield of this crop are lack of genetic variability, poor harvest index, suitable varieties and genotypes with adaptation to local condition. Yield is considered as an end product of a set of plant processes which are related to each other. It is very complex trait which controlled by poly genes and interlinked with other yield components, hence it is very difficult often to improve yield directly. It can be achieved by improving closely related traits. The study of correlation coefficient gives a measure of the relationship between traits and provides the degree to which various characters are associated with productivity. Path coefficient is an efficient statistical technique specially designed to quantify the relationship of different components and their direct and indirect effects on seed yield. Hence selection based on these statistical analysis is highly predominant.

## MATERIALS AND METHODS

Seventeen black gram genotypes *viz*., IC587753, IC436720, IC436519, IC343947, IC519805, IC343952, IC587752, IC587751, IC282009, IC436753, IC436610, IC436665, IC398971, IC281987 and three testers viz., PU-19, LBG-20 and T-9 were collected from different agro climatic zones of Andhra Pradesh by NBPGR, Regional research center, Hyderabad. Crosses were affected in Line x Tester fashion grown in unpaired planting method with two staggered sowings at 15 days interval to obtain synchronization in flowering at Hayathnagar research farm, CRIDA, Hyderabad in 2012 kharif. The resultant $F_1$s (hybrids) along with parental lines were sown on 25th June 2013 in randomized complete block design with three replications. Each replication consisted of 10 plants per replication in a row of 1m with spacing of 10 x 30cm. The plants were grown purely under rainfed condition without applying irrigation and fertilizers and the crop received 555.4mm rainfall during the crop growth period in 32 rainy days. The minimum temperature was 19.0°C and the maximum was 38.6°C. Relative humidity and sun shine hours during crop growth period ranged from 44.0% to 97.0% and 0.0 to 10.3 hrs respectively.

In each replication, five plants were tagged randomly for recording observation on morphological, phenological and yield traits such as plant height (cm), number of branches, days to 50% flowering, days to 50% podding, number of clusters per plant, number of pods per plant, pod length (cm), number of seeds per pod, number of seeds per plant, 100 seed weight (g), seed yield (g/plant), fodder weight (g/plant), total biomass (g/plant) and harvest index (%). The phenotypic and genotypic correlation coefficients were calculated as per method developed by Johanson et al. (1955), and path coefficient analysis was worked out as per Dewey and Lu (1959).

## RESULTS AND DISCUSSION

The analysis of variance exhibited the existence of significant differences among the genotypes for all the selected traits indicating that presence of variability in the material selected. The correlation analysis revealed that seed yield showed positive correlation with all morphological, yield traits but not with phenological traits (Days to 50% flowering and Days to 50% podding). The genotypic correlations were higher than phenotypic ones for all the characters studied (Table 1). Highly significant and positive phenotypic and genotypic correlation for seed yield was observed with pod weight ($r_p$=0.936$^{**}$, $r_g$=0.991$^{**}$), number of seeds per plant ($r_p$=0.925$^{**}$, $r_g$=0.919$^{**}$), number of pods per plant ($r_p$ =0.877$^{**}$, $r_g$=0.896$^{**}$), number of clusters per plant ($r_p$ =0.689$^{**}$, $r_g$=0.624$^{**}$), total biomass ($r_p$ =0.634$^{**}$, $r_g$=0.864$^{**}$), and number of branches ($r_p$ =0.419$^{**}$, $r_g$=0.967$^{**}$). Similar positive and significant correlation of seed yield with number of pods per plant was reported in black gram (Isha Perveen et al., 2011; Chauhan et al., 2007; Misra 1983 and Singh 1998), with number of cluster per plant (Veeranjaneylu et al., 2007; Govindraju and Subramaniam 2001; Misra 1983). It reveals that the selection of more number of pods per plant, number of seeds per plant, number of clusters per plant, number of branches could lead to higher seed yield per plant in blackgram.

Highly significant phenotypic and genotypic correlation of number of pods per plant was observed with number of seeds per plant ($r_p$= 0.922$^{**}$, $r_g$= 0.940$^{**}$), pod weight ($r_p$= 0.902$^{**}$, $r_g$= 0.917$^{**}$) and fodder weight ($r_p$=0.597$^{**}$, $r_g$=0.815$^{**}$). None of the traits showed significant negative phenotypic and genotypic correlation with pods per plant (Table 1). Similarly days to 50% flowering showed highly positive and significant phenotypic and genotypic correlation with days to 50% podding ($r_p$=0.969$^{**}$, $r_g$= 0.964$^{**}$). Plant height showed significant positive phenotypic and genotypic correlation with fodder biomass ($r_p$=0.718**, $r_g$= 0.703**), number of pods per plant ($r_p$=0.174*, $r_g$= 0.199**) pod length ($r_p$=0.170*, $r_g$= -0.041), number of seeds per pod ($r_p$=0.256**, $r_g$= 0.193*), number of seeds per plant ($r_p$=0.161*, $r_g$= 0.245**), days to 50% flowering ($r_p$=0.387**, $r_g$= 0.596**), days to 50% podding ($r_p$=0.330**, $r_g$= 0.519**), total biomass ($r_p$=0.477**, $r_g$= 0.699**), pod weight ($r_p$=0.186*, $r_g$= 0.260**) and 100 seed weight ($r_p$=0.231**, $r_g$= 0.380**). It indicates that selection of the plants with higher plant height could result in increasing fodder biomass and attaining more number of pods, longer pods with more number of seeds and increased seed weight. On contrary, plant height showed significant negative association with harvest index ($r_p$ =- 0.288**, $r_g$ = -0.321**) indicating that selection of plants with more plant height may not always result in similar increase biomass and seed weight. Significant phenotypic and genotypic positive association of plant height with pod length (Goud *et al.* 1977); with number of seeds per pod (Santha and Paramasivam, 1999); with 100-seed weight (Natarajan and Rathinaswamy, 1999) was reported in blackgram. Number of clusters per plant showed highly positive and significant phenotypic and genotypic correlation with number of pods per plant ($r_p$=0.777$^{**}$, $r_g$= 0.712$^{**}$), number of seeds per plant ($r_p$=0.691$^{**}$, $r_g$= 0.611$^{**}$), pod weight ($r_p$=0.678$^{**}$, $r_g$= 0.604$^{**}$) and fodder weight ($r_p$=0.469$^{**}$, $r_g$= 0.498$^{**}$). It suggests that selection of more number of clusters per plant could increase the number of pods per plant, number of seeds per plant, pod weight and lead to higher seed yield in blackgram crop. The positive significant phenotypic and genotypic correlation of pods per plant with number of clusters per plant reported in urdbean (Gopikrishnan et al., 2002). Number of seeds per plant showed positive and significant phenotypic and genotypic correlation with pod weight ($r_p$=0.914$^{**}$, $r_g$= 0.974$^{**}$) and fodder weight ($r_p$=0.612$^{**}$, $r_g$= 0.870$^{**}$). Harvest index showed significant and negative correlation with total biomass ($r_p$=-0.519$^{**}$, $r_g$= -0.650$^{**}$) indicating improved total biomass always may not result in similar improvement in fodder weight and seed weight.

### Path analysis

The seed yield per plant had direct positive association with number of seeds per plant (P=0.5733, G=0.8154), pod weight (P=0.3309, G=0.3561), 100 seed weight (P=0.2120, G=0.3962), harvest index (P=0.0768, G=-0.1133) and number of clusters per plant (P=0.0756, G=0.0388) (Table 2). This indicates that the selection for higher seed yield in blackgram crop would be effective by these traits. The seed yield had highest positive direct effect with number of seeds per plant (P=0.5733, G=0.8154). In pigeon pea, direct effect of number of seeds per plant with seed yield was recorded (Vijayalakshmi et al., 2013; Rao and Suryavanshi 1988; Gartan and Sood 1996). The harvest index had positive direct effect with seed yield in blackgram (Chauhan et al., 2007). From the present study it was found that the number of branches, number of pods per plant, pod length, number of seeds per pod and days to 50% podding had negative direct effect with seed yield. In blackgram seed yield had negative direct effect with pod length (Gopikrishnan et al., 2002; Chauhan et al., 2007) and number of pods per plant in pigeon pea (Vijayalakshmi et al., 2013). From the data it was observed that number of pods per plant had negative direct effect on seed yield where as pod weight had positive direct effect which indicates a indirect effect of number of seeds per plant and 100 seed weight on the seed yield.

**Table.1: Phenotypic and Genotypic Correlation among Yield Influencing Traits in Parental and $F_1$ Generation of Black Gram**

| Character | | No.of branches | No. of clusters | No. of pods | Pod length (cm) | Seeds / pod | No. of seeds / pl | Days to 50% flowering | Days to 50% podding | Total biomass (g/pl) | Fodder biomass (g/pl) | Pod wt. (g/pl) | 100 seed wt (g) | HI (%) | Correlation with seed yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant height (cm) | $r_p$ | 0.116 | 0.144 | 0.174* | 0.170* | 0.256** | 0.161* | 0.387** | 0.330** | 0.477** | 0.718** | 0.186* | 0.231** | -0.288** | **0.221**** |
| | $r_g$ | -0.097 | 0.078 | 0.199** | -0.041 | 0.193* | 0.245** | 0.596** | 0.519** | 0.699** | 0.703** | 0.260** | 0.380** | -0.321** | **0.346**** |
| No. of branches | $r_p$ | | 0.430** | 0.466** | 0.198** | 0.103 | 0.417** | -0.142 | -0.134 | 0.412** | 0.238** | 0.428** | 0.070 | 0.075 | **0.419**** |
| | $r_g$ | | 0.745** | 0.938** | 0.420** | 0.059 | 0.911** | -0.219** | -0.208** | 0.812** | 0.403** | 0.904** | 0.185* | 0.237** | **0.967**** |
| No. of clusters | $r_p$ | | | 0.777** | 0.262** | 0.195** | 0.691** | -0.012 | -0.044 | 0.469** | 0.204** | 0.678** | 0.015 | 0.172* | **0.689**** |
| | $r_g$ | | | 0.712** | 0.532** | 0.356** | 0.611** | -0.030 | -0.075 | 0.498** | 0.213** | 0.604** | 0.048 | 0.320** | **0.624**** |
| No. of pods/pl | $r_p$ | | | | 0.259** | 0.159* | 0.922** | -0.042 | -0.053 | 0.597** | 0.214** | 0.902** | -0.010 | 0.272** | **0.877**** |
| | $r_g$ | | | | 0.530** | 0.290** | 0.940** | -0.082 | -0.102 | 0.815** | 0.319** | 0.917** | -0.036 | 0.376** | **0.896**** |
| Pod length(cm) | $r_p$ | | | | | 0.565** | 0.261** | -0.181* | -0.203** | 0.181* | 0.047 | 0.293** | 0.053 | 0.038 | **0.243**** |
| | $r_g$ | | | | | 0.414** | 0.536** | -0.424** | -0.445** | 0.178* | -0.210** | 0.624** | 0.206** | 0.742** | **0.596**** |
| No. of Seeds / pod | $r_p$ | | | | | | 0.146 | 0.045 | -0.001 | 0.134 | 0.123 | 0.233** | 0.207** | 0.068 | **0.201**** |
| | $r_g$ | | | | | | 0.253** | 0.025 | -0.043 | 0.030 | -0.045 | 0.384** | 0.359** | 0.729** | **0.406**** |
| No. of seeds/ pl | $r_p$ | | | | | | | -0.042 | -0.027 | 0.612** | 0.206** | 0.914** | -0.020 | 0.328** | **0.925**** |
| | $r_g$ | | | | | | | -0.103 | -0.081 | 0.870** | 0.329** | 0.974** | -0.126 | 0.407** | **0.919**** |
| Days to 50% flowering | $r_p$ | | | | | | | | 0.969** | 0.155* | 0.318** | -0.106 | -0.038 | -0.214** | **-0.083** |
| | $r_g$ | | | | | | | | 0.964** | 0.269** | 0.505** | -0.187* | -0.057 | -0.561** | **-0.155*** |
| Days to 50% podding | $r_p$ | | | | | | | | | 0.155* | 0.299** | -0.081 | -0.035 | -0.190* | **-0.068** |
| | $r_g$ | | | | | | | | | 0.273** | 0.481** | -0.150* | -0.052 | -0.511** | **-0.134** |
| Total biomass (g/pl) | $r_p$ | | | | | | | | | | 0.660** | 0.635** | 0.188* | -0.280** | **0.634**** |
| | $r_g$ | | | | | | | | | | 0.916** | 0.834** | 0.141 | -0.164 | **0.864**** |
| Fodder biomass (g/pl) | $r_p$ | | | | | | | | | | | 0.216** | 0.109 | -0.519** | **0.225**** |
| | $r_g$ | | | | | | | | | | | 0.318** | 0.160* | -0.650** | **0.360**** |
| Pod wt. (g/pl) | $r_p$ | | | | | | | | | | | | 0.125** | 0.3244** | **0.936**** |
| | $r_g$ | | | | | | | | | | | | 0.119 | 0.5297** | **0.991**** |
| 100 seed wt (g) | $r_p$ | | | | | | | | | | | | | 0.1776* | **0.269**** |
| | $r_g$ | | | | | | | | | | | | | 0.2838** | **0.299**** |
| HI (%) | $r_p$ | | | | | | | | | | | | | | **0.386**** |
| | $r_g$ | | | | | | | | | | | | | | **0.563**** |

*Significant at 0.05% and ** 0.01 % level

**Table 2. Phenotypic and Genotypic path Coefficient Analysis of Fifteen yield Components in Parental and $F_1$ Generation of Black Gram**

| Character | | Plant height (cm) | No.of branches | No. of clusters | No. of pods | Pod length (cm) | Seeds / pod | No. of seeds/pl | Days to 50% flowering | Days to 50% podding | Total biomass (g/pl) | Fodder biomass (g/pl) | Pod wt. (g/pl) | 100 seed wt (g) | HI (%) | Correlation with seed yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant height(cm) | P | 0.0258 | 0.0030 | 0.0037 | 0.0045 | 0.0044 | 0.0066 | 0.0042 | 0.0100 | 0.0085 | 0.0123 | 0.0185 | 0.0048 | 0.0060 | -0.0074 | **0.2211** |
| | G | -0.0037 | 0.0004 | -0.0003 | -0.0007 | 0.0002 | -0.0007 | -0.0009 | -0.0022 | -0.0019 | -0.0026 | -0.0026 | -0.0010 | -0.0014 | 0.0012 | **0.3458** |
| No. of branches | P | -0.0015 | **-0.0129** | -0.0055 | -0.0060 | -0.0026 | -0.0013 | -0.0054 | 0.0018 | 0.0017 | -0.0053 | -0.0031 | -0.0055 | -0.0009 | -0.0010 | **0.4194** |
| | G | -0.0088 | **0.0910** | 0.0678 | 0.0854 | 0.0382 | 0.0054 | 0.0829 | -0.0200 | -0.0190 | 0.0739 | 0.0366 | 0.0822 | 0.0168 | 0.0216 | **0.9669** |
| No. of clusters | P | 0.0109 | 0.0325 | **0.0756** | 0.0588 | 0.0198 | 0.0148 | 0.0523 | -0.0009 | -0.0033 | 0.0355 | 0.0154 | 0.0513 | 0.0011 | 0.0130 | **0.6891** |
| | G | 0.0030 | 0.0289 | **0.0388** | 0.0276 | 0.0206 | 0.0138 | 0.0237 | -0.0012 | -0.0029 | 0.0193 | 0.0083 | 0.0234 | 0.0019 | 0.0124 | **0.6238** |
| No. of pods | P | -0.0078 | -0.0210 | -0.0350 | **-0.0450** | -0.0117 | -0.0072 | -0.0415 | 0.0019 | 0.0024 | -0.0269 | -0.0096 | -0.0406 | 0.0005 | -0.0123 | **0.8773** |
| | G | -0.0338 | -0.1594 | -0.1209 | **-0.1699** | -0.0900 | -0.0492 | -0.1597 | 0.0139 | 0.0173 | -0.1385 | -0.0542 | -0.1559 | 0.0061 | -0.0640 | **0.8961** |
| Pod length (cm) | P | -0.0065 | -0.0076 | -0.0100 | -0.0099 | **-0.0381** | -0.0215 | -0.0099 | 0.0069 | 0.0077 | -0.0069 | -0.0018 | -0.0112 | -0.0020 | -0.0015 | **0.2433** |
| | G | 0.0037 | -0.0376 | -0.0477 | -0.0475 | **-0.0896** | -0.0371 | -0.0481 | 0.0380 | 0.0399 | -0.0160 | 0.0188 | -0.0559 | -0.0185 | -0.0665 | **0.5962** |
| No. of Seeds / pod | P | -0.0022 | -0.0009 | -0.0016 | -0.0013 | -0.0047 | **-0.0084** | -0.0012 | -0.0004 | 0.0000 | -0.0011 | -0.0010 | -0.0020 | -0.0017 | -0.0006 | **0.2014** |
| | G | 0.0101 | 0.0031 | 0.0186 | 0.0152 | 0.0217 | **0.0523** | 0.0133 | 0.0013 | -0.0022 | 0.0016 | -0.0024 | 0.0201 | 0.0188 | 0.0381 | **0.4065** |
| No. of seeds / pl | P | 0.0926 | 0.2388 | 0.3961 | 0.5283 | 0.1496 | 0.0836 | **0.5733** | -0.0242 | -0.0157 | 0.3508 | 0.1182 | 0.5241 | -0.0114 | 0.1878 | **0.9250** |
| | G | 0.1997 | 0.7425 | 0.4979 | 0.7662 | 0.4372 | 0.2066 | **0.8154** | -0.0839 | -0.0658 | 0.7095 | 0.2684 | 0.7943 | -0.1028 | 0.3320 | **0.9188** |
| Days to 50% flowering | P | 0.0091 | -0.0034 | -0.0003 | -0.0010 | -0.0043 | 0.0011 | -0.0010 | **0.0236** | 0.0229 | 0.0037 | 0.0075 | -0.0025 | -0.0009 | -0.0051 | **-0.0827** |
| | G | 0.0997 | -0.0367 | -0.0050 | -0.0137 | -0.0709 | 0.0043 | -0.0172 | **0.1673** | 0.1613 | 0.0450 | 0.0845 | -0.0312 | -0.0095 | -0.0939 | **-0.1552** |
| Days to 50% podding | P | -0.0180 | 0.0073 | 0.0024 | 0.0029 | 0.0111 | 0.0000 | 0.0015 | -0.0528 | **-0.0545** | -0.0084 | -0.0163 | 0.0044 | 0.0019 | 0.0104 | **-0.0685** |
| | G | -0.0845 | 0.0339 | 0.0122 | 0.0166 | 0.0724 | 0.0070 | 0.0131 | -0.1568 | **-0.1626** | -0.0444 | -0.0782 | 0.0243 | 0.0084 | 0.0831 | **-0.1338** |
| Total biomass (g/pl) | P | 0.0208 | 0.0179 | 0.0204 | 0.0260 | 0.0079 | 0.0058 | 0.0266 | 0.0068 | 0.0067 | **0.0435** | 0.0287 | 0.0276 | 0.0082 | -0.0122 | **0.6345** |
| | G | 0.0019 | 0.0022 | 0.0013 | 0.0022 | 0.0005 | 0.0001 | 0.0023 | 0.0007 | 0.0007 | **0.0027** | 0.0024 | 0.0022 | 0.0004 | -0.0004 | **0.8640** |
| Fodder biomass (g/pl) | P | 0.0096 | 0.0032 | 0.0027 | 0.0028 | 0.0006 | 0.0016 | 0.0027 | 0.0042 | 0.0040 | 0.0088 | **0.0133** | 0.0029 | 0.0015 | -0.0069 | **0.2248** |
| | G | -0.1211 | -0.0694 | -0.0367 | -0.0549 | 0.0362 | 0.0078 | -0.0567 | -0.0870 | -0.0829 | -0.1579 | **-0.1723** | -0.0548 | -0.0276 | 0.1120 | **0.3598** |
| Pod wt. (g/pl) | P | 0.0615 | 0.1418 | 0.2242 | 0.2984 | 0.0971 | 0.0771 | 0.3025 | -0.0350 | -0.0269 | 0.2103 | 0.0716 | **0.3309** | 0.0413 | 0.1073 | **0.9356** |
| | G | 0.0926 | 0.3218 | 0.2150 | 0.3266 | 0.2223 | 0.1366 | 0.3469 | -0.0664 | -0.0533 | 0.2969 | 0.1133 | **0.3561** | 0.0424 | 0.1886 | **0.9910** |
| 100 seed wt (g) | P | 0.0490 | 0.0149 | 0.0032 | -0.0022 | 0.0113 | 0.0439 | -0.0042 | -0.0081 | -0.0074 | 0.0398 | 0.0232 | 0.0264 | **0.2120** | 0.0376 | **0.2690** |
| | G | 0.1505 | 0.0732 | 0.0189 | -0.0142 | 0.0816 | 0.1423 | -0.0500 | -0.0225 | -0.0204 | 0.0559 | 0.0635 | 0.0472 | **0.3962** | 0.1124 | **0.2990** |
| HI (%) | P | -0.0221 | 0.0057 | 0.0132 | 0.0209 | 0.0029 | 0.0052 | 0.0252 | -0.0165 | -0.0146 | -0.0215 | -0.0398 | 0.0249 | 0.0136 | **0.0768** | **0.3861** |
| | G | 0.0364 | -0.0269 | -0.0363 | -0.0426 | -0.0841 | -0.0826 | -0.0461 | 0.0636 | 0.0579 | 0.0186 | 0.0737 | -0.0600 | -0.0322 | **-0.1133** | **0.5635** |

Bold figures represent direct effect. Off diagonal figures represent indirect effect. Residual effect (phenotypic)=0.1980; Residual effect (genotypic)=SQRT(1-1.0192).

## CONCLUSION

It can be concluded that in blackgram the number of seeds per plant, number of pods per plant, number of cluster per plant, pod weight, and number of branches should be considered as yield improvement characters. Similarly, analysis of path coefficient results are indicating that the number of seeds per plant followed by, 100 seed weight, harvest index, number of cluster per plant and pod weight were directly contributing to seed yield. These elite traits should be considered for selection of blackgram cultivars in improving seed yield.

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