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ASSOCIATION STUDIES FOR YIELD AND YIELD ATTRIBUTED TRAITS IN MUTANT LINES OF BLACKGRAM (*VIGNA MUNGO* L. HEPPER) DURING *KHARIF* AND ZAID SEASON

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ABSTRACT

Yield and yield attributing parameters are the most widely targeted traits for blackgram improvement. A clear understanding of the association of plant characters with yield is necessary for a successful crop improvement programme. Correlation studies simply measure the association of yield and yield attributes and does not give the actual dependence of yield on the correlated characters. Path coefficients analysis is an effective method to determine the direct and indirect causes of association and examine the specific forces acting to produce to a given correlation.

A field experiment was carried out during *kharif* 2022 laid out in an augmented design at AHRS, Bavikere, to evaluate 90 lines of F_4M_3 generation obtained through the hybridization (PU31 × Rashmi) and gamma irradiation (20kr) of F_2 generation seeds (IIHR, Bangalore). Based on seed yield, disease index and disease incidence, 30 F_5M_4 lines were selected and assessed during zaid (summer) 2023 laid out RCBD design.

The material assessed in the present investigation possessed wide range of variation for most of the characters studied. For the first season, traits like number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length, 100 seed weight and number of seeds per pod were significantly positive and direct association with seed yield per plant. Traits like number of pods per cluster, number of pods per plant and pod length exerted a significant positive direct association on seed yield per plant in second season. Hence, selection of these traits would improve the plant yield in black gram.

***Key words*:** Irradiation, Mutant lines, Yield, Correlation Coefficient, Path Analysis

Introduction

A blackgram (Vigna mungo L.) well-known lentil in Southern Asia and it's belong to Fabaceae family. It is an autogamous, diploid plant (2n=22). India is the place of its genesis (Vavilov, 1926). It is believed that Vigna mungo var. silvestris is the blackgram's progenitor (Lukoki *et al*., 1980).

The world's largest producer and consumer of blackgram is India. From 30.23 lakh hectares of land, it yields roughly 21.06 lakh tonnes of blackgram yearly, with an average productivity of 697 kg per hectare (Gobi, 2025). One of the main states in India that grows blackgram is Karnataka, which has an area of 0.78 lakh hectares, produces 0.38 lakh tonnes, and has a productivity

of 466 kg ha^{-1} (Directorate of Economics and Statistics, 2023). Blackgram is mostly produced in Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Karnataka, and Andhra Pradesh in India.

The critical position of pulse production, mainly blackgram against the increased population, poses a challenge for breeders to develop high-yielding, short-duration, bold-grained and disease-resistant varieties. This can be achieved through a planned breeding program and adopting proper agronomic practices.

Grain yield is the most complex character and is influenced by several component characters such as days to 50 per cent flowering, plant height, number of pods per cluster, number of clusters per plant, number of pods per plant, number of seeds per pod, pod length, 100 seed weight and grain yield per plant. In black gram yield can be enhanced by selecting highly heritable and correlated morphological attributes that contribute to yield in a given environment and combining them to identify genotypes with a desirable combination of traits.

A clear understanding of the association of plant characters with yield is necessary for a successful crop improvement programme. Correlation coefficients show the magnitude and direction of the association of yield components and facilitate the plant breeders in identifying traits that are useful as selection criteria to improve crop yield under the target environment through correlated response.

Path coefficient analysis is a standardized partial regression coefficient. This splits the correlation into the measures of direct and indirect effects. Therefore, it reveals whether the association of these characters with the yield is due to their direct effect on yield or if it is a consequence of their indirect effect through some other character. If the correlation between yield and other characters is due to the direct effect of that particular character, it reflects the true relationship between them.

Taking all of this into consideration, the current investigation in blackgram was conducted using mutant lines that were selected based on high mean performance for seed yield and produced from hybridization of PU31 × Rashmi and mutation with a dosage of 20 Kr of gamma radiation.

Materials and Methods

The experimental material comprised of five checks (PU31, Rashmi, DBGV5 DU1, LBG 791) and mutant lines of cross (PU31 × Rashmi) in black gram [*Vigna mungo* (L.) Hepper].

In the D-8 block of AHRS, Bavikere, an experiment was laid out at research station for the first season using an augmented experimental design (Federer, 1961). There were six blocks, each with 15 lines, and a total of 90 mutant lines. While checks were replicated twice in each block to estimate an error and blocking effects, while the genotypes were not replicated. Individual genotypes were directly sown for *Kharif* 2022, by dividing two seeds each hill into a 4-meter-long row, with 45 cm between rows and 30 cm between plants.

In the second season, 30 mutant lines were selected from 90 mutant lines sown in the first season by comparing yield, disease incidence, and disease severity along with five checks. The experiment was laid out at research station in the D-8 block of AHRS, Bavikere, using an RCBD experimental design. Compared to the others, these 30 mutant lines yied more and were resistant to disease (YVMV). The estimates of error and blocking effects were obtained by replicating both genotypes and checks.

Table 1: Phenotypic path coefficient analysis showing direct and indirect effects on seed yield in blackgram (*Kharif* 2022).

Effect of traits	Via Character									
	DFF	**PH**	**NB**	**NCP**	**NPC**	**NPP**	**PL**	**NSP**	**HSW**	**R-value**
DFF	**-0.1561**	-0.0020	-0.0567	-0.0365	-0.0423	-0.0067	-0.0717	-0.1959	-0.0115	**-0.5793****
PH	0.0154	**0.0206**	-0.0156	-0.0212	-0.0071	-0.0026	-0.0280	0.0007	0.0002	**-0.0375**
NB	0.0740	-0.0027	**0.1196**	0.0526	0.0531	0.0089	0.0891	0.2500	0.0165	**0.6612****
NCP	0.0450	-0.0034	0.0498	**0.1264**	0.0533	0.0154	0.0707	0.1934	0.0119	**0.5625****
NPC	0.0487	-0.0011	0.0468	0.0497	**0.1355**	0.0147	0.0950	0.2361	0.0202	**0.6455****
NPP	0.0402	-0.0020	0.0408	0.0751	0.0764	**0.0260**	0.1072	0.2350	0.0224	**0.6210****
PL	0.0574	-0.0030	0.0547	0.0459	0.0661	0.0143	**0.1948**	0.2716	0.0118	**0.7137****
NSP	0.0720	0.0000	0.0703	0.0575	0.0753	0.0144	0.1245	**0.4250**	0.0184	**0.8574****
HSW	0.0235	0.0001	0.0259	0.0198	0.0358	0.0076	0.0302	0.1026	**0.0763**	**0.3218***

Residual value = 0.3587; **Significance at 0.01 probability level; *Significance at 0.05 probability level
DFF Days to 50% flowering, PH Plant height, NB Number of branches plant^{-1}, NCP Number of clusters plant^{-1}, NPC Number of pods cluster^{-1}, NPP Number of pods plant^{-1}, PL Pod length (cm), NSP Number of seeds pod^{-1}, HSW 100 seed weight(g) and TSY Total seed yield(g)

Table 2: Phenotypic path coefficient analysis showing direct and indirect effect on seed yield in blackgram (Zaid 2023).

Effect of traits	Via Character									
	DFF	**PH**	**NB**	**NCP**	**NPC**	**NPP**	**PL**	**NSP**	**HSW**	**R-value**
DFF	**-0.2022**	-0.0018	0.0007	0.0124	-0.0526	-0.0789	-0.1966	-0.0009	-0.0008	**-0.5187****
PH	-0.0156	**-0.0232**	0.0031	-0.0050	-0.0096	-0.0063	0.0131	-0.0001	0.0002	**-0.0434**
NB	-0.0028	-0.0014	**0.0440**	-0.0166	0.0307	0.0399	0.0633	0.0006	-0.0002	**0.1729**
NCP	0.0265	-0.0012	0.0091	**-0.0626**	0.0390	0.0849	0.0951	0.0007	-0.0036	**0.2305**
NPC	0.0546	0.0011	0.0082	-0.0188	**0.1475**	0.0963	0.2031	0.0014	-0.0018	**0.5662****
NPP	0.0720	0.0007	0.0094	-0.0363	0.0850	**0.1644**	0.2303	0.0002	-0.0034	**0.6056****
PL	0.0770	-0.0006	0.0064	-0.0174	0.0770	0.0988	**0.5119**	0.0002	-0.0076	**0.7475****
NSP	-0.0269	0.0003	0.0047	-0.0104	0.0433	0.0083	0.0161	**0.0065**	-0.0025	**0.0377**
HSW	-0.0086	0.0003	0.0005	-0.0173	0.0178	0.0379	0.1980	0.0008	**-0.0196**	**0.2099**

Residual value = 0.3587; **Significance at 0.01 probability level; *Significance at 0.05 probability level
DFF Days to 50% flowering, PH Plant height, NB Number of branches plant^{-1}, NCP Number of clusters plant^{-1}, NPC Number of pods cluster^{-1}, NPP Number of pods plant^{-1}, PL Pod length (cm), NSP Number of seeds pod^{-1}, HSW 100 seed weight(g) and TSY Total seed yield(g)

To directly sow individual genotypes, two seeds were dibbled into each hill, with a 30-cm plant-to-plant spacing and a 45-cm row-to-row spacing. To produce healthy crop, Proper field management measures were undertaken. In order to fertilize the soil, 5 t ha^{-1} of farmyard manure and 25:50:25 kg ha^{-1} of NPK were applied. Urea (46 percent N) was used to supply nitrogen in two separate doses: 50% at basal and 50% 30 days after seeding. Both potassium and phosphorus were supplied as muriate of potash (60 percent K2O) and single super phosphate (16 percent P2O5), respectively. The crop was managed by taking the required steps and irrigating once a week.

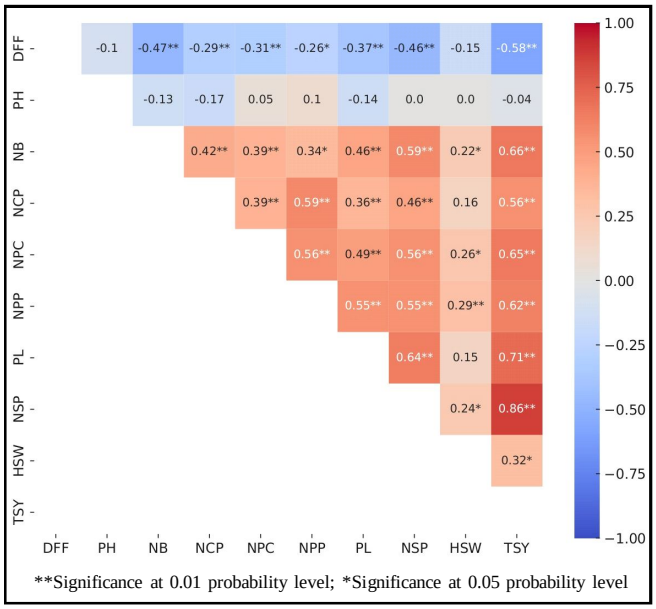

Fig. 1: Phenotypic correlation coefficients for growth, yield and yield contributing traits in Blackgram (*Kharif* 2022). [DFF Days to 50% flowering, PH Plant height, NB Number of branches plant^{-1}, NCP Number of clusters plant^{-1}, NPC Number of pods cluster^{-1}, NPP Number of pods plant^{-1}, PL Pod length (cm), NSP Number of seeds pod^{-1}, HSW 100 seed weight(g) and TSY Total seed yield(g)].

Using R software and WINDOWSTAT version 9.2 software, statistical analysis was done on the data of traits mean recorded on 15 selected plants for yield and its attributable traits.

Results and Discussion

Correlation coefficient and path analysis for first season (*Kharif* 2022)

Seed yield per plant exhibited a significant positive association with the number of branches per plant ((0.66), number of clusters per plant (0.56), number of pods per cluster (0.65), number of pods per plant (0.62), pod length (0.71), 100 seed weight (0.32) and number of seeds per pod (0.86). Consequently, yield can be improved by

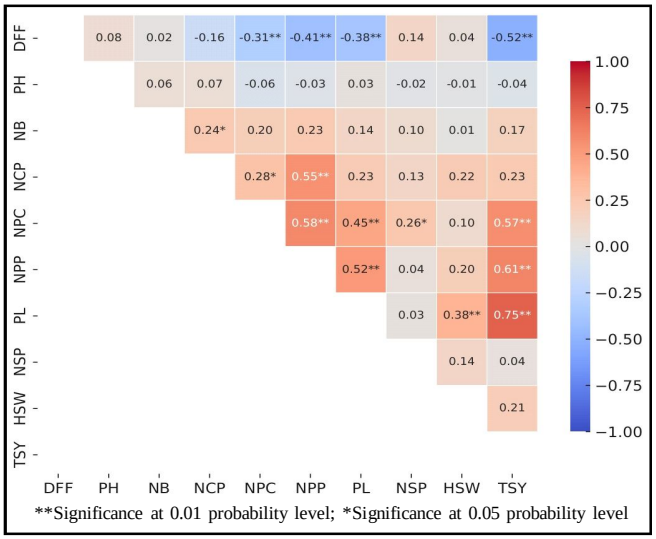

Fig. 2: Phenotypic correlation coefficients for growth, yield and yield contributing traits in Blackgram (Summer 2023). [DFF Days to 50% flowering, PH Plant height, NB Number of branches plant^{-1}, NCP Number of clusters plant^{-1}, NPC Number of pods cluster^{-1}, NPP Number of pods plant^{-1}, PL Pod length (cm), NSP Number of seeds pod^{-1}, HSW 100 seed weight(g) and TSY Total seed yield(g)].

utilizing these yield-attributing traits for direct selection. In contrast, days to 50 *per cent* flowering (-0.58) showed a significant negative association with seed yield per plant, which will be helpful in the development of early maturing varieties. The results obtained by Ali *et al*., (2008), Saima *et al.*, (2011), Singh *et al*., (2014), Mehra *et al*., (2016), Miah *et al*., (2016) and Saran *et al*., (2023) and Sarma *et al*., (2025) were in close agreement with the results of the present findings (Fig. 1).

Traits such as number of branches per plant (0.1196), number of clusters per plant (0.1264), number of pods per cluster (0.1355), number of pods per plant (0.9260), pod length (0.1948), 100 seed weight (0.0763) and number of seeds per pod (0.4250) exerted a positive direct effect on seed yield per plant. Selection would be rewarding if these traits were considered accordingly. The value of residual effect (0.3587) indicates that there may be some other secondary components that should not be ignored. Similar findings were obtained by the previous studies conducted by Veeramani *et al*., (2005), Gill *et al*., (2017), Sathya *et al*., (2018), Partap *et al*., (2019), Shanthi *et al*., (2019), Sridhar *et al*., (2020), Saran *et al*., (2023), Jamil *et al.*, (2023), Bharti and Lal (2024).

The number of seeds per pod (0.4250), pod length (0.1948) and number of pods per cluster (0.1355) exerted the highest positive direct effects on seed yield per plant. Pod length (0.2716), number of branches per plant (0.2500) and number of pods per cluster (0.2361) exerted the highest positive indirect effect through the number of seeds per pod on seed yield per plant, considering these traits while selecting the genotype for the breeding program would be rewarding. Hence, priority should be given to these traits while selecting genotypes for high yield in blackgram (Table 1).

Correlation coefficient analysis and path analysis for the second season (Zaid 2023)

Seed yield per plant showed a significant positive association with the number of pods per cluster (0.57), the number of pods per plant (0.61) and pod length (0.75). It indicates their primary role in enhancing seed yield per plant through improving these traits. Hence, these traits may be considered for yield improvement in crop breeding programs. The number of branches per plant (0.17), the number of clusters per plant (0.23), the number of seeds per pod (0.04) and 100 seed weight (0.21) showed non-significant a positive effect with seed yield per plant. The results obtained by Gopinath *et al*., (2018), Hadimani *et al*., (2019), Chowdhury *et al*., (2020), Jamil *et al.*, *(*2022), Gomathi *et al*., (2023) and Veeramani *et al.*, (2024) were in close agreement with the results of the present findings (Fig. 2).

The yield-attributing traits such as number of branches per plant(0.0440), number of pods per cluster(0.1475), number of pods per plant(0.1644), pod length(0.5119) and number seeds per pod(0.0065) exerted a positive direct effect on seed yield per plant. Selection for these traits would be helpful. The residual value (0.3128) indicated that some other secondary characteristics influenced seed yield. Similar findings were obtained from the previous studies conducted by Hemalatha *et al*., (2017), Ragul *et al*., (2018) and Shanti *et al*., (2019) and Rajput *et al*., (2025).

Pod length (0.5119) and number of pods per plant (0.1644) exerted the highest positive direct effects on seed yield per plant. The number of pods per plant (0.2303), number of pods per cluster (0.2031) and 100 seed weight (0.1980) exerted the highest positive indirect effect through pod length on seed yield per plant, considering these traits while selecting the genotype for the breeding program would be rewarding. Hence, priority should be given to these traits while selecting genotypes for high yield in blackgram (Table 2).

Conclusion

For both seasons, number of pods per cluster, number of pods per plant and pod length exerted a significant positive direct association on seed yield per plant. Seed yield per plant showed a strong positive association with various yield-attributing traits. Hence, selecting more than one character is helpful to get the desired selection response and yield improvement in blackgram breeding programme.

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