DIRECT AND INDIRECT EFFECTS OF YIELD CONTRIBUTING CHARACTERS ON SEED YIELD IN BLACK GRAM (*Vignamungo*(L.) HEPPER)

Comment [WU1]: In what environmental condition???

Comment [WU2]: Name of country???

Comment [WU3]: Similarity index report????

ABSTRACT

India is the largest producer and consumer of pulses in the world. Pulses play a crucial role in the nutrition of mankind and can be cultivated all over the world, making them important both economically as well as nutritionally. The present investigation was carried out with objective of assessing genetic variability, genetic parameters like GCV, PCV, heritability, genetic advance, correlation and path analysis on 26 Blackgram genotypes with one check using randomizedblockdesignwiththreereplicationduring*Kharif*2021inexperimentalFarmofthe Department Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technologyand Sciences, Prayagraj, Uttar Pradesh. Observations were recorded for 13 characters viz., days to 50% flowering, days to 50% pod setting, days to maturity, plant height (cm), number of primary branches, number of clusters per plant,number of pods per plant, number of seeds per pod, pod length (cm), biological yield per plant (g), harvest Index (%), seed index, seed yield per plant (g). based on mean performance MASH - 338foundtobesuperiorinseedyieldperplantfollowedbyIPU-99.Amongthe13quantitative characters,highestimatesofGCVandPCVwererecordedrespectivelyfornumberofpodsper plant followed by number of clusters per plant. Number of pods per plant showed high heritability and genetic advance. Positive and significant correlation with number of clusters perplantatgenotypicandphenotypiclevel.Atgenotypiclevel,thehighestpositivedirecteffect on Seed yield per plant effect was found for number of clusters per plant and harvest index at genotypiclevel.

Comment [WU4]: Concluding & recommendation comments???

Key words: variability, GCV, PCV, heritability, correlation, path analysis

Introduction:

India is the largest producer and consumer of pulses in the world. Pulses play a crucial role in the nutrition of mankind and can be cultivated all over the world, making them important both economically as well as nutritionally. They are used as fodder, excellent green manure for soil reclamation and maintain soil fertility. Pulses provide proteins, carbohydrates, dietary fibres, vitamins, phytochemicals and minerals such as iron, zinc, folate and magnesium. Legumes are the third largest family of higher plants with more than 20,000 species having major impact on agriculture,humanandlivestocknutritionandenvironment.Thesearesecondonlytograssesin agricultural importance (Doyle2001).

Blackgram(*Vignamungo*(L.)Hepper),popularlyknownasurdbeanormashinIndia.Itbelongs to the family of Leguminoseae and sub-family Papilionaceae. it is a self-pollinating diploid (2n=2x=22) annual crop with a small genome size estimated to be 0.56pg/1C (574Mbp) (Gupta *et al*.,2008).

Indiaproducesaround30to33lakhtonsofblackgramannually fromabout50.31lakhhectares of area, and an average productivity of 650 to 750 kg per hectare. (Source: ICAR-Directorate of Pulses Development Annual Report, (2019-2020). ICAR -Indian Institute of Pulses Research E-PulseDataBook).Blackgramoutputaccountsforabout13.1%ofIndia'stotalpulseproduction and 15.3% of India's total pulse growing area (Pulses in India Retrospect & Prospects,2020).

Limited variability has been utilized in varietal development programmes in Blackgram. Pedigree analysis of the released cultivars indicated that small number of parents with high degreeofrelatednesswasrepeatedlyusedincrossingprogrammes.Inblackgram,thevarietyT9 isthemostfrequentlyusedancestorappearingin64%ofthevarieties.Thisindicatedverynarrow genetic base of the released varieties of blackgram. (Kumar *et al*., 2004). Research on this crop has lagged behind that of cereals and other legumes. Hence, development of this crop required through application of available genetic diversity which is essential in any hybridization programme.

Theimpactofselectionincropimprovementisdependsuponthedifferencespresentinthemain targetmaterialanduptowhichextentitisheritable.Occasionallyitishardtojustifywhetherthe recorded variation for a specific traits is heritable or may be varying environment factors. Consequently estimation of heritability is important. Burton (1952) and Johnson *et al*. (1955) reported to come to more accurate conclusion, genetic variability and heritability should be consideredandtoassessmaximumeffectofselection,geneticadvanceshouldalsobe

Comment [WU5]: Back ground of research???

Comment [WU6]: Statement of problem???

Comment [WU7]: Hypothesis???

Comment [WU8]: Old reference????

considered. All these genetic parameters should be considered in totality so as to bring an effective improvement in yield and yield related characters.

Wright(1921)proposedestimatesofpathcoefficientanalysisasanimportanttoolinpartitioning the correlation coefficient into direct and indirect effects, which will be useful in selection of important biometrical characters to achieve highyields.

Comment [WU9]: Very old refrence???

Comment [WU10]: Aims & objective of research???

Materials and methods:

The genetic material for this study comprised of 26 genotypes of Blackgram from different geographicaloriginweresowntheRandomizedblockdesignwith3replicationsforthe"Direct andIndirectEffectsofYieldContributingCharactersonSeedYieldinBlackgram(*Vignamungo*(L.) Hepper)" was conducted at the Experimental Farm of the Department Genetics and Plant Breeding,NainiAgriculturalInstitute,SamHigginbottomUniversityofAgriculture,Technology and Sciences, Prayagraj, Uttar Pradesh during *Kharif*,2021

Comment [WU11]: What country or globe???

Theobservationsforallthefollowingtraitswererecordedonrandomlyselectedfivecompetitive plants per plot in each replication for following 13 quantitative characters. 1. Days to 50% flowering 2. Days to 50% pod setting 3. Days to maturity 4.Plant height (cm) 5.Number of primary branches 6.Number of clusters per plant 7.Number of pods per plant 8.Number of seeds per pod 9.Pod length (cm) 10.Biological yield per plant (g) 11. Harvest Index (%) 12. Seed index 13. Seed yield per plant(g).

Experimental materials used in the present investigation is collected from Department of Genetics and Plant Breeding, Naini Agricultural Institute, SHUATS, Prayagraj, UP.

Statistical analysis:

- Analysis of variance **(Fisher,1918)**
- Genetic variability **(Burton,1952)**

  Genotypic Coefficient of Variation**(GCV)**
  Phenotypic Coefficient of Variation**(PCV)**
- Estimation of Heritability (Broad sense) **(Burton and Devane,1953)**
- Genetic advance **(Johnson *et al*.,1955)**
- Correlation co-efficient analysis **(AI Jibouri*et al*.,1958)**
- Path coefficient analysis **(Dewey and Lu,1954)**

Results and discussion:

Comment [WU12]: Need more discussion with comparison of latest review????

The mean sum of squares values for 13 biometrical traits was presented in table 1. The mean sumofsquaresduetothegenotypesweresignificantforallthecharactersstudiedatbothlevel of significance 1% and 5%, suggesting the existence of high genetic variability among the genotypes for all the traits. This indicates that there is sample for selection of genotypes from the present gene pool for yield and its componenttraits.

Table 1. Analysis of Variance (ANOVA) among 26 Blackgram genotypes for 13 quantitative traits

Sl.No.	Traits	Mean sum of squares		
		Replication	Treatment	Error
	Degrees of freedom	2	25	50
1	Days to fifty percent flowering	0.6280	19.882**	1.922
2	Days to fifty percent pod setting	1.7820	8.978**	1.675
3	Days to maturity	0.7310	18.213**	3.704
4	Plant height (cm)	31.3410	300.166**	22.668
5	Number of primary branches	0.0930	3.922**	0.18
6	Number of clusters per plant	0.0690	27.764**	0.548
7	Number of pods per plant	1.290	175.426**	3.447
8	Number of seeds per pod	0.2190	0.232**	0.099
9	Pod length (cm)	0.0840	0.096**	0.042
10	Seed yield per plant (g)	0.6360	0.692**	0.3
11	Biological yield per plant (g)	1.8710	16.537**	3.334
12	Harvest Index (%)	2.4550	45.587**	5.536
13	Seed Index (g)	0.0030	1.038**	0.101

*** 5% LevelofSignificance** **** 1% Level ofSignificance**

Based on mean performance out of 26 Blackgram genotypes evaluated for various characters 13genotypeswerefoundsuperiorfordifferentcharacters.Amongthelines,MASH-338(7.44), PDU-1 (7.353), recorded the highest seed yield per plant followed by the genotypes PLU-570 (7.353), PKGU-03 (7.313), L-6(7.047).

Among the 13 quantitative characters, high estimates of GCV and PCV were recorded respectivelyfornumberofpodsperplant(35.072,36.111),numberofclustersperplant(29.163, 30.031), number of primary branches (23.695,25.352).

Moderate estimates of GCV and PCV were recorded respectively for plant height (15.515, 17.312),seedindex(12.316,14.17)LowestimatesofGCVandPCVwereobservedrespectively for days to fifty percent flowering (5.408, 6.216), pod length (3.28, 5.969), days to maturity (3.436, 4.566)**,** days to fifty percent pod setting (2.984,3.878).

Heritability estimates

Inpresentinvestigation,highheritabilitywasreportedforthecharacterviz.,numberofpodsper plant(94.328%),numberofclustersperplant(94.304%),numberofprimarybranches(87.359), plantheight(80.318%),daysto50%flowering(75.702%),seedindex(75.552%),harvestindex (70.687 %). Moderate heritability was reported for the character viz., days to 50% pod setting (59.234%),biologicalyieldperplant(56.899%),daystomaturity(56.629%),numberofseeds per pod (30.812 %), seed yield per plant (30.359 %), pod length (30.204%).

Genetic advance

Geneticadvancewasestimatedforallthecharactersunderstudyandarepresentedin(Table2). Data on genetic advance exhibited the highest value of 17.756 % genetic advance for plant height followed by number of pods per plant (15.148 %), number of pods plant (15.148 %), harvest index (6.328 %), number of clusters per plant (6.025 %), days to 50% flowering(4.385 %), biological yield per plant (3.26 %), days to maturity (3.409 %), days to 50% pod setting (2.474 %), number of primary branches (2.15 %), seed index (1.001 %), seed yield per plant (0.41 %), pod length (0.152 %), number of seeds per pod exhibited the least genetic advance (0.24 %).

Table 2. Genetic parameters for 13 quantitative traits of 26 Blackgram genotypes

Sl.No.	Parameters	GCV	PCV	h^2 (Broad Sense) %	Genetic Advance 5%	Gen. Adv as % of Mean 5%
1	Days to fifty percent flowering	5.408	6.216	75.702	4.385	9.693
2	Days to fifty percent pod setting	2.984	3.878	59.234	2.474	4.731
3	Days to maturity	3.436	4.566	56.629	3.409	5.327
4	Plant height (cm)	15.515	17.312	80.318	17.756	28.643
5	Number of primary branches	23.695	25.352	87.359	2.15	45.623
6	Number of clusters per plant	29.163	30.031	94.304	6.025	58.34
7	Number of pods per plant	35.072	36.111	94.328	15.148	70.17
8	Number of seeds per pod	3.463	6.239	30.812	0.24	3.96
9	Pod length (cm)	3.28	5.969	30.204	0.152	3.714
10	Seed yield per plant (g)	5.278	9.579	30.359	0.41	5.99
11	Biological yield per plant (g)	8.872	11.761	56.899	3.26	13.785
12	Harvest Index (%)	18.684	22.223	70.687	6.328	32.36
13	Seed Index (g)	12.316	14.17	75.552	1.001	22.053

GCV: Genotypic Coefficient of Variation, PCV: Phenotypic Coefficient of Variation h^2bs: heritability (Broad sense), GA: Genetic Advance, GAM: Genetic Advance as Percent of Mean

Phenotypic Correlation Coefficient:

InthepresentinvestigationseedyieldperplantshownpositiveandsignificantassociationwithPlant height (0.267*), number of clusters per plant (0.408**), number of pods per plant (0.242*) number ofseedsperpod(0.282*),SeedIndex(0.302*).positiveandnon-significantwithdaystofiftypercent pod setting (0.1060), number of primary branches (0.1528), biological yield per plant (0.0623), harvest index (0.1659). Negative and non significant with Days to fifty percent flowering (-0.0322), Days to maturity (-0.0399), Pod length (-0.0376) in (table3.1).

Genotypic correlation coefficient:

In the present investigation seed yield per plant shown positive and significant association with number of clusters per plant (0.388**), number of pods per plant (0.252*) number of seeds per pod (0.312*), Seed Index (0.252*). positive and non-significant with Plant height (0.1329), days to fifty percent pod setting (0.0594), days to maturity (0.0159), number of primary branches (0.1036), Pod length (0.0726), biological yield per plant (0.1073), harvest index (0.1126). Negative and non significant with Days to fifty percent flowering (-0.0609) in (table 3.2).

Phenotypic Path coefficient analysis:

In the present investigation positive direct effect on seed yield was shown by days to fifty percent pod setting (0.1720), days to maturity (0.0251), plant height (0.4407), number of clusters per plant (0.3092), number of pods per plant (0.0276), number of seeds per pod (0.2175), harvest Index (0.3148), seed Index (0.0841). Negative direct effect was showed by Days to fifty percent flowering (-0.0772), number of primary branches (-0.0477), pod length (-0.0182) in (table 4.1)

Genotypic Path coefficient analysis:

The maximum direct positive effect on seed yield per plant was observed in number of clusters per plant (0.3204) followed by number of seeds per pod (0.2476), plant height (0.2312), harvest index (0.1639),seedindex(0.1405),biologicalyieldperplant(0.1258),numberofpodsperplant(0.1129) and days to 50% pod setting (0.1094). Maximum negative direct effect on seed yield per plant was observedfromnumberofprimarybranches(-0.1471)followedbydaysto50%flowering(-0.0616). in (table4.2)

Table 3.1 Estimation of phenotypic correlation coefficient between yield and yield attributing traits in 13 quantitative traits of 26 Blackgram genotypes

Table 3.2 Estimation of Genotypic correlation coefficient between yield and yield attributing traits in 13 quantitative traits of 26 Blackgram genotype

Traits	Days to fifty percent flowering	Days to fifty percent pod setting	Days to maturity	Plant height (cm)	Number of primary branches	Number of clusters per plant	Number of pods per plant	Number of seeds per pod	Pod length (cm)	Biological yield per plant (g)	Harvest Index (%)	Seed Index (g)	Seed yield per plant
Days to fifty percent flowering	1.0000	0.613**	0.1086	0.244*	0.1154	-0.0315	0.0096	-0.284*	-0.0732	0.2054	-0.2170	-0.1448	-0.0609
Days to fifty percent pod setting		1.0000	0.2180	0.0724	0.0871	-0.0987	-0.0839	-0.0742	-0.0225	0.0361	0.0510	0.1191	0.0594
Days to maturity			1.0000	-0.0499	0.0791	-0.0953	0.0412	0.1345	0.1480	0.1652	-0.264*	-0.278*	0.0159
Plant height (cm)				1.0000	0.2074	0.0828	-0.1202	-0.1744	-0.328*	0.597**	-0.433**	-0.1002	0.1329
Number of primary branches					1.0000	0.589**	0.488**	-0.0469	-0.0232	0.1131	-0.1891	-0.1363	0.1036
Number of clusters per plant						1.0000	0.622**	0.244*	-0.0079	0.0905	-0.0128	0.0741	0.388**
Number of pods per plant							1.0000	0.1171	0.2040	-0.1070	0.0840	0.0455	0.252*
Number of seeds per pod								1.0000	0.1909	0.0229	-0.0635	-0.1008	0.312*
Pod length (cm)									1.0000	-0.2121	0.1756	0.0776	0.0726
Biological yield per plant (g)										1.0000	-0.738**	-0.235*	0.1073
Harvest Index (%)											1.0000	0.812**	0.1126
Seed Index (g)												1.0000	0.252*
Seed yield per plant													1.0000

Table 4.1 Phenotypic path between yield and yield attributing traits in 13 quantitative traits of 26 Blackgram genotypes

Traits	Days to fifty percent flowering	Days to fifty percent pod setting	Days to maturity	Plant height (cm)	Number of primary branches	Number of clusters per plant	Number of pods per plant	Number of seeds per pod	Pod length (cm)	Biological yield per plant (g)	Harvest Index (%)	Seed Index (g)	Seed yield per plant
Days to fifty percent Flowering	**-0.0772**	-0.0560	-0.0135	-0.0152	-0.0110	0.0020	0.0013	0.0174	-0.0001	-0.0222	0.0215	0.0129	-0.0322
Days to fifty percent pod Setting	0.1248	**0.1720**	0.0372	0.0045	0.0007	-0.0232	-0.0120	-0.0022	0.0092	0.0148	0.0055	0.0235	0.1060
Days to maturity	0.0044	0.0054	**0.0251**	-0.0012	0.0030	-0.0005	0.0019	0.0050	0.0037	0.0020	-0.0058	-0.0078	-0.0399
Plant height (cm)	0.0868	0.0115	-0.0208	**0.4407**	0.1123	0.1025	-0.0205	-0.0009	-0.1087	0.3213	-0.2628	-0.1029	0.267*
Number of primary branches	-0.0068	-0.0002	-0.0057	-0.0122	**-0.0477**	-0.0288	-0.0250	0.0043	0.0008	-0.0090	0.0107	0.0067	0.1528
Number of clusters per plant	-0.0079	-0.0418	-0.0065	0.0719	0.1866	**0.3092**	0.1905	0.0408	-0.0433	0.0538	-0.0065	0.0364	0.408**
Number of pods per plant	-0.0005	-0.0019	0.0021	-0.0013	0.0145	0.0170	**0.0276**	0.0024	0.0046	-0.0030	0.0040	0.0038	0.242*
Number of seeds per pod	-0.0491	-0.0028	0.0432	-0.0004	-0.0196	0.0287	0.0190	**0.2175**	0.0052	-0.0114	0.0027	-0.0177	0.282*
Pod length (cm)	0.0000	-0.0002	-0.0007	0.0011	0.0001	0.0006	-0.0007	-0.0001	**-0.0044**	0.0015	-0.0011	-0.0005	-0.0376
Biological yield per plant (g)	-0.0052	-0.0016	-0.0014	-0.0133	-0.0034	-0.0032	0.0020	0.0010	0.0060	**-0.0182**	0.0140	0.0054	0.0623
Harvest Index (%)	-0.0875	0.0101	-0.0729	-0.1877	-0.0707	-0.0067	0.0462	0.0039	0.0809	-0.2422	**0.3148**	0.2580	0.1659
Seed Index (g)	-0.0141	0.0115	-0.0260	-0.0196	-0.0119	0.0099	0.0117	-0.0068	0.0086	-0.0250	0.0689	**0.0841**	0.302*
Seed yield per plant	-0.0322	0.1060	-0.0399	0.267*	0.1528	0.408**	0.242*	0.282*	-0.0376	0.0623	0.1659	0.302*	1.0000

Residual effect -0.324 * 5% LevelofSignificance ** 1% Level ofSignificance

Table 4.2 Genotypic path between yield and yield attributing traits in 13 quantitative traits of 26 Blackgram genotypes

Traits	Days to fifty percent flowering	Days to fifty percent pod setting	Days to maturity	Plant height (cm)	Number of primary branches	Number of clusters per plant	Number of pods per plant	Number of seeds per pod	Pod length (cm)	Biological yield per plant(g)	Harvest Index (%)	Seed Index (g)	Seed yield per plant
Days to fifty percent flowering	**-0.0616**	-0.0378	-0.0067	-0.0151	-0.0071	0.0019	-0.0006	0.0175	0.0045	-0.0127	0.0134	0.0089	-0.0609
Days to fifty percent pod setting	0.0670	**0.1094**	0.0238	0.0079	0.0095	-0.0108	-0.0092	-0.0081	-0.0025	0.0040	0.0056	0.0130	0.0594
Days to maturity	0.0074	0.0149	**0.0683**	-0.0034	0.0054	-0.0065	0.0028	0.0092	0.0101	0.0113	-0.0180	-0.0190	0.0159
Plant height (cm)	0.0565	0.0167	-0.0115	**0.2312**	0.0480	0.0192	-0.0278	-0.0403	-0.0758	0.1380	-0.1001	-0.0232	0.1329
Number of primary branches	-0.0170	-0.0128	-0.0116	-0.0305	**-0.1471**	-0.0866	-0.0718	0.0069	0.0034	-0.0166	0.0278	0.0201	0.1036
Number of clusters per plant	-0.0101	-0.0316	-0.0305	0.0265	0.1886	**0.3204**	0.1992	0.0782	-0.0025	0.0290	-0.0041	0.0237	0.388**
Number of pods per plant	0.0011	-0.0095	0.0047	-0.0136	0.0551	0.0702	**0.1129**	0.0132	0.0230	-0.0121	0.0095	0.0051	0.252*
Number of seeds per pod	-0.0702	-0.0184	0.0333	-0.0432	-0.0116	0.0605	0.0290	**0.2476**	0.0473	0.0057	-0.0157	-0.0249	0.312*
Pod length (cm)	-0.0038	-0.0012	0.0077	-0.0170	-0.0012	-0.0004	0.0106	0.0099	**0.0520**	-0.0110	0.0091	0.0040	0.0726
Biological yield per plant (g)	0.0258	0.0045	0.0208	0.0751	0.0142	0.0114	-0.0135	0.0029	-0.0267	**0.1258**	-0.0928	-0.0296	0.1073
Harvest Index (%)	-0.0356	0.0084	-0.0432	-0.0710	-0.0310	-0.0021	0.0138	-0.0104	0.0288	-0.1210	**0.1639**	0.1331	0.1126
Seed Index (g)	-0.0203	0.0167	-0.0391	-0.0141	-0.0192	0.0104	0.0064	-0.0142	0.0109	-0.0330	0.1141	**0.1405**	0.252*
Seed yield per plant	-0.0609	0.0594	0.0159	0.1329	0.1036	0.388**	0.252*	0.312*	0.0726	0.1073	0.1126	0.252*	1.0000

Residualeffect:0.282 * 5% LevelofSignificance ** 1% Level ofSignificance

Fig. 1.Phenotypicalpathdiagram

Fig. 2. Genotypical pathdiagram

Conclusion:

The present investigation concluded that among 26 genotypes of blackgram on basis of mean performanceMASH–338wasfoundtobesuperiorinyieldoverthecheck(Shekar-2).Asblackgram is mainly self pollinated crop different traits has different adoptions to different environmental conditions where those adaptions may have direct and indirect effect on yield contributing characters on seed yield. Positive and direct effect over a seed yield per plant is exhibited by number of pods per plantandnumberofclustersperplant.Wherepositiveandsignificanteffectoveraseedyieldperplant wasexhibitedbynumberofpodsperplantandnumberofclustersperplantatgenotypicandphenotypic level. Hence these traits must primarily included in breedingprocedure.

Comment [WU13]: Recommendation???

Comment [WU14]: Creation of new knowledge????

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Comment [WU15]: Tally each reference with text

Comment [WU16]: Reference formate is according to journal???

Comment [WU17]: