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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 2476-2481

www.thepharmajournal.com
Received: 27-09-2022
Accepted: 29-10-2022

BK Dawane
Department of Agricultural Botany (GPB), College of Agriculture, Badnapur, Jalna, Maharashtra, India

DK Patil
Principal Scientist (Plant Breeding) & I/c Agricultural Research Station, VNMKV, Parbhani, Maharashtra, India

VK Gite
Scientist (Plant Breeding), Agricultural Research Station, VNMKV, Parbhani. Maharashtra, India

JK Dawane
Department of Agricultural Botany (GPB), College of Agriculture, Badnapur, Jalna, Maharashtra, India

DG Kale
Jr. Breeder, Department of Research and Development, Cotton, Ajeet Seed Pvt Ltd. Aurangabad, Maharashtra, India

Corresponding Author:
BK Dawane
Department of Agricultural Botany (GPB), College of Agriculture, Badnapur, Jalna, Maharashtra, India

Character association and path analysis studies on seed yield and its yield attributing traits in greengram (*Vigna radiata* (L.) Wilczek)

BK Dawane, DK Patil, VK Gite, JK Dawane and DG Kale

Abstract
The present investigation was undertaken to study the extent of correlation and path coefficient analysis in forty genotypes of greengram. The genotypes were evaluated in randomized block design with two replications during *Kharif* 2021-22, at farm of College of Agriculture, Badnapur. Observations were recorded for eleven characters *viz*., plant stand, days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of seeds per pod, 100 seed weight, seed yield per plant and harvest index. Hence, the selection of genotypes based on these characters as selection criterion would be helpful in improving the seed yield potential of greengram.

Keywords: Greengram, correlation and path coefficient analysis

Introduction

Greengram (*Vigna radiata* (L.) Wilczek) is economically one of the most important pulse crop belongs to family Leguminaceae/Fabaceae and sub family papilionaceae, genus *Vigna* and species *radiata* having diploid chromosome number 2n = 2x = 22. It is economically most important crop of the '*Vigna*' group. There are three subgroups of *Vigna radiata*: one is cultivated (*Vigna radiata subsp. radiata)*, and two are wild (*Vigna radiata subsp. sublobata* and *Vigna radiata subsp. glabra*) (Asari *et al.* 2019) [1]. Greengram (*Vigna radiata var. radiata)* is believed to have originated in Indian subcontinent (Zukovskij, 1962) [11]. Since India has a wide range of genetic diversity of cultivated, as well as of weedy wild types of greengram, it is considered as the region of its first domestication (Baudon and Marechal, 1988) [2].

Correlation coefficient is statistical measure which is used to find out the degree and direction of association between two or more variables. The association of one or more characters influenced by a large number of genes is elaborated statistically by correlation coefficient. Correlation studies provide information about yield contributing characters. Thus, it is useful in determining yield components which can be used for genetic improvement of yield. This information is useful to plant breeder in selection of elite genotypes from diverse genetic populations. A positive correlation between desirable characters is favorable to the plant breeder because it helps in simultaneous improvement of both the characters. The genetic improvement of dependent trait can be achieved by applying strong selection to character which is genetically correlated with dependent character.

The association of one or more characters influenced by a large number of genes is elaborated statistically by correlation coefficient. Genotypic correlation coefficient provides a measure of genotypes conjugation between characters. The method of partitioning the correlation into direct and indirect effects by path coefficient analysis was suggested by Wright (1921) [12].

Path coefficient analysis provides information about the cause and effect situation in understanding the cause of association between two variables. It also helps in determining yield components by providing estimates of direct effects of various traits on yield as well as indirect effects via other component traits. Therefore, it provides basis for selection of superior genotypes from the diverse breeding population.

In applied plant breeding, success of the programme may be predicted to its genetic variability of different selection method is known. The correlation and path coefficient analysis provide information on genetic association of yield and different yield contributing characters, which in turn are useful in developing breeding strategies.

Material and Methods

The present investigation was conducted at farm of College of Agriculture, Badnapur, during *kharif* season of 2021-22. The experimental materials used for study consisted of thirty-six genotypes of greengram, out of which 26 genotypes were obtained from the germplasm of National Bureau of Plant Genetic Resources, New Delhi, available at Agricultural Research Station, Badnapur, 10 stable interspecific recombinants from Agricultural Research Station, Badnapur and 4 standard checks *viz.*, BPMR 145, BM 2002-1, BM 4, BM 2003-2 were evaluated in a randomized block design with two replications during *kharif* season of 2021-22. Each genotype was sown in two rows of 4 m length with spacing of 45 cm between rows and 10 cm between plants.

The data were recorded on five randomly selected plants of each replication for all characters such as plant stand, days to 50% of flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of seeds per pod, 100 seed weight, seed yield and harvest index. The genotypic co-variance was calculated as per Johnson *et al.* (1955) [6]. To establish a cause and effect relationship the partitioning of genotypic and phenotypic correlation coefficient was done into direct and indirect effects by path analysis as suggested by Dewey and Lu (1959) [4] and developed by Wright (1921) [12].

Result and Discussion

Correlation coefficients

The phenotypic and genotypic correlations for yield and its component characters studied are presented in Table 1 and 2 and fig. 1. The only significant correlation either in positive or negative are described. In general, the genotypic correlations were higher than the corresponding phenotypic correlations coefficient.

Seed yield per plant had positive significant correlation with 100 seed weight (rp = 0.5342, rg = 0.6229), and harvest index (rp = 0.5572, rg = 0.5931) both at phenotypic and genotypic level, while number of secondary branches per plant (rg = 0.2609) at genotypic level and non-significant correlation with days to 50% flowering (rp = 0.0645, rg = 0.0631), plant height (cm) (rp = 0.1821, rg = 0.1390), number of secondary branches per plant (rp = 0.1583), number of pods per plant (rp = 0.0442, rg = 0.0534) and number of seeds per pods (rp = 0.2020, rg = 0.2200).

The characters days to maturity (rp = -0.1523, rg = -0.0733) and number of primary branches per plant (-0.0900, rg = -0.1272) showed negative and non-significant correlation with seed yield at phenotypic and genotypic level.

The character viz. number of secondary branches per plant, number of seeds per pod, 100 seed weight and harvest index recorded highly positive significant correlation with seed yield. In other words, an increase in the magnitude of these characters would lead to an increase in the magnitude of grain yield.

Earlier studies too have indicated such positive significant correlation for number of seeds per pod and 100 seed weight by Venkateswralu *et al*. (2001) [10]. Garje *et al.* (2014) [5] found significant and positive relationships among seed yield and secondary branches per plant and number of seeds per pod.

From the foregoing discussion on character associations, it is evident that characters *viz.*, number of secondary branches per plant, number of seeds per pod, 100 seed weight (g) and harvest index (%) displayed positive correlation with yield per plant (g) at both genotypic and phenotypic levels. Hence, these characters could be given due emphasis in formulating selection criterion for improvement of seed yield in greengram.

Path analysis

To find out the direct and indirect contribution from each of the characters towards seed yield per plant, path coefficient analysis was carried out. The genotypic correlation coefficients being more important are only partitioned to direct and indirect effects which are presented in Table 4. Phenotypic and genotypic path diagram were furnished in fig.2 and 3 respectively.

Among all the components, number of secondary branches per plant exhibited the highest direct effect (g=1.6734) on grain yield followed by number of primary branches per plant (g=1.5453), 100 seed weight (g=0.5815), number of pods per plant (g=0.4969), number of seeds per pod (G=0.4806), days to 50% flowering (g=0.1289), days to maturity (g=0.1218), harvest index (g=0.0783) and plant height (g= - 0.3468) at genotypic level.

At phenotypic level, 100 seed weight exhibited the highest direct effect (p=0.5212) followed by number of pods per plant (p=0.3759), number of seeds per pod (p=0.3207), harvest index (p=0.3168), days to 50% flowering (p=0.1394), plant height (p=0.1128), number of primary branches per plant (p=0.0146), number of secondary branches per plant (p=0.0919) and days to maturity (p=-0.0295).

The characters number of secondary branches per plant, number of primary branches per plant,100 seed weight (g), number of pods per plant, number of seeds per pod, days to 50% flowering, days to maturity and harvest index (%) on seed yield in decreasing order of magnitude revealing that these were major yield contributing traits in greengram.

Similar results were reported by Reddy (2003) [7] for number of pods per plant, and number of seeds per pod. Number of seeds per pod had also directly effect on seed yield as reported by Thippani *et al.* (2013) [8].

From the above discussion, it is evident that number of secondary branches per plant, number of primary branches per plant,100 seed weight (g), number of pods per plant, number of seeds per pod, days to 50% flowering, days to maturity and harvest index (%) on seed yield showed positive direct effect on seed yield. While the characters *viz.* number of secondary branches per plant, number of seeds per pod, 100 seed weight (g) and harvest index (%) showed positive and significant correlation with seed yield.

Table 1: Estimation of phenotypic (above diagonal) correlation coefficients in greengram:

Characters	**Days to 50% flowering**	**Days to maturity**	**Plant height**	**Number of primary branches per plant**	**Number of secondary branches per plant**	**Number of pods per plant**	**Number of seeds per pod**	**100 seed weight**	**Harvest Index**	**Seed Yield per plant**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Days to 50% flowering	1.000	0.2908**	0.3435**	0.1217	0.0463	-0.0272	0.0217	-0.1304	-0.1079	0.0645
Days to maturity		1.0000	0.0380	0.4299***	0.4658***	0.4866***	-0.3168**	-0.3146**	-0.4315***	-0.1533
Plant height			1.0000	-0.1253	-0.2435**	-0.0777	0.3531**	-0.0741	-0.0592	0.1821
Number of primary branches per plant				1.0000	0.8988***	0.5898***	-0.7977***	-0.1570	-0.1614	-0.0900
Number of secondary branches per plant					1.0000	0.5699***	-0.7846***	-0.2400**	-0.1703	0.1583
Number of pods per plant						1.0000	-0.5143***	-0.3303**	-0.0863	0.0442
Number of seeds per pod							1.0000	0.0739	0.1448	0.2020
100 seed weight								1.0000	0.4752***	0.5342***
Harvest Index									1.0000	0.5572***
Seed yield per plant										1.0000

****** Significant at 5% level of probability or level of significance, ******* Significant at 1% level of probability or level of significance

Table 2: Estimation of Genotypical (above diagonal) correlation coefficients in greengram:

Character number	**Days to 50% flowering**	**Days to maturity**	**Plant height**	**Number of primary branches / plant**	**Number of secondary branches / plant**	**Number of pods / plant**	**Number of seeds / pod**	**100 seed weight**	**Harvest Index**	**Seed yield /plant**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Days to 50% flowering	1.0000	0.3701***	0.3715***	0.1074	0.0236	-0.0491	0.0317	-0.1688	-0.1113	0.0631
Days to maturity		1.0000	0.1168	0.7267***	0.6088***	0.6868***	-0.5637***	-0.4936***	-0.6773***	-0.0733
Plant height			1.0000	-0.1592	-0.2993**	-0.0655	0.4016***	0.0733	-0.0732	0.1390
Number of primary branches per plant				1.0000	0.9809***	0.6911***	-0.8595***	-0.1607	-0.1583	-0.1272
Number of secondary branches per plant					1.0000	0.6722***	-0.8631***	-0.2603**	-0.2568**	0.2609**
Number of pods per plant						1.0000	-0.5671***	-0.3508***	0.0874	0.0534
Number of seeds per pod							1.0000	0.0761	0.1656	0.2200**
100 seed weight								1.0000	0.5563***	0.6229***
Harvest Index									1.0000	0.5931***
Seed yield per plant										1.0000

******* Significant at 5% level of probability or level of significance, ****** Significant at 1% level of probability or level of significance

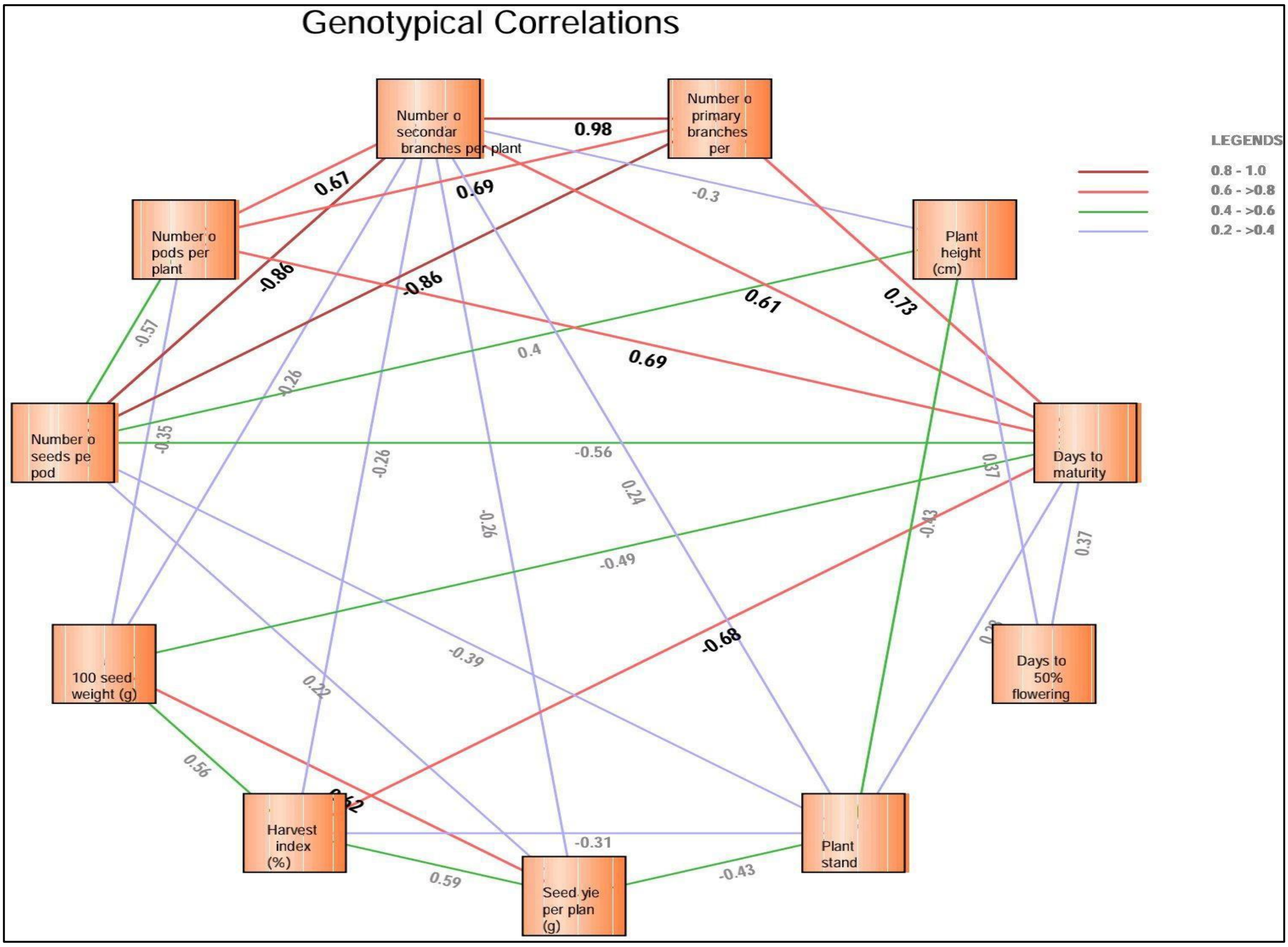

Fig 1: Diagram showing the genotypic correlation in yield and its component of greengram

Table 3: Direct and indirect effect of yield and its component characters on grain yield at phenotypic level

Sr. no	Characters	Days to 50% flowering	Days to maturity	Plant height	Number of primary branches per plant	Number of secondary branches per plant	Number of pods per plant	Numbers of seeds per pod	100 seed weight	Harvest index	Total phenotypic correlation with Seed yield per plant
1	Days to 50% flowering	0.1394	0.0405	0.0479	0.0170	0.0065	-0.0038	0.0030	0.0182	0.0150	0.0645
2	Days to maturity	-0.0086	-0.0295	-0.0011	-0.0127	-0.0138	-0.0144	0.0094	0.0093	0.0127	-0.1533
3	Plant height	0.0387	0.0043	0.1128	-0.0141	-0.0275	-0.0088	0.0398	-0.0084	-0.0067	0.1821
4	Number of primary branches per plant	0.0018	0.0063	-0.0018	0.0146	0.0131	0.0086	-0.0117	-0.0023	-0.0024	-0.0900
5	Number of secondary branches per plant	0.0043	0.0428	-0.0224	0.0826	0.0919	0.0524	-0.0721	-0.0221	-0.0157	0.1583
6	Number of pods per plant	-0.0102	0.1829	-0.0292	0.2217**	0.2142	0.3759	-0.1933	-0.1242	-0.0324	0.0442
7	Numbers of seed per pod	0.0070	-0.1016	0.1132	-0.2558	0.2516**	-0.1649	0.3207***	0.0237	0.0464	0.2020
8	100 seed weight	-0.0679	-0.1640	-0.0386	-0.0818	-0.1251	-0.1722	0.0385	0.5212***	0.2477**	0.5342***
9	Harvest index	-0.0342	-0.1.367	-0.0188	-0.0511	-0.0539	-0.0273	0.0459	0.1505	0.3168***	0.5557***

Residual effect= 0.5493 R SQUARE = 0.4913, Underlined figures indicate direct effect. Bold and underlined figures = Direct effect Normal figures = indirect effect ***, ** indicates significant at 5 and 1% level of significant respective

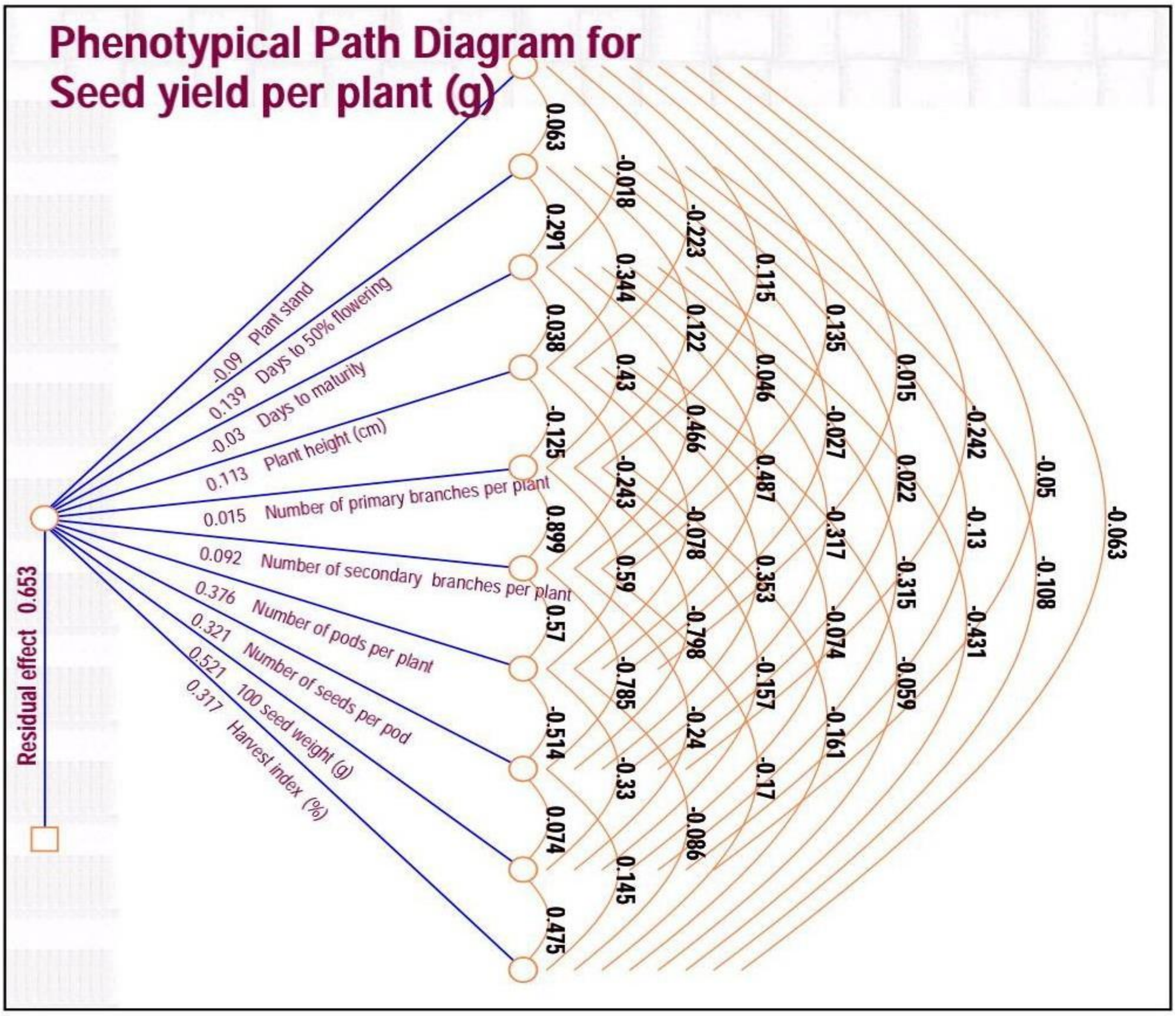

Fig 2: Diagram showing the phenotypic path correlation of yield and its component characters in greengram

Table 4: Direct and indirect effect of yield and its component characters on grain yield at genotypic level

Sr. no	Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Number of pods per plant	Number of seeds per pod	100 seed weight	Harvest index	Total phenotypic correlation with Seed yield per plant
1	Days to 50% flowering	0.1289	0.0477	0.0479	0.0138	0.0030	-0.0063	0.0041	-0.0218	-0.0144	0.0631
2	Days to maturity	0.0451	0.1218	0.0142	0.0885	0.0741	0.0836	-0.0686	-0.0601	-0.0825	-0.0733
3	Plant height	-0.1288	-0.0405	-0.3468	0.0552	0.1038	0.0227	-0.1393	0.0254	0.0254	0.1390
4	Number of primary branches per plant	0.1660	1.1229***	-0.2461**	1.5453	1.5157***	1.0680	-1.3281***	-0.2483**	-0.2546**	-0.1272
5	Number of secondary branches per plant	-0.0396	-1.0188***	0.5008***	-1.6414***	1.6734	-1.1249***	1.4444***	0.4356***	0.4298***	0.2609**
6	No of pods per plant	-0.0244	0.3413***	-0.0326	0.3434***	0.3340***	0.4969	-0.2818**	-0.1743	-0.0434	0.0534
7	No of seeds per pod	0.0153	-0.2709**	0.1930	-0.4131***	-0.4148***	-02726**	0.4806	0.0366	0.0796	0.2200**
8	100 seed weight	-0.0981	-0.2870**	-0.427	-0.0934	-0.1513	-0.2040	0.0443	0.5815	0.3235***	0.6229***
9	Harvest index	-0.0087	-0.0530	-0.0057	-0.0124	-0.0201	-0.0068	0.0130	0.0436	0.0783	0.5931***

Residual effect= 0.5493, R SQUARE = 0.4913, Underlined figures indicate direct effect. Bold and underlined figures = Direct effect
Normal figures = indirect effect ***, ** indicates significant at 5 and 1% level of significant respective

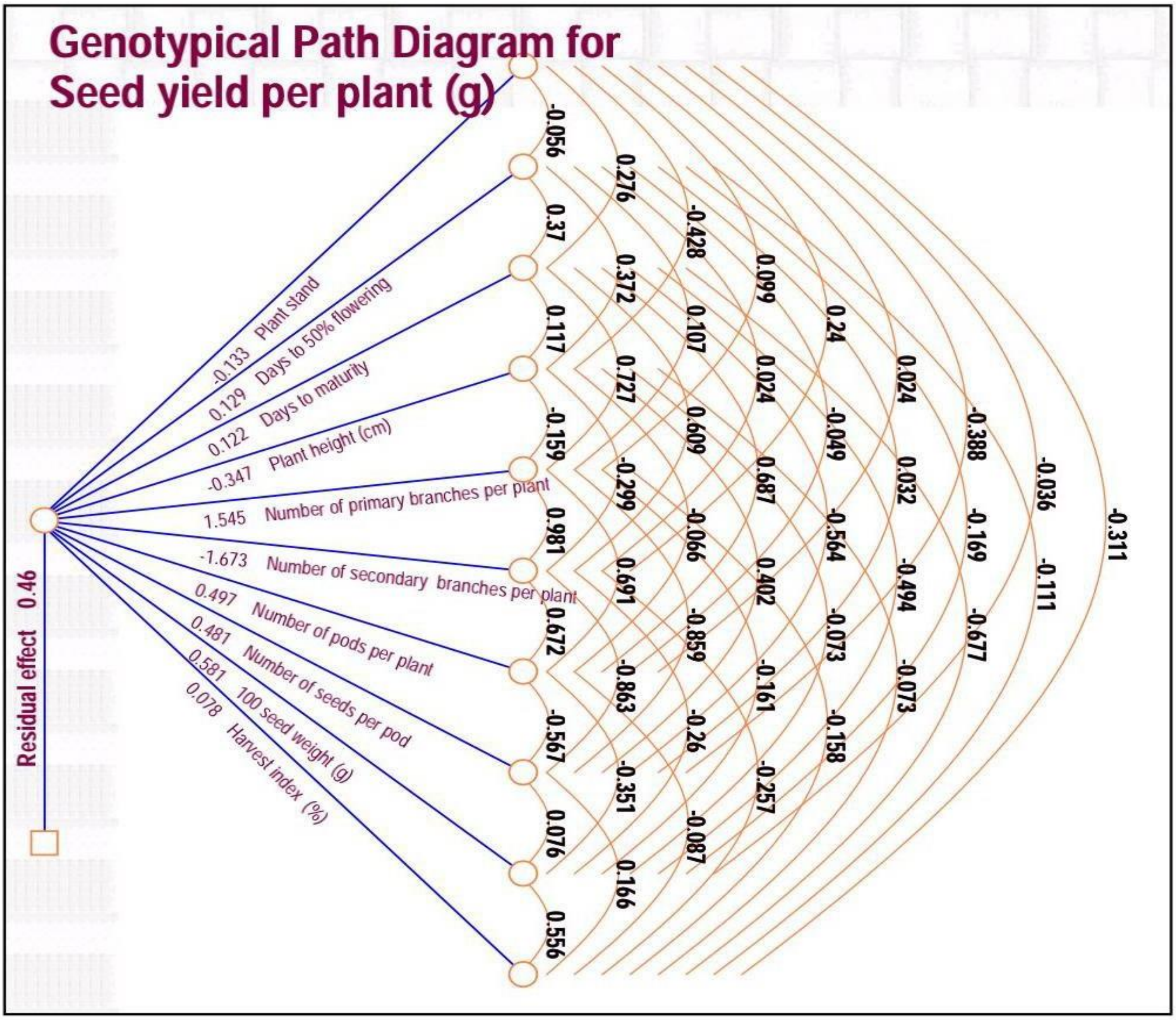

Fig 3: Diagram showing the genotypic path correlation of yield and its component characters in greengram

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