Plant Archives Vol. 25, Supplement 2, 2025 pp. 2711-2722 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.345

TRAIT ASSOCIATION AND PATH ANALYSIS FOR YIELD-RELATED TRAITS IN GREENGRAM

Tasphiya Elahi[1*], Sanjay Kumar Singh[2], Pratik Kumar[1], Shailendra Sagar Prajapati[3] and Kumar Jai Anand[3]

[1]CRP on Hybrid Technology (Rice), Department of Genetics and Plant Breeding, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur 482004, India
[2]AICRP on Seed (crops), Department of Genetics and Plant Breeding, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur 482004, India
[3]IRRI-JNKVV Collaborative Project, Department of Genetics and Plant Breeding, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur 482004, India
*Corresponding author E-mail: tasphiyaelahi437@gmail.com
(Date of Receiving : 26-04-2025; Date of Acceptance : 02-07-2025)

ABSTRACT

This research aims to evaluate the relationships between yield and yield component traits and quantify these traits direct and indirect impact on grain yield in 40 crosses and 14 parental lines. The experiment was conducted over the summer of 2020 and 2021. Association and path coefficients were analysed to ascertain the links between these variables and seed yield. Character association studies indicated that selection for no. of pods^{-1}, biological yield^{-1}, and harvest index would be advantageous for the genetic enhancement of Greengram. The genotypic correlations moderately exceeded the corresponding phenotypic correlations. The path coefficient analysis demonstrated that the number of pods^{-1} exerted the most significant direct influence on seed yield, succeeded by the number of branches^{-1}, harvest index, plant height, hundred seed weight, and biological yield-1. Targeted selection utilising these characteristics can enhance mungbean grain yield and quality.
***Keywords*:** Character association, Direct and indirect effect, Greengram, Yield.

Introduction

Mungbean [*Vigna radiata* (L.) Wilczek] is a grain legume crop predominantly grown in South Asia, Southeast Asia, and Australia. It is nutrient-dense, early maturing and adaptable to various environmental conditions Nair and Schreinemachers (2020). Compared to other pulses, mungbean is a short-duration crop employed in major cropping systems that contributes significantly to grain-based diets in Asia Kumar *et al*. (2013). They are edible, nutritious, and nonbombastic food sources. It contains a high lysine content and a protein composition that includes all nine required amino acids Mubarak *et al*. (2005). It is quickly digested and contains numerous vitamins, minerals, antioxidants, 22-28% of seed protein, 1-1.5% fat, and 60-65% carbs Sandhu and Singh (2021).

Mungbean is employed in several ways to fulfil local taste preferences because of its healthy composition. Although it is typically consumed as "daal" soup, it may also be processed to generate noodles, porridge, curries, ice cream, cakes, bean paste, soups, desserts, and flour Dahiya *et al*. (2015). Using mungbean seeds, fodder, and haulms as fertilizer and animal feed is also possible Kim *et al*. (2015). Additionally, it grows in various temperate and tropical latitudes with little to no input of fertilizer or water and can tolerate harsh climatic circumstances Tantasawat *et al*. (2015). Mungbean is a well-known and important pulse crop in India. However, productivity is still low because of several factors, including low yield, subpar crop management techniques, inconsistent growth patterns, pod shattering, lodging, late/indeterminate maturity, vulnerability to diseases and pests, and, most importantly, grain quality. Therefore, there is a

pressing need to increase mungbean production by introducing new cultivars and better cultural practices.

Inefficient plant types and low yielding potential, lack of suitable ideotypes for various cropping systems, poor harvest index, low level of crop management, increased competition with weeds, and susceptibility to biotic and abiotic stresses are the main obstacles to achieving higher yields Sarobol (1997), Souframanien and Gopalakrishna (2004) and Srinives (2006). This is most likely a result of the Indian subcontinent's gene pool being neglected and only a few carefully chosen genotypes of mungbean being employed in cultivar development initiatives Gupta *et al*. (2004), Chattopadhyay *et al*. (2010).

A correlation coefficient is a statistical metric used to determine the degree and direction of the association between two or more variables functioning simultaneously. It also helps to comprehend how the improvement in one character would generate simultaneous change in other characters. While path analysis is a normalized partial regression coefficient, it breaks the correlation coefficient into direct and indirect effects, which describe each character's relative contribution Shanthala *et al*. (2004). Plant breeders need to know about correlation and path coefficient analysis to create an efficient selection programme, breed genotypes with higher yield potential, and understand how various factors affect seed yield. A study into each trait's direct and indirect effects on yield or quality traits could be an extra advantage in supporting the selection process Wamanrao *et al*. (2020). In the present research, the correlation and path coefficients have been examined to estimate the contribution of characteristics on grain yield in mungbean. Considering this, the current study evaluated the correlation and path analysis of 14 mungbean genotypes and 40 crosses concerning a range of desired attributes. The insights gained will be beneficial to identify suitable lines for hybridization research to investigate high-yielding, high-quality mungbean cultivars.

Materials and Methods

The present investigation was carried out on green gram at Seed Breeding Farm, Department of Plant Breeding and Genetics, College of Agriculture, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur (Madhya Pradesh). The 40 crosses were made from 10 lines and four testers in the Summer of 2020 (February-May) and evaluated for combining ability during the Summer of 2021 (March-May). The experimental area occupied was relatively uniform in terms of topography and fertility. The experiment was carried out with fourteen test genotypes of green gram. The seed material for this research was obtained from the project entitled "Field Evaluation of Trombay Mutant Selections and Research Activities in Agriculture" and Mung and Urd Improvement Project**,** Department of Plant Breeding and Genetics, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh (Table. 1). The investigation was laid out using a Randomized Complete Block Design, consisting of three replications performed in two rows, each measuring 3 meters in length pursuing a spacing of 30 cm between the rows and 10 cm between the plants to evaluate the yield and yield attributing traits. Observations were recorded on 12 quantitative traits, i.e. days to 50% flowering, days to maturity, plant height (cm), no. of branches plant^{-1}, number of pods plant^{-1}, number of pods cluster^{-1}, number of clusters plant^{-1}, number of seeds pod^{-1}, hundred seed weight (g), biological yield plant^{-1} (g), harvest index (%) and seed yield plant^{-1} (g). The mean value of data was subjected to statistical analysis as per the method given by Miller *et al.* (1958), and the contribution of direct and indirect effects of different traits on seed yield was calculated using path coefficient analysis as proposed by Wright (1921) and elaborated by Dewey and Lu (1959).

Results and Discussion

Correlation coefficient analysis

The present investigation revealed that genotypic correlation was higher than the corresponding phenotypic values for parents and crosses (Tables 4, 5, 6 and 7), indicating a strong inherent association between characters. However, the expression was suppressed due to the effect of the environment, which modified the phenotypic expression and phenotypic coefficient values. This is in confirmation with the findings of Sreedevi and Sekhar (2004), Ramesh *et al*. (2005), Verma and Garg (2007), Khanpara *et al*. (2012) and Narasimhulu *et al*. (2014). In parents, seed yield per plant showed substantial and positive phenotypic correlation with the number of pods plant^{-1} (0.407**) followed by biological yield plant^{-1} (0.366*) and harvest index (0.337*). The rest of the parameters revealed a non-significant but positive correlation with seed yield plant^{-1} except plant height and number of pods cluster^{-1}. In crosses, highest positive and significant phenotypic association with seed yield was expressed by biological yield plant^{-1} and harvest index (0.779*) followed by number of pods plant^{-1} (0.435**), hundred seed weight (0.283**), number of clusters plant^{-1} (0.262**), number of branches plant^{-1} (0.256*) and number of pods cluster^{-1} (0.205*). On the contrary,

a strong significant and negative association was identified with plant height (-0.395**) and number of seeds pod^{-1} (-0.189*). These findings are in confirmation with the findings of Ramesh *et al*. (2005), Pandiyan *et al*. (2006), Biradar *et al*. (2007), Wani *et al*. (2007), Hakim *et al*. (2008), Gul *et al*. (2008), Peerajade *et al*. (2009), Vinay *et al*. (2010), Tabasum *et al*. (2010), Khajudparn and Tantasawat (2011), Srivastava and Singh (2012), Khanpara *et al*. (2012), Zaid *et al*. (2012), Ahmad *et al*. (2013), Baisakh *et al*. (2013), Jyothsna and Anuradha (2013), Begum *et al*. (2013), Itefa *et al*. (2014), Lalinia and Khameneh (2014), Narasimhulu *et al*. (2014) for pods per plant and Anbumalarmathi *et al*. (2005), Iranna and Kajjidoni (2005), Ramesh *et al*. (2005), Pandiyan *et al*. (2006), Mallikarjuna *et al*. (2006), Biradar *et al*. (2007), Kaveri *et al*. (2007), Saxena *et al*. (2007), Tabasum *et al*. (2010), Khajudparn and Tantasawat (2011), Khanpara *et al*. (2012), Ahmad *et al*. (2013), Baisakh *et al*. (2013) for cluster per plant.

Significant and positive associations of seed yield with pods cluster^{-1} conformed with the reports of Iranna and Kajjidoni (2005), Kaveri *et al*. (2007), Wani *et al*. (2007), Peerajade *et al*. (2009), Srivastava and Singh (2012), Khanpara *et al*. (2012), Srikanth *et al*. (2013), Narasimhulu *et al*. (2014); Dhuppe *et al*. (2005), Saxena *et al*. (2007), Shwetha (2011), Srivastava and Singh (2012), Ahmad *et al*. (2013), Jyothsna and Anuradha (2013) and Itefa *et al*. (2014). For number of branches plant^{-1} was in agreement with conformity of the findings of Bhattacharya and Vijaylaxmi (2005), Saxena *et al*. (2007), Verma and Garg (2007), Singh et al. (2009), Tabasum et al. (2010), Khajudparn, Tantasawat (2011), Itefa *et al*. (2014) and Narasimhulu *et al*. (2014). For biological yield per plant, the present findings conformed with the findings of Pratibha *et al*. (2016). Thus, the seed production in Greengram can be raised by selecting genotypes with a larger number of pods plant^{-1}, number of pods cluster^{-1}, number of clusters plant^{-1}, number of branches plant^{-1}, biological yield plant^{-1} and harvest index.

Path coefficient analysis

The present study conducted path coefficient analysis based on fourteen parents and 40 crossings for seed yield and its contributing traits. The genotypic direct and indirect effects were found to be slightly higher in magnitude than phenotypic direct and indirect effects (Tables 8, 9, 10 and 11). The discussion is presented here under. In parents, the number of pods exerted the largest direct effect on seed yield, followed by the number of branches plant^{-1}, harvest index, plant height, hundred seed weight, biological yield plant^{-1} and days to maturity. Conversely, the number of clusters plant^{-1} followed by days to 50% flowering demonstrated considerable negative direct effects on seed yield. In crosses, the harvest index revealed a more significant positive direct effect on seed yield followed by biological yield plant^{-1}, number of seeds pod^{-1}, number of pods cluster^{-1} and days to 50% flowering. Conversely, the hundred seed weight, plant height, number of clusters plant^{-1}, and number of branches plant^{-1} negatively affected seed yield. Other negative indirect effects were minor. The findings of prior researchers viz., Saifullah and Mahmood (2002), Mallikarjuna *et al*. (2006), Pandey *et al*. (2007), Itefa *et al*. (2014) and Narasimhulu (2014) were in line with present findings for harvest index. Positive direct effects of number of pods plant^{-1}, number of branches plant^{-1}, number of seeds pod^{-1} and hundred seed weight on seed yield were reported by Sanhita *et al*. (2019). The positive direct effect of the plant height on seed yield was reported by Manivelan *et al*. (2019). In contrast, the positive direct effect of days to 50% flowering as well as negative direct effects of days to maturity, plant height, hundred seed weight and number of seeds pod^{-1} was reported earlier by Marawar *et al*. (2020).

The critical study of the results of path analysis for seed yield revealed that the direct effect of biological yield plant^{-1} and harvest index were strong and positive in both parents and crosses, indicating that they are the key contributing features for seed yield in Greengram. Direct effects of the number of pods plant^{-1} and the number of clusters plant^{-1} were negative in both parents and crosses. Similar results were evident from the investigations of Haritha and Reddydekhar (2002), Mallikarjuna *et al*. (2006), Pandey *et al*. (2007), Itefa *et al*. (2014) and Narasimhulu *et al*. (2014). In parents, the number of pods plant^{-1} displayed the strongest direct effect on seed production plant^{-1}; consequently, the number of pods plant^{-1} also appeared as a significant direct yield component at the genotypic level. The number of pods plant^{-1} was identified as an important yield component by Pandey *et al*. (2007), Khajudparn and Tantasawat (2011), Ahmed *et al*. (2013), Jyothsna and Anuradha (2013), Srikanth *et al*. (2013), Lalinia and Khameneh (2014).

The majority of indirect impacts of several independent qualities via other traits were minimal of either sign. Only a few characters had greater, moderate and low positive or negative indirect impacts. In parents, days to 50% flowering showed somewhat favourable indirect effects on seed yield per plant through indirect positive effects of the number of pods plant^{-1} followed by the number of branches plant^{-1}, plant height, biological yield plant^{-1} and days to

maturity. Negative indirect effects were indicated through the number of clusters plant^{-1}, the number of cluster pod^{-1} and the hundred seed weight. The remaining indirect impacts of this characteristic via other traits were negative, relatively minor and inconsequential. In crosses, the indirect effects of days to 50% flowering on seed yield plant^{-1} via other features were extremely low and nonexistent. The positive indirect effect of days to 50% flowering on seed yield plant^{-1} was observed via positive indirect effects of the number of pods plant^{-1} and plant height. In contrast, the negative indirect effect of this trait on seed yield plant^{-1} via hundred seed weight conformed with the result of Alom *et al*. (2014).

Conclusion

The study on Greengram (*Vigna radiata* L.) revealed a strong positive relationship between seed yield plant^{-1} and several key variables, including the number of pods plant^{-1}, biological yield plant^{-1}, and harvest index. This underscores their importance in selecting for yield improvement. Genotypic correlations were found to be slightly higher than phenotypic correlations, indicating a significant genetic relationship among the traits, though environmental factors influenced phenotypic expressions. The path coefficient analysis identified biological yield plant^{-1} and harvest index as the most important direct contributors to seed yield. Notably, the negative correlation between plant height and seed yield suggests that breeding shorter plants with greater pod production and biological output may enhance overall yield. These insights are valuable for the development of high-yielding greengram genotypes.

Table 1: Details of parents

S. No.	Lines	S. No.	Testers
1	TJM 196	1	PDM 139
2	TJM 136	2	Shikha
3	TJM 3	3	Kanika
4	TMB 37	4	Virat
5	Ganga 8		
6	LGG 60		
7	HUM I		
8	SL668		
9	Pusa Vishal		
10	PDM 11		

Table 2: Pedigree of Greengram Parental Lines

S. No.	Name	Pedigree	Source
01.	TJM 196	-	BARC, Mumbai
01	TJM 136	-	BARC, Mumbai
03	TJM 3	Kopargoan X TARM 1B	BARC, Mumbai
04	TMB 37	Kopargoan X TARM 2B	BARC, Mumbai
05	Ganga 8	K 851 X Pusa 105	RAU, Sri Ganga Nagar
06	LGG 460	Lam M2 X ML 267	ANGRAU AP
07	HUM 1	BHUM 1 X Pant U 30	BHU, Varanasi
08	SL 668	-	PAU, Ludhiana
09	Pusa Vishal	Selection from NM 92	IARI, New Delhi
10	PDM 11	Selection from LM 595	IIPR, Kanpur
11	PDM 139	ML 20/19 X ML 5	IIPR, Kanpur
12	Shikha	IPM 03-1 X NM-1	IIPR, Kanpur
13	Kanika	PM 4/ EC398897	IIPR, Kanpur
14	Virat	IPM 2-1 X EC 398889	IIPR, Kanpur

Table 3: Cross combinations (F_1's)

1	TJM 196 X PDM139	21	LGG 460 X PDM 139
2	TJM 196 X Shikha	22	LGG 460 X Shikha
3	TJM 196 X Kanika	23	LGG460 X Kanika
4	TJM 196 X Virat	24	LGG460 X Virat
5	TJM 136 X PDM139	25	HUM 1 X PDM139
6	TJM 136 X Shikha	26	HUM 1 X Shikha

7	TJM 136 X Kanika	27	HUM 1 X Kanika
8	TJM 136 X Virat	28	HUM 1 X Virat
9	TJM 3 X PDM139	29	SL668 X PDM139
10	TJM 3 X Shikha	30	SL668 X Shikha
11	TJM 3 X Kanika	31	SL668 X Kanika
12	TJM 3 X Virat	32	SL668 X Virat
13	TMB 37 X PDM139	33	Pusa Vishal X PDM139
14	TMB 37 X Shikha	34	Pusa Vishal X Shikha
15	TMB 37 X Kanika	35	Pusa Vishal X Kanika
16	TMB 37 X Virat	36	Pusa Vishal X Virat
17	Ganga 8 X PDM139	37	PDM 11 X PDM139
18	Ganga 8 X Shikha	38	PDM 11 X Shikha
19	Ganga 8 X Kanika	39	PDM 11 X Kanika
20	Ganga 8 X Virat	40	PDM 11 X Virat

Table 4: Phenotypic correlation coefficients for seed yield and its attributing characters in parents

Traits	DF	DM	PH (cm)	NBPP	NPPP	NPPC	NCPP	NSPP	HSW (g)	BYPP (g)	HI (%)	SYPP (g)
DF	**1.000**	0.834**	0.347*	0.190	0.472**	0.202	0.279	0.048	-0.318*	0.372*	-0.071	0.149
DM		**1.000**	0.423**	0.185	0.314*	0.208	0.162	0.030	-0.233	0.258	0.081	0.101
PH (cm)			**1.000**	-0.056	-0.113	0.253	-0.274	-0.160	-0.079	0.410**	-0.379*	-0.101
NBPP				**1.000**	0.432**	-0.281	0.591**	0.246	-0.291	0.394**	-0.162	0.239
NPPP					**1.000**	0.066	0.698**	0.137	-0.069	0.550**	-0.101	0.407**
NPPC						**1.000**	-0.568**	-0.298	-0.194	0.049	-0.221	-0.072
NCPP							**1.000**	0.284	-0.008	0.356*	0.049	0.255
NSPP								**1.000**	0.098	0.056	0.196	0.239
HSW (g)									**1.000**	-0.072	0.265	0.096
BYPP (g)										**1.000**	-0.482**	0.366*
HI (%)											**1.000**	0.337*

*, ** Significant at 5% & 1% level of significance respectively

DF: Days to 50% flowering, **DM:**Days to maturity, **PH:** Plant height (cm), **NBPP:** Number of branches per plant, **NPPP:** Number of pods per plant, **NPPC:** Number of pods per cluster, **NCPP:** Number of clusters per plant, **NSPP:** Number of seeds per pod, **HSW:** Hundred seed weight (g), **BYPP:** Biological yield (g), **HI:** Harvest index (%), **SYPP:** Seed yield per plant (g)

Table 5: Genotypic correlation coefficients for seed yield and its attributing characters in parents

Traits	DF	DM	PH (cm)	NBPP	NPPP	NPPC	NCPP	NSPP	HSW (g)	BYPP (g)	HI (%)	SYPP (g)
DF	**1.000**	0.927**	0.419**	0.224	0.538**	0.321*	0.357*	0.058	-0.455**	0.403**	-0.063	0.282
DM		**1.000**	0.462**	0.166	0.312*	0.386*	0.104	0.045	-0.524**	0.296	0.048	0.310*
PH (cm)			**1.000**	-0.144	-0.135	0.426**	-0.357*	-0.335*	-0.274	0.437**	-0.795**	-0.297
NBPP				**1.000**	0.448**	-0.042	0.588**	0.784**	-0.440**	0.553**	-0.286	0.583**
NPPP					**1.000**	0.149	0.810**	0.270	-0.092	0.621**	-0.268	0.733**
NPPC						**1.000**	-0.424**	-1.043**	-1.022**	0.100	-0.528**	-0.507**
NCPP							**1.000**	0.888**	0.346*	0.523**	-0.128	0.762**
NSPP								**1.000**	-0.442**	0.059	0.562**	0.755**
HSW (g)									**1.000**	-0.211	0.042	-0.093
BYPP (g)										**1.000**	-0.746**	0.754**
HI (%)											**1.000**	0.212

*, ** Significant at 5% & 1% level of significance respectively

DF: Days to 50% flowering, **DM:**Days to maturity, **PH:** Plant height (cm), **NBPP:** Number of branches per plant, **NPPP:** Number of pods per plant, **NPPC:** Number of pods per cluster, **NCPP:** Number of clusters per plant, **NSPP:** Number of seeds per pod, **HSW:** Hundred seed weight (g), **BYPP:** Biological yield (g), **HI:** Harvest index (%), **SYPP:** Seed yield per plant (g)

Table 6: Phenotypic correlation coefficients for seed yield and its attributing characters in crosses

Traits	DF	DM	PH (cm)	NBPP	NPPP	NPPC	NCPP	NSPP	HSW (g)	BYPP (g)	HI (%)	SYPP (g)
DF	**1.000**	0.591**	0.230*	-0.170	-0.036	-0.064	0.000	-0.030	-0.098	0.051	0.062	0.088
DM		**1.000**	0.087	0.068	0.019	-0.056	0.046	0.017	-0.027	0.062	0.059	0.090
PH (cm)			**1.000**	-0.251**	-0.293**	-0.108	-0.251**	0.128	-0.301**	-0.429**	-0.262**	-0.395**
NBPP				**1.000**	0.303**	0.199*	0.125	0.006	0.217*	0.193*	0.216*	0.256**
NPPP					**1.000**	0.560**	0.495**	-0.081	0.117	0.436**	0.309**	0.435**

NPPC						**1.000**	-0.407**	-0.056	0.342**	0.224*	0.133	0.205*
NCPP							**1.000**	-0.032	-0.204*	0.236**	0.211*	0.262**
NSPP								**1.000**	0.029	-0.095	-0.228*	-0.189*
HSW (g)									**1.000**	0.178	0.247**	0.283**
BYPP (g)										**1.000**	0.269**	0.779**
HI (%)											**1.000**	0.799**

*, ** Significant at 5% & 1% level of significance respectively

DF: Days to 50% flowering, **DM:**Days to maturity, **PH:** Plant height (cm), **NBPP:** Number of branches per plant, **NPPP:** Number of pods per plant, **NPPC:** Number of pods per cluster, **NCPP:** Number of clusters per plant, **NSPP:** Number of seeds per pod, **HSW:** Hundred seed weight (g), **BYPP:** Biological yield (g), **HI:** Harvest index (%), **SYPP:** Seed yield per plant (g)

Table 7: Genotypic correlation coefficients for seed yield and its attributing characters in crosses

Traits	DF	DM	PH (cm)	NBPP	NPPP	NPPC	NCPP	NSPP	HSW (g)	BYPP (g)	HI (%)	SYPP (g)
DF	**1.000**	0.716**	0.240**	-0.221*	-0.048	-0.159	0.050	-0.203*	-0.117	0.049	0.091	0.111
DM		**1.000**	0.083	0.086	0.018	-0.042	0.040	0.012	0.022	0.049	0.062	0.094
PH (cm)			**1.000**	-0.304**	-0.303**	-0.179	-0.288**	0.306**	-0.402**	-0.463**	-0.425**	-0.484**
NBPP				**1.000**	0.383**	0.293**	0.218*	0.287**	0.341**	0.252**	0.183*	0.238**
NPPP					**1.000**	0.707**	0.605**	-0.257**	0.152	0.459**	0.458**	0.505**
NPPC						**1.000**	-0.107	-0.130	0.514**	0.300**	0.262**	0.302**
NCPP							**1.000**	-0.185*	-0.274**	0.301**	0.378**	0.373**
NSPP								**1.000**	0.268**	-0.289**	-0.493**	-0.349**
HSW (g)									**1.000**	0.278**	0.361**	0.375**
BYPP (g)										**1.000**	0.462**	0.902**
HI (%)											**1.000**	0.790**

*, ** Significant at 5% & 1% level of significance respectively**DF:**Days to 50% flowering, **DM:**Days to maturity, **PH:** Plant height (cm), **NBPP:** Number of branches per plant, **NPPP:** Number of pods per plant, **NPPC:** Number of pods per cluster, **NCPP:** Number of clusters per plant, **NSPP:** Number of seeds per pod, **HSW:** Hundred seed weight (g), **BYPP:** Biological yield (g), **HI:** Harvest index (%), **SYPP:** Seed yield per plant (g)

Table 8: Phenotypic path matrix for seed yield and its attributing characters in parents

Traits	DF	DM	PH (cm)	NBPP	NPPP	NPPC	NCPP	NSPP	HSW (g)	BYPP (g)	HI (%)	SYPP (g)
DF	**0.141**	-0.212	-0.026	0.036	0.236	-0.047	-0.175	0.003	0.010	0.234	-0.050	0.149
DM	0.118	**-0.254**	-0.032	0.035	0.157	-0.048	-0.102	0.002	0.007	0.162	0.057	0.101
PH (cm)	0.049	-0.107	**-0.076**	-0.011	-0.056	-0.059	0.172	-0.009	0.002	0.258	-0.265	-0.101
NBPP	0.027	-0.047	0.004	**0.188**	0.216	0.065	-0.371	0.013	0.009	0.248	-0.113	0.239
NPPP	0.066	-0.080	0.009	0.081	**0.499**	-0.015	-0.438	0.007	0.002	0.346	-0.071	0.407**
NPPC	0.028	-0.053	-0.019	-0.053	0.033	**-0.231**	0.357	-0.016	0.006	0.031	-0.155	-0.072
NCPP	0.039	-0.041	0.021	0.111	0.349	0.131	**-0.628**	0.015	0.000	0.224	0.034	0.255
NSPP	0.007	-0.008	0.012	0.046	0.068	0.069	-0.179	**0.054**	-0.003	0.035	0.137	0.239
HSW (g)	-0.045	0.059	0.006	-0.055	-0.035	0.045	0.005	0.005	**-0.031**	-0.045	0.186	0.096
BYPP (g)	0.052	-0.066	-0.031	0.074	0.275	-0.011	-0.224	0.003	0.002	**0.629**	-0.338	0.366*
HI (%)	-0.010	-0.021	0.029	-0.030	-0.051	0.051	-0.031	0.011	-0.008	-0.303	**0.700**	0.337*

*, ** Significant at 5% & 1% level of significance respectively

Residual effect= (0.645), Diagonals: Direct effect, Off diagonals: Indirect effects; **DF:**Days to 50% flowering, **DM:**Days to maturity, **PH:** Plant height (cm), **NBPP:** Number of branches per plant, **NPPP:** Number of pods per plant, **NPPC:** Number of pods per cluster, **NCPP:** Number of clusters per plant, **NSPP:** Number of seeds per pod, **HSW:** Hundred seed weight (g), **BYPP:** Biological yield (g), **HI:** Harvest index (%), **SYPP:** Seed yield per plant (g)

Table 9: Genotypic path matrix for seed yield and its attributing characters in parents

Traits	DF	DM	PH (cm)	NBPP	NPPP	NPPC	NCPP	NSPP	HSW (g)	BYPP (g)	HI (%)	SYPP (g)
DF	**-0.328**	0.105	0.267	0.363	2.073	-0.612	-1.462	-0.002	-0.263	0.206	-0.065	0.282
DM	-0.304	**0.113**	0.294	0.269	1.203	-0.737	-0.425	-0.001	-0.303	0.151	0.050	0.310*
PH (cm)	-0.137	0.052	**0.636**	-0.233	-0.521	-0.813	1.463	0.010	-0.158	0.223	-0.820	-0.297
NBPP	-0.074	0.019	-0.092	**1.618**	1.729	0.081	-2.406	-0.024	-0.255	0.282	-0.296	0.583**
NPPP	-0.176	0.035	-0.086	0.725	**3.857**	-0.284	-3.317	-0.008	-0.053	0.317	-0.276	0.733**
NPPC	-0.105	0.044	0.271	-0.068	0.575	**-1.906**	1.735	0.032	-0.591	0.051	-0.545	-0.507**
NCPP	-0.117	0.012	-0.227	0.951	3.124	0.808	**-4.095**	-0.028	0.200	0.267	-0.132	0.762**
NSPP	-0.019	0.005	-0.213	1.269	1.040	1.988	-3.637	**-0.031**	-0.255	0.030	0.580	0.755**
HSW (g)	0.149	-0.059	-0.174	-0.712	-0.356	1.947	-1.415	0.014	**0.578**	-0.108	0.043	-0.093

BYPP (g)	-0.132	0.034	0.278	0.895	2.396	-0.191	-2.143	-0.002	-0.122	**0.510**	-0.769	0.754**
HI (%)	0.021	0.005	-0.506	-0.463	-1.032	1.006	0.523	-0.017	0.024	-0.380	**1.032**	0.212

*, ** Significant at 5% & 1% level of significance respectively

Residual effect=(0.893), Diagonals: Direct effect, Off diagonals: Indirect effects;**DF:**Days to 50% flowering, **DM:**Days to maturity, **PH:** Plant height (cm), **NBPP:** Number of branches per plant, **NPPP:** Number of pods per plant, **NPPC:** Number of pods per cluster, **NCPP:** Number of clusters per plant, **NSPP:** Number of seeds per pod, **HSW:** Hundred seed weight (g), **BYPP:** Biological yield (g), **HI:** Harvest index (%), **SYPP:** Seed yield per plant (g)

Table 10: Phenotypic path matrix for seed yield and its attributing characters in crosses

Traits	DF	DM	PH (cm)	NBPP	NPPP	NPPC	NCPP	NSPP	HSW (g)	BYPP (g)	HI (%)	SYPP (g)
DF	**0.007**	0.002	0.010	-0.002	0.000	0.003	0.000	0.000	-0.003	0.032	0.040	0.088
DM	0.004	**0.004**	0.004	0.001	0.000	0.002	-0.001	0.000	-0.001	0.039	0.038	0.090
PH (cm)	0.002	0.000	**0.044**	-0.003	-0.001	0.005	0.007	0.001	-0.010	-0.271	-0.168	-0.395**
NBPP	-0.001	0.000	-0.011	**0.010**	0.002	-0.008	-0.003	0.000	0.007	0.122	0.138	0.256**
NPPP	0.000	0.000	-0.013	0.003	**0.005**	-0.024	-0.013	-0.001	0.004	0.276	0.198	0.435**
NPPC	0.000	0.000	-0.005	0.002	0.003	**-0.042**	0.011	-0.001	0.011	0.141	0.085	0.205*
NCPP	0.000	0.000	-0.011	0.001	0.002	0.017	**-0.026**	0.000	-0.007	0.149	0.136	0.262**
NSPP	0.000	0.000	0.006	0.000	0.000	0.002	0.001	**0.009**	0.001	-0.060	-0.146	-0.189*
HSW (g)	-0.001	0.000	-0.013	0.002	0.001	-0.014	0.005	0.000	**0.032**	0.113	0.158	0.283**
BYPP (g)	0.000	0.000	-0.019	0.002	0.002	-0.009	-0.006	-0.001	0.006	**0.632**	0.172	0.779**
HI (%)	0.000	0.000	-0.012	0.002	0.002	-0.006	-0.006	-0.002	0.008	0.170	**0.641**	0.799**

*, ** Significant at 5% & 1% level of significance respectively

Residual effect= (0.121), Diagonals: Direct effect, Off diagonals: Indirect effects; **DF:**Days to 50% flowering, **DM:**Days to maturity, **PH:** Plant height (cm), **NBPP:** Number of branches per plant, **NPPP:** Number of pods per plant, **NPPC:** Number of pods per cluster, **NCPP:** Number of clusters per plant, **NSPP:** Number of seeds per pod, **HSW:** Hundred seed weight (g), **BYPP:** Biological yield (g), **HI:** Harvest index (%), **SYPP:** Seed yield per plant (g)

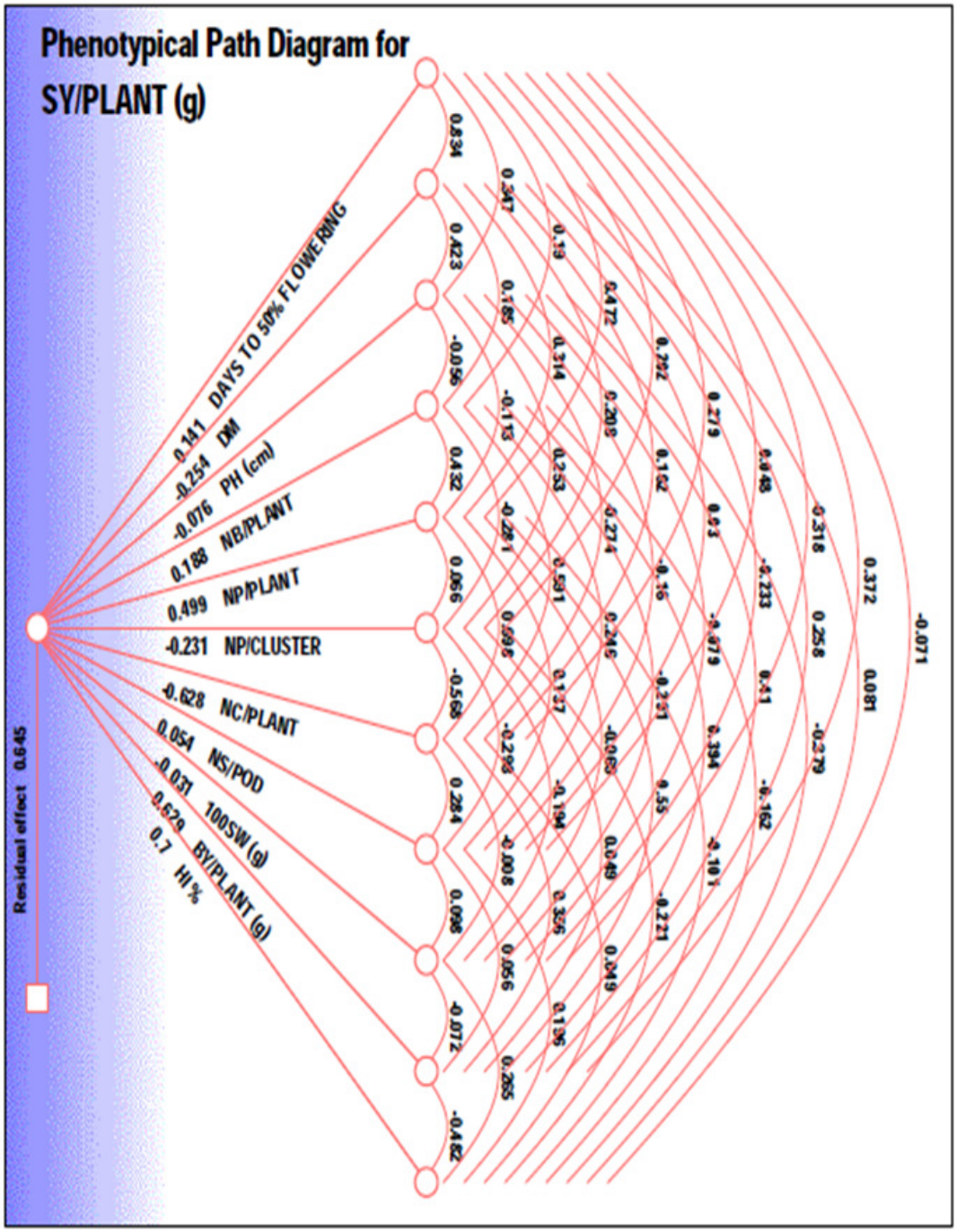
Table 11: Genotypic path matrix for seed yield and its attributing characters in crosses

Traits	DF	DM	PH (cm)	NBPP	NPPP	NPPC	NCPP	NSPP	HSW (g)	BYPP (g)	HI (%)	SYPP (g)
DF	**0.123**	-0.028	-0.040	0.023	0.002	-0.021	-0.007	-0.080	0.036	0.036	0.067	0.111
DM	0.088	**-0.039**	-0.014	-0.009	-0.001	-0.006	-0.005	0.005	-0.007	0.035	0.046	0.094
PH (cm)	0.030	-0.003	**-0.165**	0.031	0.010	-0.023	0.038	0.121	0.125	-0.336	-0.311	-0.484**
NBPP	-0.027	-0.003	0.050	**-0.103**	-0.012	0.038	-0.029	0.113	-0.106	0.182	0.134	0.238**
NPPP	-0.006	-0.001	0.050	-0.039	**-0.032**	0.093	-0.079	-0.102	-0.047	0.333	0.336	0.505**
NPPC	-0.020	0.002	0.029	-0.030	-0.022	**0.131**	0.014	-0.051	-0.160	0.217	0.192	0.302**
NCPP	0.006	-0.002	0.047	-0.022	-0.019	-0.014	**-0.131**	-0.073	0.085	0.218	0.277	0.373**
NSPP	-0.025	-0.001	-0.050	-0.029	0.008	-0.017	0.024	**0.396**	-0.083	-0.210	-0.361	-0.349**
HSW (g)	-0.014	-0.001	0.066	-0.035	-0.005	0.067	0.036	0.106	**-0.311**	0.202	0.264	0.375**
BYPP (g)	0.006	-0.002	0.076	-0.026	-0.015	0.039	-0.039	-0.115	-0.087	**0.725**	0.339	0.902**
HI (%)	0.011	-0.003	0.070	-0.019	-0.015	0.034	-0.049	-0.195	-0.112	0.335	**0.733**	0.790**

*, ** Significant at 5% & 1% level of significance respectively

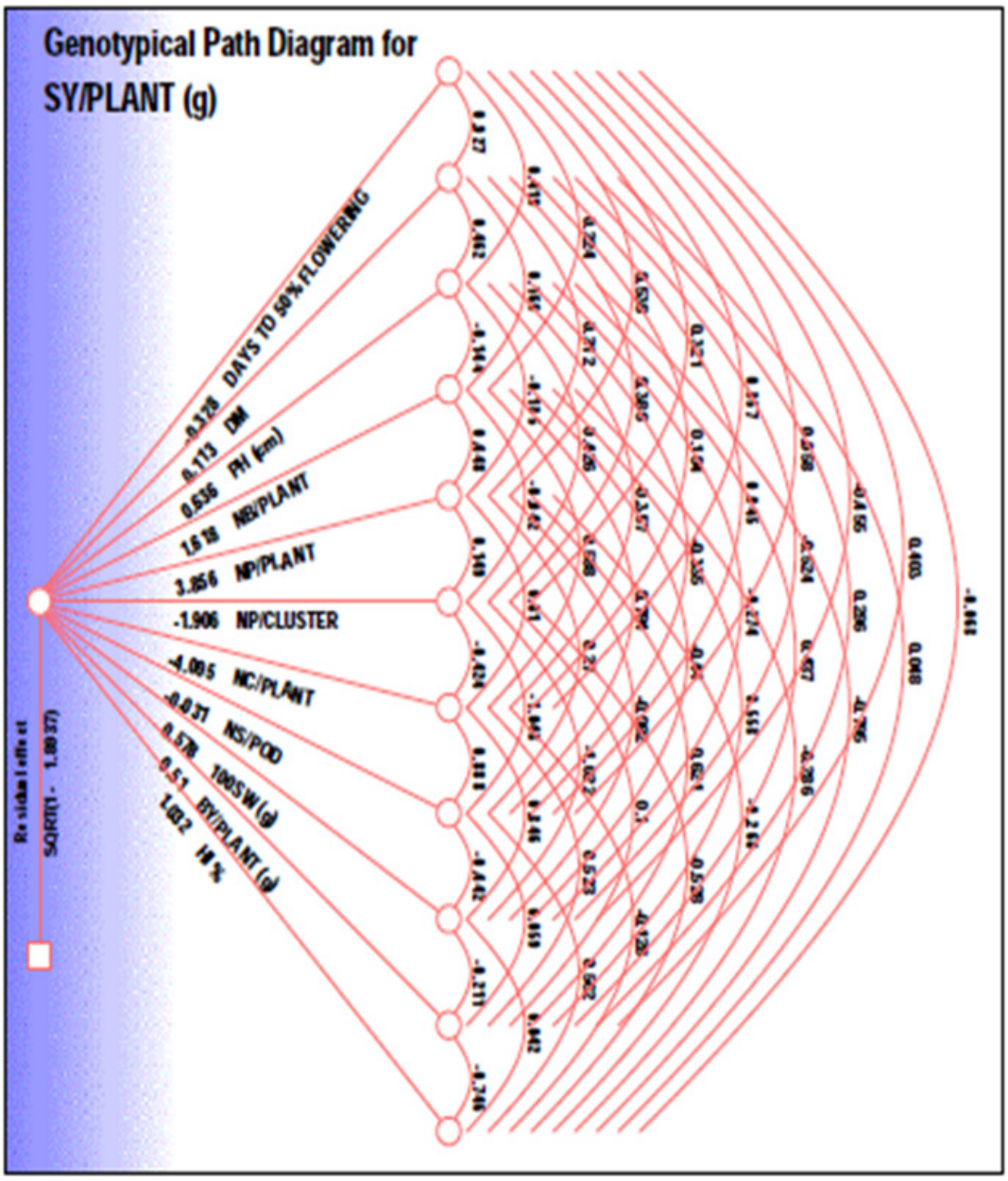
Residual effect= (0.018), Diagonals: Direct effect, Off diagonals: Indirect effects; **DF:**Days to 50% flowering, **DM:**Days to maturity, **PH:** Plant height (cm), **NBPP:** Number of branches per plant, **NPPP:** Number of pods per plant, **NPPC:** Number of pods per cluster, **NCPP:** Number of clusters per plant, **NSPP:** Number of seeds per pod, **HSW:** Hundred seed weight (g), **BYPP:** Biological yield (g), **HI:** Harvest index (%), **SYPP:**Seedyield per plant (g)

Fig. 1: Phenotypic path diagram of seed yield and yield components in parents



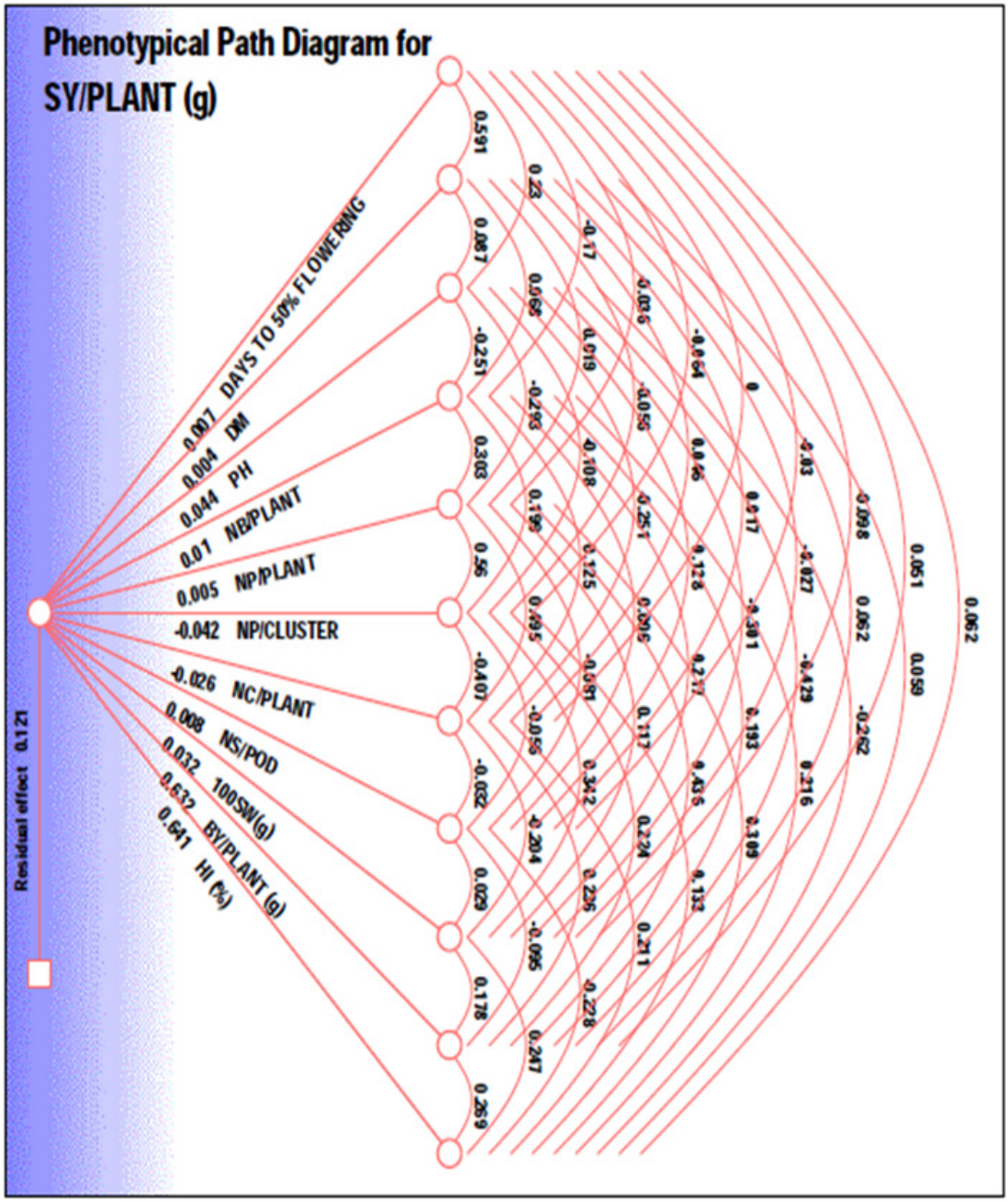
DF: Days to 50% flowering, **DM:**Days to maturity, **PH:** Plant height (cm), **NB/P:** Number of branches per plant, **NP/P:** Number of pods per plant, **NP/C:** Number of pods per cluster, **NC/P:** Number of clusters per plant, **NS/P:** Number of seeds per pod, **HSW:** Hundred seed weight (g), **BY/P:** Biological yield (g), **HI:** Harvest index (%), **SY/P:** Seed yield per plant (g)

Fig 2: Genotypic path diagram of seed yield and yield components in parents



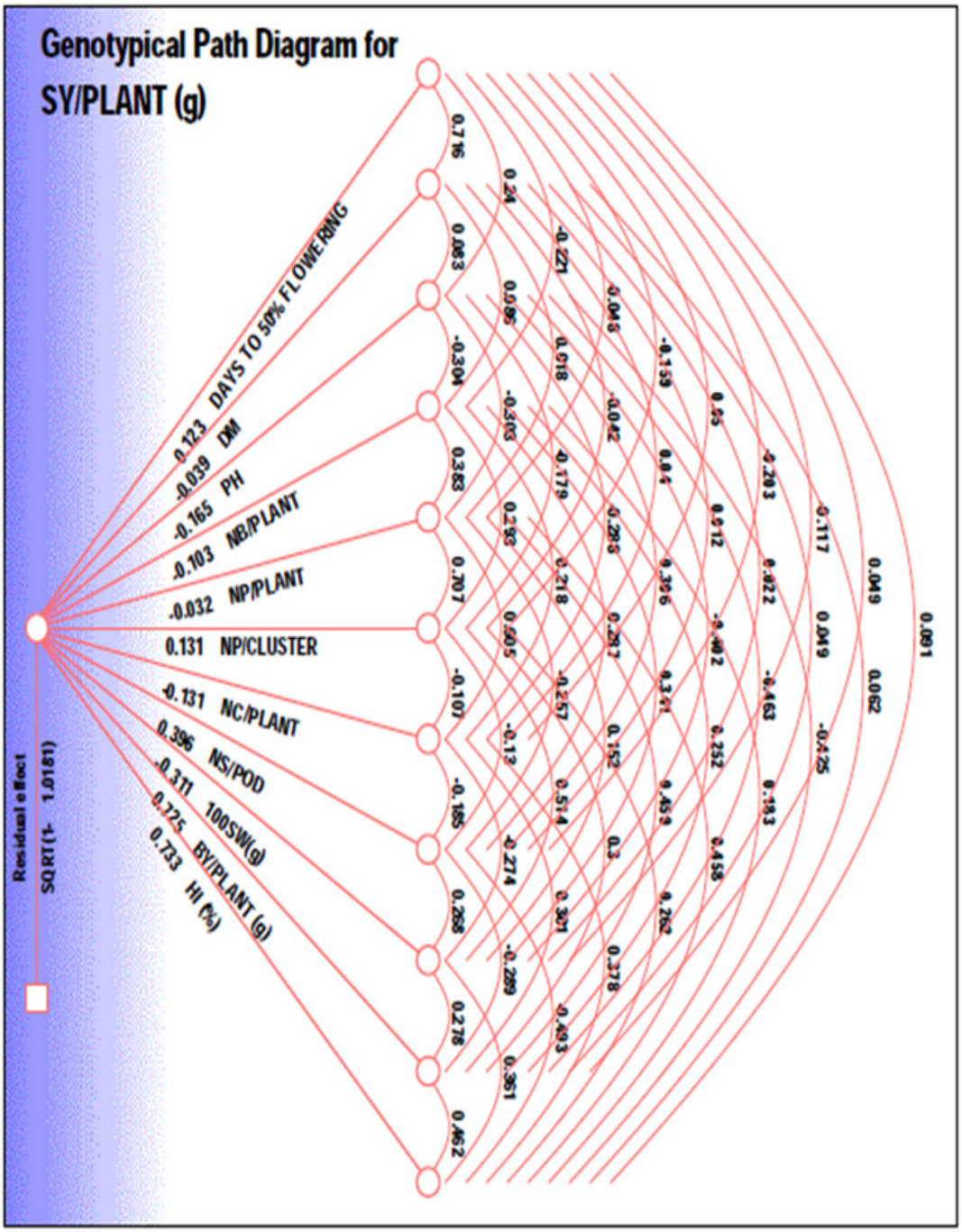
DF: Days to 50% flowering, **DM:**Days to maturity, **PH:** Plant height (cm), **NB/P:** Number of branches per plant, **NP/P:** Number of pods per plant, **NP/C:** Number of pods per cluster, **NC/P:** Number of clusters per plant, **NS/P:** Number of seeds per pod, **HSW:** Hundred seed weight (g), **BY/P:** Biological yield (g), **HI:** Harvest index (%), **SY/P:** Seed yield per plant (g)

Fig 3: Phenotypic path diagram of seed yield and yield components in crosses



DF: Days to 50% flowering, **DM:**Days to maturity, **PH:** Plant height (cm), **NB/P:** Number of branches per plant, **NP/P:** Number of pods per plant, **NP/C:** Number of pods per cluster, **NC/P:** Number of clusters per plant, **NS/P:** Number of seeds per pod, **HSW:** Hundred seed weight (g), **BY/P:** Biological yield (g), **HI:** Harvest index (%), **SY/P:** Seed yield per plant (g)

Fig. 4: Genotypic path diagram of seed yield and yield components in crosses



DF: Days to 50% flowering, **DM:**Days to maturity, **PH:** Plant height (cm), **NB/P:** Number of branches per plant, **NP/P:** Number of pods per plant, **NP/C:** Number of pods per cluster, **NC/P:** Number of clusters per plant, **NS/P:** Number of seeds per pod, **HSW:** Hundred seed weight (g), **BY/P:** Biological yield (g), **HI:** Harvest index (%), **SY/P:** Seed yield per plant (g)

References

Abbas, G., Asghar, M.J., Rizwan, M., Akram, M., Hussain, J and Ahmad, F. (2018). Genetic Analysis of Yield and Yield Components for the Improvement of Mungbean Germplasm. *Pakistan Journal of Agricultural Research*, **31**(2): 158-165.

Biradar, Kaveri, S., Salimath, P.M and Ravikumar, R.L. (2007). Genetic studies in greengram and association analysis. *Karnataka Journal of Agricultural Science*, **20**(4): 843-844.

Chattopadhyay, N., Ghosh, T., Sinha, S., Chattopadhyay, K., Karmakar, P. and Ray, B. 2010. Polysaccharides from Turbinaria conoides: Structural features and antioxidant capacity. Food Chem. **118**:823-829.

Dahiya, P.K.; Linnemann, A.R., van Boekel, M.A.J.S., Khetarpaul, N., Grewal, R.B and Nout, M.J.R. 2015.Mung bean: Technological and nutritional potential. *Crit. Rev. Food. Sci. Nutr.* **55**, 670–688.

Dewey, D.R and Lu, K.H. (1959). A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy Journal*, **51**: 515-518.

Gupta, S., Kumar, S. and Singh, B.B. (2004). Relative genetic contributions of ancestral lines to Indian mungbean cultivars based on coefficient of parentage analysis. *Indian J. Genet.* **64**: 299-302.

Khanpara, M.D., Vchhani, J.H., Jivani, L.L., Jethava, A.S and Vaghasia, P.M. (2012). Correlation and path co-efficient analysis in greengram (*Vigna radiata* (L.) Wilczek). *Asian Journal of Biological sciences*, **7**(1): 34-38.

Kim, S.K., Nair, R.M., Lee, J., Lee, S.H. (2015). Genomic Resources in Mungbean for Future Breeding Programs. *Front. Plant Sci.* **6**, 626.

Kritika and Yadav, R. (2017). Correlation and Path Coefficients Analysis for Seed Yield and Micronutrients in Mungbean (*Vigna radiata* (L.) Wilczek). *Int. J. Pure App. Biosci,* **5**(1): 908-917.

Kumar, K., Prasad, Y., Mishra, S.B., Pandey, S.S., Kumar, R. (2013). Study on Genetic Variability, Correlation and Path Analysis with Grain Yield and Yield Attributing Traits in Green Gram [*Vigna radiata* (L.) Wilczek]. *Bioscan* **8**, 1551–1555.

Manivelan, K., Karthikeyan, M., Blessy, V., Priyanka A.R., Palaniyappan, S. and Thangavel, P. (2019). Studies on correlation and path analysis for yield and yield related traits in greengram [*Vigna radiata* (L.) Wilczek]. *The Pharma Innovation Journal*, **8**(9): 165-167.

Mubarak, A.E. (2005). Nutritional Composition and Antinutritional Factors of Mung Bean Seeds (*Phaseolus aureus*) as Affected by Some Home Traditional Processes. *Food Chem.* **89**, 489–495.

Nair, R. and Schreinemachers, P. (2020). Global Status and Economic Importance of Mungbean. In The Mungbean Genome; Springer: Cham, Switzerland, pp. 1–8.

Narasimhulu, R., Naidu, N.V., Reddy, K.H.P., Rajan, C.P.D., Mohan, N.G. and Shanthi, P.M. (2014). Genetic variability, character association and path coefficient analysis for yield attributes in mungbean (*Vigna radiata* (L.) Wilczek). *Research Journal of Agricultural Sciences*, **5**(3):547-550.

Ramesh, R.N.B., Lad, D.B and Mukhekar, G.D. (2005). Correlation and path analysis studies in greengram. *Journal of Maharashtra Agricultural Universities*, **30**(2): 156-159.

Sandhu, K. and Singh, A. (2021). Strategies for the Utilization of the USDA Mung Bean Germplasm Collection for Breeding Outcomes. *Crop Sci*. **61**, 422–442.

Sarkar, M., Sanhita Ghosh, S. and Kundagrami, S. (2014). Genetic Variability and Character Association of Yield and Yield Components in Mungbean [*Vigna radiata* (L.) Wilczek]. *Journal of Agroecology and Natural Resource Management*, **1**(3): 161-165.

Sarobol, N. (1997). Mungbean: Past, present and future. In: Proceedings of the National Mungbean Research Conference VII held at Golden Grand Hotel, Thailand, 2-4 December 1997, pp: 1-20.

Shanthala, J., Latha, J., Shailaja, H. (2004). Path coefficient analysis for grain yield with yield components in hybrid rice. *Environ. Ecol*. 22(4):734-6.

Souframanien, J. and Gopalakrishnan, T. (2004). A comparative analysis of genetic diversity in black gram genotypes using RAPD and ISSR markers. *Theoretical Appl. Genet*. **109**:1687-1693.

Sreedevi and Sekhar, M.R. (2004). Character association and path analysis of morphological attributes in greengram [*Vigna radiata* (L.) Wilczek]. *Annuals of Agricultural Research*, 25: 149-152.

Srinives, P. (2006). Research direction and legume crop development. In: Proceedings of the National Legume Crop Research Conference I, held at Rimkok Resort Hotel, Chiang Rai, Thailand, August 2006, pp: 389.

Tantasawat, P.A., Khajudparn, P., Prajongjai, T., Poolsawat, O. (2015). Heterosis for the improvement of yield in mungbean [*Vigna radiata* (L.) Wilczek]. *Genet. Mol. Res.* **14**, 10444–10451.

Tiwari, A., Mishra, S. P and Nag, S.K. (2014). Genetic Variability, Heritability and Genetic Advance Studies for Yield and Its Components in Mungbean [*Vigna radiata* (L.) Wilczek]. *Trends in Biosciences*, **7**(1): 00-00,.

Verma, P. and Garg, D.K. (2007). Correlation and path coefficient studies in Mungbean (*Vigna radiata* (L.) Wilczek). *Journal of Arid Legume*, **4**(2):88-91.

Wamanrao, A.N., Kumar, V., Meshram, K.D. (2020). Correlation and path coefficient analysis of grain yield and its growth components in soybean (*Glycine max*. L.). *Int. J. Curr. Microbiol. App. Sci.* **9**(3):2445-51.