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Full Length Research Article

Study of genetic divergence based on association among yield components in Mungbean (*Vigna radiata L.*)

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Abstract

Mung bean is a very important crop because it is used as food for humans and feed for the animals. The experiment was conducted to get the plants having uniform maturity and better yield estimate. For this we had studied the direct, indirect effects and correlation coefficient between different traits in 30 genotypes of mung bean. Plant height shows maximum heritability followed by Total Biomass and Seed yield per plant. These traits also had significant relationship with yield. Plant height (PH) had maximum genotypic association followed by harvest index (HI) and 100 seed weight (SW). Number of seeds per plant (NS) and HI had positive while PH, number of branches per plant(NB), Total biomass (TBP) number of pods per plant (NP), SW and had negative direct effect on yield in path coefficient analysis. SW, TBP, NP, NB had positive indirect effects. So, we can use NS, HI, SW, TBP, NP, NB in selection in breeding program for increasing the yield.

Key words: Correlation coefficient, Path Coefficient analysis

Introduction

Vigna radiata belongs to family Leguminosae comprises 150 species (Faris, 1824) out of which only 7 are cultivated. It is thought that it is native to the to India and Central Asia because it has been Cultivated here since 2200 BC (Jain and Mehra, 1980.). Then it has distributed to other Asian countries, Northern Africa, and recently sub-tropics of Africa, North America and Australia. The average days to flowering 45 (range 39-57), Average days to maturity 64 (range 54 to 80), plant height varied between 47 to 105 cm, pods number/plant from 4 to 22, seeds number/pod from 8.5 to 13.0, 1000-seed weight from 32 to 72 g and seed yield from 31 to 136 kg/ha (average 93 kg/ha) Choi et al. (1986). It contains 25-28% protein (Rachie and Roberts, 1974.) 3.5-4.5% fiber, 5.5% ash, 1.5% oil and 62-65% carbohydrate (Tsou and Hsu, 1978.). Digestibility of protein and carbohydrates is great which exhibits its good nutritional quality. In Pakistan, it cultivated on about 146 thousand hectares with 102 thousand tons of production (Economy Survey of Pakistan, 2016-17) which is less as compared to other Vigna radiata cultivated countries. Many biotic and abiotic factors are responsible for its lower yield in Pakistan. Verities with higher adaptability and greater yield are required to increase its production per unit area. Seed yield can be improved by improving the related traits having positive effects on yield.

Different experiments were conducted to calculate variations, direct-indirect effects, correlation and heritability of different phenotypic and genotypic traits to increase the production per unit area by selecting the traits having positive relation with yield. Correlation co-efficient (r) showed the association between characters and their relationship with yield. This further helps in calculating the direct and indirect effects of traits on yield.

Materials and Methods

Seed of 30 different mung bean genotypes had taken from germplasm of department and were sown in research area of Department Plant breeding and Genetics at university of Agriculture Faisalabad. The seeds were sown according to Randomized Complete Block Design (RCBD). Plant to plant distance was 30 cm and Row to row distance was 60 cm. The response of different genotypes was studied on the basis of different morphological traits i.e. Plant height (PH)(cm), Number of branches per plant (NB), Number of Pods per Plant (NP), number of seeds per plant (NS), 100- seed weight (SW)(g), Seed yield per plant (SY)(g), Pod length (PL)(cm), Total biomass of plant (TBP)(g), Harvest index (HI)(g).

Statistical analysis

Data of all the traits was analyzed for variance according to (Steel *et al.*, 1997). The correlation values among different characters were calculated according to method proposed by (Kown and Torrie., 1964). Path analysis was performed according to formula of (Dewey and Lu., 1959). Heritability was calculated by the formula of (Burton and Devan., 1953).

Result and discussion

Plant Height (PH)

Plant height is varied from 61 to 47 cm shown in table 1. Maximum and minimum height was found in NCM-257-10 and NM-046 respectively. Its genotypic and phenotypic coefficient of variances are 6.2 and 6.7 respectively. The heritability index of plant height is 90.5 The results are compatible to the results of with (Sinha et al., 1996), (Islam et al., 1999) and (Gill et al., 2000) who reported high heritability for plant height but differ from (Loganathan et al., 2001). They have shown the high heritability % in their results.

Correlation analysis showed significant and positive relationship with NB but had positive and non-significant association with the harvest index at both phenotypic and genotypic level as show in **table** 2 and 3. Remaining all traits showed significant but negative correlation at both levels. These results were compatible with (Pundir *et al.*, 1992), (Kumar *et al*., 2004) and (Dobhal and Rana., 1997). but these results were opposite to the results of (Yohe and Poehlman., 1975) and (Mishra and Yadav., 1992).

Path analysis showed that PH had a negative direct effect on yield but had positive indirect effects through PH, NP, SW, PL, TBP, HI but have negative indirect effect through BP, NS show in table 4. These results were related to the result of (Rehman *et al*.,1996) but these results were opposite to (Mishra and Yadav., 1992).

Number of branches per plant (NB)

Number of branches varied from to 7.52.to 12.27 shown in table 1. The value of phenotypic coefficients was 11.63 and genotypic coefficients were 12.38 and the value of Heritability estimates was 88.25% with genetic advance 2.19. The results were compatible with (Gill *et al*., 2000), (Singh 2004), (Neha *et al*., 2005), (Kapoor *et al*.,2005), (Khan *et al*., 2005), (Hakim *et al*.,2006), (Idrees *et al*.,2006), (Tadele *et al*., 2006).

Correlation analysis showed that it has negative but highly significant relation with all the traits except HI which had negative and non-significant relation (Table 2 and 3). And these results were compatible with the results of (Kumar *et al., 1995)* and (Muppidathi *et al.,* 1995) and but the results were opposite to (Naseem *et al.,* 1995) result.

Path analysis showed that NB had negative direct effect on yield but had a positive indirect effect through NP, SW, PL and TBP but have a negative indirect effect through PH, NS and HI as shown in table 4**.** These results were similar to the results of Khan (1987).

Number of pods per plant (NP)

Number of pods per plant varied from 21.52 to 15.6 shown in table 1**.** The maximum pods per plant was obtained by E-96 and minimum value showed by D 173-B-10. The value of phenotypic coefficients was7.54% and genotypic coefficients were 6.49%, and the value of Heritability estimates was 74.09% with genetic advance 2.14. The results were compatible with other scientists (Singh, 2004; Neha *et al*., 2005; Veerasmani *et al*., 2005; Khan *et al*., 2005; Hakim *et al*., 2006; Idrees *et al*., 2006; Tadele *et al*., 2006 and Gul *et al*., 2007).

Correlation analysis shown that it has negative but highly significant relation with PH, NP, and remaining all of traits shown highly significant and positive relation table 2 and 3. And these results were compatible with the results of Yohe and Poehlman (1975), Malik and Singh (1983), Kumani *et al*. (1985), Sadiq *et al*. (2005), while the results were opposite to Dhuppe *et al*. (2005).

Path coefficient analysis shown that NP had negative direct effect on yield. But the results are not according to the findings of Pundir *et al*. (1992), Khattak *et al.* (1997), Kalpande *et al*. (1997) and Dobhad and Rana (1997) who reported positive direct effect on yield. These had a positive indirect effect for PH, NB, NS, HI while negative indirect effect for SW, PL, TBP as shown in table 4 And the result were similar to the result of Malik *et al.* (2007).

Number of seeds per pod (NS)

Number of seed varied from 13.22 to 7.41 shown in table 1. The maximum number of seeds per plant were obtained by D 173-B-10 (13.25 seeds/pod) and minimum value showed by NM 46-5-2-21 (7.40 seeds/pod). The value of phenotypic coefficients was 6.64%, and genotypic coefficients were 16.52 and the value of Heritability estimates was 83.83% with genetic advance 2.83. The results were compatible with Neha *et al*. (2005), Veerasmani *et al*. (2005), Khan *et al*. (2005), Hakim *et al*. (2006), Idrees *et al*. (2006), Tadele *et al,* (2006) and Gul *et al*. (2007).

Correlation analysis shown that it has negative but highly significant relation with PH, BP. And remaining all of traits had positive and highly significant relation with HI B table 2 and 3. And these results were compatible with the results of Naseem *et al.* (1995), Haris *et al.* (1998) and Saleem *et al.* (1999) but were in contrast according to the finding of Sadiq *et al*. (2005).

Path coefficient analysis shown that SP had positive direct effect on yield and Positive indirect effects of SP on yield were observed through PH, NB, HI while NP, SW, PL and TBP showed negative indirect effect shown in table 4 And the results were similar to the result of Khan (1987) and Reddy *et al*. (1994).

100 seed weight (g) (SW)

100 seed weight varied from 4.33g to 3.03g shown in **table** 1**.** The 100-SW, genotypes NCM 255-2 and E-96 showed the maximum values and the l00-SW, genotype D 173-B-10 shown the minimum value. The value of phenotypic coefficients was 6.33%, and genotypic coefficients were 11.52 and the value of Heritability estimates was 70.56% with genetic advance 0.83. The results were compatible with the results of Arshad *et al*. (2004), Jagadeesan *et al*. (2008) and Tah (2009).

Correlation analysis shown that it has positive but highly significant relation with all the trait except PH, NB table 2 and 3. These results were compatible with the results of Rani and Rao (1981), Verma. (1992) and Mahto and Mahto (1997) but the results were opposite to the results of Gill *et al*. (2000) and Kumar *et al*. (2003).

Path coefficient analysis shown that 100-SW had negative direct effect on yield and The results were compatible with the results of Bhandari (1991) and Pundir *et al*. (1992), and positive indirect effects on yield through PH, NB, SP, HI and the results were compatible with the results of Khattak *et al*. (1997), Byregowda *et al*. (1997) and Negative indirect effects through NP, PL and TBP (table 4).

Seed yield per plant (SY)

According to table 1 seed yield is varied from 7.8 -13.36 g. the maximum yield was shown by NM-3960 -88-31 and minimum yield was shown by D 173-B-10, The value of phenotypic coefficient was 15.4 and of genotypic coefficient was 14.4. The value of heritability was 89.7 %. These results are compatible with the results of Sinha *et al*. (1996), Islam *et al*. (1999) and Gill *et al.* (2000).

Correlation analysis showed positive relationship with all considered traits but it shows the negative relationship with PH and NB. Both were significant at phenotypic and genotypic level table 2 and 3. These results were compatible with the results of Naseem *et al*. (1995), Haris *et al*. (1998) and Saleem *et al*. (1999) but opposite to the results of Sadiq *et al*. (2005).

Pod length (PL)

Pod length varied from 7.2-9.2 cm as shown in table 1. The value of phenotypic variance was 6.8 and of genotypic variance was 4.9. The value of heritability was 51.42% with 0.6 genetic advance. These results were compatible with Arshad *et al*. (2004), Neha *et al*. (2005), Veerasmani *et al*. (2005), Kapoor *et al*. (2005), Khan *et al*. (2005), Hakim *et al*. (2006), Tadele *et al*. (2006) and Gul *et al.* (2007). Their results also shown high heritability.

Correlation analysis showed positive relationship with all considered traits except PH and NB. Both were significant at genotypic and phenotypic level as shown in table 2 and 3. These results were compatible with Holkar and Raut (1992), Pundir *et al*. (1992) and Mishra *et al*. (1995). Path analysis showed that PL had negative indirect effects on yield but had positive indirect effects through PH, NB, NS had HI but have negative indirect effects through SW and TBP as shown in table 4**.** These results were similar to the results of Kar *et al*. (1995) and Solanki (2006).

Total biomass of plant (TBP)

Total biomass of plant was varied 122.3-144 g as shown in table 1. The minimum value was shown by NM 46-5-2-11 and maximum by NM 046.The value of genotypic variance was 4.4 and of phenotypic variance is 4.60. The value of heritability index was 90.4% with 11.6. This result was similar to the result of Sinha *et al*. (1996), Islam *et al*. (1999) and Gill *et al*. (2000) who reported high heritability and genetic advance for plant height but differ from Loganathan *et al*. (2001).

The correlation analysis showed that it had negative and non-significant result with NB and HI and positive but non-significant with PH at both levels (genotypic and phenotypic) as shown in table 2 and 3. Except these traits all other traits had positive and significant relationship. These results were parallel to the results of Arshad *et al*. (2004).

According to path analysis TBP had negative direct effect on seed yield. It had positive indirect effect through PH, NB, HI and NS but had negative effect through NP, SW, and PL as shown in table 4**.** These results were corresponding to the results of Makeen *et al*. (2008).

Harvest index (HI)

HI was ranged from 7.6 to 10.86% table 1**.** The minimum value showed by D 173-B-10 and maximum by NCM 257-10. The value of genotypic variance was 14 and of phenotypic variance was 15. The heritability index was 88 with 2.18 genetic advance. These results confronted the results of with Arshad *et al*. (2004), Neha *et al*. (2005), Veerasmani *et al*. (2005), Kapoor *et al*. (2005), Khan *et al*. (2005), Hakim *et al*. (2006), Tadele *et al*. (2006) and Gul *et al*. (2007).

In correlation analysis, it showed positive relationship with all traits except TBP and NB which had negative but nonsignificant relation. HI had positive and non-significant at both levels (phenotypic and genotypic) table 2 and 3. These results were similar to yhe results of Holkar and Raut (1992), Pundir *et al*. (1992) and Mishra *et al*., (1995).

Path analysis showed that it had positive direct effect on yield. It also had positive indirect effect through NB and NS and had negative indirect effect through SW, PH, TBP and PL (table 4). These results were compatible to the results of Khattak *et al*. (1997) and Byregowda *et al*. (1997) and opposite to Bhandari (1991) and Pundir *et al.* (1992).

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Table 1. Mean Values of all Studied Parameters

Sr. No	Genotype	PH	NB	NP	NS	SW(g)	SY(g)	PL	TBP(g)	HI%
1	NCM 255-2	59.6	11.3	16	10.09	4.3533	13.663	7.9267	127.4	10.723
2	NCM 257-3	58.133	10.4	17.33	11.067	3.4	9.513	8.0367	125.62	7.57
3	NCM 257-10	61.693	11.367	19.47	10.533	3.3	13.523	8.0867	124.47	10.86
4	NCM 258-10	55	10.5	16.52	8.86	3.11	8.517	7.16	131.68	6.47
5	NM-06	57.233	10.453	19.04	9.2	3.0733	10.73	8.1767	126.34	8.49
6	D 173-B-10	60.767	12.273	15.6	13.253	3.04	7.763	7.8533	123.09	6.307
7	11-2	54.8	10.103	18.8	8.907	3.09	9.133	7.59	131.76	6.93
8	4-Aug	51.5	9.067	19.9	12.8	3.6067	11.503	8.0567	134.56	8.55
9	97019	50	8.567	18.53	10	3.1633	11.31	8.0667	141.59	7.99
10	C2-94-4-36	53.867	9.367	19.27	11.967	3.3433	9.783	7.9533	133.39	7.333
11	C2-94-3-11	52.8	9.083	19.47	10.867	3.6233	11.533	7.99	137.56	8.383
12	207	53.733	9.223	18.87	9.367	3.33	11.11	7.7233	134.59	8.257
13	10-10.	53.3	9.367	18.53	9.967	3.2433	10.937	8.2333	138.19	7.917
14	6163-B-4	50.667	8.733	19.13	10.167	3.6167	11.957	8.4967	136.56	8.76
15	E-96	50.8	8.423	21.52	11.877	4.0633	13.71	9.1033	134.59	10.183
16	E-136	53.933	8.667	18.47	9.967	3.28	9.03	7.2767	136.92	6.603
17	E-136	55.933	9.717	18.5	9.163	3.3367	9.027	7.6333	129.3	6.977
18	NM 46-5-2-15	53	8.543	20.17	11.397	3.9133	12.123	8.2767	137.7	8.803
19	NM 04-2-38	57.533	11.203	18.43	8.6	3.1767	10.667	7.77	127.1	8.393
20	NM 05-1-2	58.527	11.22	18	8.167	3.1367	10.053	7.6233	125.87	7.987
21	NM 46-5-2-11	57.233	10.667	18.87	8.267	3.21	10.44	7.6767	122.27	8.54
22	NM 9800	57.67	10.493	18.23	7.693	3.0967	9.64	8.3033	123.83	7.783
23	NM 046	47.653	7.55	18.83	9.567	3.3033	10.04	8.05	144	6.977
24	NM 1-32-1	54.073	9.317	18.63	9.223	3.31	11.2	8.2533	132.13	8.477
25	NM 3960-88-31	47.693	7.523	21.5	13.067	4.3367	13.72	9.2433	142.1	9.653
26	NM 6-68-2	55.793	10.107	17.93	8.767	3.1833	9.443	7.9167	128.61	7.343
27	NM 46-5-2-21	55.733	10.08	17.7	7.4	3.1033	9.447	8.2433	127.13	7.43
28	NM 05-1-7	54.413	9.407	18.37	8.633	3.2867	9.037	8.6433	131.5	6.887
29	NM 04-3-1	54.673	9.94	18.53	9.09	3.1367	10.157	8.49	131.2	7.743
30	NM 36-15-3	50.963	8.597	18.7	9.267	3.25	10.847	8.29	136.83	7.93

Table 2. Genotypic Correlation related to Yield

	PH	NB	NP	NS	SW	SY	PL	TBP	HI
PH									
NB	0.97^{**}								
NP	-0.63^{**}	-0.72^{**}							
NS	-0.26^{*}	-0.25^{*}	0.31^{**}						
SW	-0.36^{**}	-0.41^{**}	0.44^{**}	0.57^{**}					
SY	-0.27^{*}	-0.32^{**}	0.61^{**}	0.37^{**}	0.82^{**}				
PL	-0.49^{**}	-0.5^{**}	0.67^{**}	0.33^{**}	0.54^{**}	0.64^{**}			
TBP	-0.93^{**}	-0.93^{**}	0.52^{**}	0.34^{**}	0.38^{**}	0.31^{**}	0.32^{**}		
HI	0.03^{NS}	-0.04^{NS}	0.47^{**}	0.27^{*}	0.73^{**}	0.96^{**}	0.53^{**}	0.004^{NS}	

Table 3. Phenotypic correlation with yield

	PH	NB	NP	NS	SW	SY	PL	TBP	HI
PH									
NB	0.92**								
NP	-0.55**	-0.6**							
NS	-0.24*	-0.24*	0.33**						
SW	-0.3**	-0.36**	0.41**	0.55**					
SY	-0.24*	-0.28**	0.55**	0.35**	0.70**				
PL	-0.36**	-0.39**	0.46**	0.32**	0.47**	0.46**			
TBP	-0.9**	-0.87**	0.46**	0.32**	0.34**	0.278**	0.260*		
HI	0.04NS	-0.014NS	0.42**	0.25*	0.61**	0.95**	0.39**	-0.03NS	

Table 4. Direct and Indirect effects of yield related traits

	PH	NB	NP	NS	SW	PL	TBP	HI	SY (rg)
PH	-0.11	-0.52	0.17	-0.04	0.08	0.03	0.10	0.03	-0.3
NB	-0.12	-0.51	0.18	-0.04	0.07	0.03	0.10	-0.05	-0.3
NP	0.06	0.40	-0.31	0.04	-0.08	-0.06	-0.06	0.57	0.6
NP	0.02	0.13	-0.08	0.15	-0.12	-0.02	-0.05	0.31	0.4
SW	0.03	0.22	-0.12	0.08	-0.19	-0.04	-0.04	0.88	0.8
PL	0.05	0.30	-0.16	0.06	-0.11	-0.08	-0.03	0.66	0.7
TBP	0.12	0.50	-0.14	0.04	-0.08	-0.03	-0.11	0.005	0.3
HI	-0.003	0.03	-0.12	0.05	-0.15	-0.04	-0.0004	1.2	0.96