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Correlation, direct and indirect effect on yield and yield contributing characters in moth bean [*Vigna aconitifolia* (Jacq.)]

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Abstract
A field experiment entitled "Genetic diversity in moth bean [*Vigna aconitifolia* Jacq.)] was conducted at Agricultural Botany Research Farm, College of Agriculture, Pune during *Kharif* 2018. 30 genotypes were obtained from Dry and Agricultural Research Station, Solapur. The experiment carried out in randomized block design with three replications. The seed yield per plant showed significant and positive relationship with peduncle length followed by number of clusters per branch, number of seeds per pod, secondary branches per plant and primary branches per plant at the genotypic level. The seed yield per plant showed significant and negative correlation with days to 50 per cent maturity (-0.2843) and days to maturity (-0.4161). In present study, the character peduncle length showed highest direct positive effect on seed yield per plant followed by secondary branches per plant, clusters per branch, days to 50 per cent flowering, seeds per pod (0.1315). Thus, direct selection for these traits will be beneficial in yield improvement programme.

Keywords: moth bean, correlation coefficient, path analysis

Introduction
As we know that main objective of any breeding programme is high yield. It is ultimate criteria which plant breeder has always to keep in view. Yield is a complex character and is governed by a polygenic system. Also, it is influenced by fluctuations in the environment. Hence, selection of plants that is based directly on yield would not be very reliable in many cases. A study was therefore, conducted to find out the degree and nature of association between yield and its components. Moth bean plant is normally bushy to semi erect with large number of leaves and short stem; it is deep rooted, drought tolerant plant. The average temperature requirement for growth and development of the crop is 25-30 ^{0}C, but has been shown to tolerate up to 45 ^{0}C during the day. Bright sunshine and normal humidity are considered good for growth and high yield. Crop can be grown successfully in sandy loam of soil with low to moderate fertility. While, optimal annual rainfall for production is 500-750 mm, it is able to grow with 200-300 mm annually, and some yield has been noted at rainfall level as low as 50-60 mm per year.
According to De Candolle (1884) [4], Vavilov (1926) [21, 22] and Jain and Mehta (1980) [7] moth bean is originated in India. Plateau of central India is considered as its primary centre of origin. India has major area under moth bean cultivation in the world. It is also grown in Pakistan, Sri Lanka, Malaysia, Myanmar, South China and United States of America (USA). In India, moth bean is mainly grown in Rajasthan which contribute about 75 per cent of total area and production in the country. Other important states for cultivation of moth bean are Maharashtra, Gujarat, Jammu & Kashmir and Punjab.

Materials and Methods
The present investigation was carried out at Agricultural Botany Research Farm, College of Agriculture, Pune during *Kharif* 2018. The experiment was laid down in a Randomized Block Design with three replications. The experimental material with 30 genotypes of Moth bean collected from Dry land Agricultural Research Station, Solapur. The spacing between rows was 30 cm and plants were 15 cm. Plot consist of 1 row of 4.5 meters length each. Data were collected for 12 characters *viz*. days to 50 per cent flowering, days to maturity, plant height, primary branches per plant, secondary branches per plant, pod length, peduncle length, clusters per branch, seeds per pod, 100 seed weight, seed yield per plant and protein content. The genotypic coefficient of variation were calculated as per suggested by Burton (1952) [3] and path coefficient for yield and yield contributing characters Dewey and Lu, (1959).

Table 1: List of 30 genotypes of moth bean

Sr. No.	Genotypes	Sr. No.	Genotypes	Sr. No.	Genotypes	Sr. No.	Genotypes
1.	MBS-1	9.	MBS-13	17.	MBS-23	25.	MBS-34
2.	MBS-2	10.	MBS-14	18.	MBS-24	26.	MBS-35
3.	MBS-4	11.	MBS-15	19.	MBS-25	27.	MBS-36
4.	MBS-6	12.	MBS-16	20.	MBS-26	28.	MBS-37
5.	MBS-8	13.	MBS-17	21.	MBS-27	29.	MBS-38
6.	MBS-9	14.	MBS-19	22.	MBS-28	30.	MBS-39
7.	MBS-10	15.	MBS-21	23.	MBS-29		
8.	MBS-11	16.	MBS-22	24.	MBS-30		

Results and Discussion

Correlation

The seed yield per plant showed significant and positive relationship with peduncle length (0.8774) followed by number of clusters per branch (0.6542), number of seeds per pod (0.3247), secondary branches per plant (0.2621) and primary branches per plant (0.2525) at the genotypic level. The seed yield per plant showed significant and negative correlation with days to 50 per cent maturity (-0.2843) and days to maturity (-0.4161). Similar results were reported by Mistra (1975) [13]; Jindal and Vir (1983) [8]; Kakani *et al.* (2002) [9]; Kakani *et al.* (2003) [10]; Parmeshwarappa and Salimath (2007) [15] and Patil *et al.* (2007) [16].

In the association between component characters, days to maturity, pod length, peduncle length, number of seeds per pod, pod length, number of clusters per branch and protein content were significant and positively correlated with each other. The findings of Kakani *et al.* (2002) [9] were similar to these results. Bhavsar and Birari (1989) [2] observed positive correlation of yield per plant with all the characters of moth bean except 100 seed weight. The correlation coefficients were highly significant for the days to maturity, number of primary branches, plant height, number of clusters per branch, number of pods per cluster, number of seeds per pod, and number of pods per plant. Singh *et al.* (2009) [19] reported that seed yield per plant exhibited positive association with days to 50 per cent flowering at genotypic and phenotypic correlation level in mung bean. Tabasum *et al.* (2010) [20] revealed a positive significant genotypic and phenotypic correlation of seed yield with pods per plant, total plant weight and harvest index but negative correlation with pods per cluster. Kumar *et al.* (2016) [11] reported that seed yield per hectare had positive correlation with number of pods per plant, while rest of the traits it had negative correlation with seed yield per hectare. Dhoot *et al.* (2017) [5] revealed that seed yield was significantly and positively correlated with pods per plants and harvest index in F_2 population of Meha × Pusa Vishal and with plant height, primary branches per plant, cluster per plant, pods per plants, and straw yield per plant and harvest index in F_2 population of Meha × Pusa Vishal in mung bean.

Path analysis

In present study, the character peduncle length (0.8165) showed highest direct positive effect on seed yield per plant followed by secondary branches per plant (0.3686), clusters per branch (0.2141), days to 50 per cent flowering (0.1405), seeds per pod (0.1315) and plant height (0.0392) given in (Table No. 3) Thus, direct selection for these traits will be beneficial in yield improvement programme. The characters 100 seed weight (-0.0754), pod length (-0.2185), days to maturity (-0.2783), primary branches per plant (-0.3377) and protein content (-0.3774) showed negative direct effect on seed yield per plant. Similar results were observed by Naidu *et al.* (1986) [14]; Malik *et al.* (1987) [12]; Bhavsar and Bihari (1989) [2]; Patil *et al.* (2007) [16]; Tabasum *et al.* (2010) [20]; Alom *et al.* (2014) [1]; Hemavathy *et al.* (2015) [6] and Kumar *et al.* (2016) [11]. Thus, from the above results it becomes clear that direct selection based on peduncle length, number of primary branches per plant, number of secondary per plant, days to maturity and number of seeds per pod can help in the improvement of seed yield in moth bean.

The yield component *viz.*, plant height recorded magnitudinally low direct effect but positively correlated with seed yield per plant and indirectly contributed towards seed yield.

These results were disagreements with the results of Parmeshwarappa and Salimath (2007) [15] for plant height; Alom *et al.* (2014) [1] for plant height. Kakani *et al.* (2002) [9] reported that that the number of clusters per plant and number of pods per cluster had the highest positive direct effect, whereas, the number of days to maturity had the greatest direct negative effect on seed yield in moth bean. The number of clusters per plant and number of pods per cluster were the most important criteria for selection for higher fodder yield. Ramakrishnan *et al.* (2018) [17] carried out path analysis in mung bean and suggested that pod yield per plant had very high positive direct effect followed by high positive direct effect of number of pods per plant and number of clusters per plant on seed yield per plant. Sahoo *et al.* (2018) [18] observed that days to 50 per cent flowering and days to maturity had positive direct effect on seed yield per plant. The characters plant height, number of seeds per pod and 100 seed weight had positive association with seed yield per plant but their direct effect were negative in moth bean,

Thus, from the above results it becomes clear that direct selection based on peduncle length, number of primary branches per plant, number of secondary per plant, days to maturity and number of seeds per pod can help in the improvement of seed yield in moth bean

Table 2: Genotypic correlation coefficient of twelve characters in 30 genotypes of Moth bean

Observations	Day to maturity (No.)	Plant height (cm)	Primary branches per Plant (No.)	Secondary branches per Plant (No.)	Pod length (cm)	Peduncle length (cm)	Clusters per branch (No.)	Seeds Per pod (No.)	100 seed weight (g)	Protein content (%)	Seed yield per plant (g)
Days to 50% flowering (No.)	0.5577**	-0.2321*	-0.5822**	-0.5416**	-0.4070**	-0.2862**	-0.2107	-0.2521*	-0.1144	0.1140	-0.2843**
Days to maturity (No.)		-0.2689*	-0.3957**	-0.2808**	-0.4039**	-0.3655**	0.3811**	-0.3466**	-0.1884	-0.2315*	-0.4161**
Plant height (cm)			0.0074	0.0472	-0.1020	-0.0386	0.2095	0.05080	0.4057**	0.1436	0.0539
Primary branches per plant (No.)				0.9456**	0.6494**	0.2837**	0.2701*	0.2855**	0.0085	-0.0758	0.2525*
Secondary branches per plant (No.)					0.5218**	0.2992**	0.2545*	0.1859	0.0404	-0.0074	0.2621*
Pod length (cm.)						0.2989**	0.2377*	0.7110**	0.1237	-0.0650	0.2093
Peduncle length (cm)							0.5829**	0.4308**	-0.0660	0.3567**	0.8784**
Clusters per branch (No.)								0.1190	-0.1827	0.2943**	0.6542**
Seeds per pod (No.)									0.1619	0.1819	0.3247**
100 seed weight (g)										-0.1218	-0.0639
Protein content (%)											0.1331

*, ** Significant at 5 and 1 per cent respectively

Table 3: Direct (diagonal) and Indirect (above and below diagonal) path effects of different characters towards seed yield at genotypic level in moth bean

Observations	Day to 50 per cent flowering (No.)	Days to maturity (No.)	Plant height (cm)	Primary branches per plant (No.)	Secondary branches per plant (No.)	Pod length (cm)	Peduncle length (cm)	Clusters Per branch (No.)	Seeds per pod (No.)	100 seed weight (g)	Protein content (%)	Seed yield per plant (g)9
Days to 50 per cent flowering (No.)	0.1405	-0.1552	-0.0091	0.1966	-0.1997	0.0889	-0.2337	-0.0451	-0.0331	0.0086	-0.0430	-0.2843**
Days to maturity (No.)	-0.1552	-0.2783	-0.0105	0.1336	-0.1035	0.0883	-0.2984	-0.0816	-0.0456	0.0142	0.0873	-0.4161**
Plant height (cm)	-0.0326	0.0748	0.0392	-0.0025	0.0174	0.0223	-0.0315	0.0448	0.0067	-0.0306	-0.0542	0.0539
Primary branches per plant (No.)	-0.0818	0.1101	0.0003	-0.3377	0.3486	-0.1419	0.2316	0.0578	0.0375	-0.0006	0.0286	0.2525*
Secondary branches per plant (No.)	-0.0761	0.0781	0.0019	-0.3193	0.3686	-0.1140	0.0028	0.0545	0.0244	-0.0030	0.0028	0.2621*
Pod length (cm)	-0.0572	0.1124	-0.0040	-0.2193	0.1923	-0.2185	0.2440	0.0509	0.0935	-0.0093	0.0245	0.2093
Peduncle length (cm)	-0.0402	0.1017	-0.0015	-0.0958	0.1103	-0.0653	0.8165	0.1248	0.0566	0.0050	-0.1346	0.8784**
Clusters per branch (No.)	-0.0296	0.1061	0.0082	-0.0912	0.0938	-0.0519	0.4759	0.2141	0.0262	0.0138	-0.1111	0.6542**
Seed per pod (No.)	-0.0354	0.0964	0.0020	-0.0964	0.0685	-0.1554	0.3517	0.0426	0.1315	-0.0122	-0.0687	0.3247**
100 seed weight (g)	-0.1610	0.0524	0.0159	0.0029	0.0149	-0.0270	-0.0539	-0.0391	0.0213	-0.0754	0.0460	-0.0639
Protein content (%)	0.0160	0.0644	0.0056	0.0256	-0.0027	0.0142	0.2912	0.0630	0.0239	0.0092	-0.3774	0.1331

(R=0.321) *, ** Significant at 5 and 1 per cent respectively

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