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Studies on Variability and Character Association for Yield and Yield Related Traits in Faba Bean (*Vicia faba*)

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ABSTRACT

One hundred and forty-five faba bean genotypes were assessed for two years for 13 agronomic traits against three elite varieties PRT-7, PRT-12 and Vikrant in Augmented Design. There was significant difference among the blocks for leaf length, leaf width and 100 seed weight but no difference was observed for days to flowering, days to maturity, plant height, number of branches, number of pods per plant, number of grains per pod, number of pods per cluster, pod length, yield per plant and seed yield. Among the checks, PRT-12 registered highest seed yield (kg/ha). Three germplasm lines viz. EC243770, EC117792, EC329725 showed higher seed yield (kg/ha) than the best check variety PRT-12 (1565 kg/ha).

Keywords: Genetic resources, germplasm, variability, faba bean

Introduction

Today, entire world is concerned about the impact of climate alteration on crop plants. In the last two centuries, climate change was so fast that certain plant species have found it hard to adapt. The climate change will have dramatic consequences for crops (Arya et al. 2020). The earth's average surface temperature has increased by 1 degree F in just over the last century. Consequently, agriculture researchers consider any assessment has to be individually considering each location. But in order to meet the challenges of temperature ahead of global warming, concerted efforts are need to evaluate, identify and develop genotypes suitable for terminal heat stressed environment (Arya et al. 2016).

Faba bean (*Vicia faba* L.) also known as broad bean, is an annual crop. It is a partially allogamous crop. The per cent mean cross pollination in this crop has been reported to range from 32 and 40 per cent, however, it belongs to family Fabaceae. The rate of outcrossing depends on the genotype, environmental factors, row space and the number of pollinating insects (Bishnoi et al. 2015). It is mainly grown in hills and northern plains for its protein rich pulse and green pods which are used as vegetable. Faba bean is grown in over 3 million hectares in the world with a total production is over 4.5 million tons. Average productivity of faba bean is 2800 to 4800 kg/ha. It is mainly used as animal feed in advanced countries and food for human consumption in developing countries. Its value as a feed and food specially is due to availability its high lysine-rich protein, vitamins, minerals, and carbohydrates (Kumar et al. 2019), which make it one of the best solutions to the malnutrition, mainly in developing countries.

It fixes atmospheric nitrogen and used as an important component in crop rotation, which is almost neglected in modern cropping system. Today, there is an urgent need to minimize the impact of chemical fertilizers on the environment, reduce emissions of undesirable grasses and to economize of the following crops (Arya, 2018). It is good for sustainable agriculture in marginal areas (Arya et al. 2019). Efforts have been made to evaluate, characterize, conserve and catalogue

the genetic resources of faba bean. Improvement for the seed and protein yields are receiving foremost attention in this crop. Hence there is a need to intensify efforts to search for appropriate donors for utilization in the locations specific breeding programmes. In the present paper an attempt has been made to evaluate the genetic resources of a faba bean augmented recently to assess their potential use in varietal development programme for faba bean.

Materials and Methods

One hundred and forty-five accessions faba bean along with three standard checks were evaluated in Augmented Block Design (Federer, 1956 and 1961) during the *rabi* 2015-16 and 2016-17 at New Area IARI, New Delhi. The accessions were grown in two rows of 3 m length with 30x15 cm spacing. Standard agronomic practices were followed and plant protection measures were adopted as and when required. Observations were recorded on five competitive randomly selected plants for 13 yield attributes. The data was analysed according to MS-Office Excel program. The one hundred and forty-five test entries were equally distributed in ten block containing 15 entries per block for first nine block and ten entries for last 10th block. The three different checks, namely, PRT-7, PRT-12 and Vikrant were randomly distributed in each block. The total plots per block were 18 and in 10th block was 13. The total number of plots in ten blocks were 175. Correlation and direct and indirect effects were computed by using standard statistical methods (Dewey and Lu, 1959).

Results and Discussion

Genotypes performance

Results have been calculated on the basis of 13 attributes because significant difference among the test entries was observed for all the characters. Therefore, 13 characters were studied for selecting the promising lines. No significant difference was observed among the blocks for days to flowering, days to maturity, plant height, number of branches, number of pods per plant, number of grains per pod, number of pods per cluster, pod length, yield per plant and seed yield. Since there is no block effect on the test entries, the observed value of test entries will be the actual performance of particular genotypes while the significant difference was observed among the blocks for leaf length, leaf width and 100 seed weight. The adjusted values of these characters were calculated. The observed value of 145 test entries for different 10 agronomic traits and adjusted value for three characters were consider for identify the promising line and mean, range and phenotypic coefficient of variation (PCV) for different characters were given in Table 1. The highest check mean value along with the standard error for different characters have been obtained here as a criteria for selecting the better performing genotypes on the basis of observed values for ten characters and adjusted values for three characters. The list of promising genotypes for different yield attributes (better than check values) is given in Table 2. Three germplasm lines viz. EC243770, EC117792, EC329725 showed higher seed yield (kg/ha) than the best check variety PRT-12 (1565 kg/ha). Similar results for one or more characters were reported by Bakhiet et al. 2015; Arya 2018 and Arya et al. 2020.

Characters inter-relationship

Correlation coefficients for thirteen matrix traits in faba bean are presented in Table 3. Seed yield (kg/ha) was positively correlated with all the characters except days to maturity. However the highly positive significant correlation of seed yield were observed with plant height (0.4229), number of pods per plant (0.5239), No. of pods per cluster (0.1715), pod length (0.2769), leaf width (0.2158), 100 seed weight (0.5058) and seed yield/plant (0.6586). Therefore, selection of high value for these characters will ultimately increase the seed yield. The days to flowering, days to maturity, No. of branches, No. of grains per pod and leaf length have the nonsignificant association with seed yield.

The contribution of these characters was further analyzed by computing their direct and indirect effects on seed yield (kg/ha) and is presented in Table 4. The days to flowering, plant height, pods per plant, no. of seed per pod, no. of pods per cluster, leaf width, 100 seed weight and seed yield per plant had direct positive effect. The direct effect of remaining characters was negative and small in magnitude. The characters showing high positive direct effect and indirect effect via each other. The seed yield per plant showed the highest indirect effect on seed yield (kg/ha) through pods per plant, pod length, leaf width and 100 seed weight. 100 seed weight also showed the indirect effects on the seed yield through the days to maturity, plant height, leaf width and pod length. On the other hand, days to maturity showed negative indirect effect of seed yield through all the characters except no. of branches, pod per plant, no. of seeds per pod and no. of pods per cluster. Plant height had the positive indirect effect on seed yield except no. of pods and no. of grains per cluster. Similar results for one or more characters were reported by Bakhiet et al. 2015; Tofiq et al. 2016; Arya et al. 2019 and Dewangan et al. 2019.

Table 1. Mean, range and coefficient of variation (CV) for different characters in faba bean germplasm based on 2 years data.

No.	Characters	Mean	Range	SD	CV (%)
1.	Days to 50% flowering	92.26	67.0-120.0	6.12	6.63
2.	Days to maturity	159.78	150-172	4.89	3.06
3.	Plant height (cm)	72.46	49.0-95.0	9.58	13.23
4.	No. of branches	6.11	2.0-17.0	1.84	30.04
5.	Pods per plant	30.09	2.38-81.40	12.06	40.09
6.	No. of grains per pod	2.88	1.40-4.00	0.37	12.71
7.	No. of pods per cluster	1.27	1.00-2.80	0.31	24.61
8.	Pod length (cm)	4.11	2.50-7.20	0.63	15.33
9.	Leaf length (cm)	6.32	4.62-7.70	0.52	8.27
10.	Leaf width (cm)	2.86	2.24-3.60	0.29	10.26
11.	100 seed weight (g)	24.00	2.00-36.50	6.24	26.00
12.	Yield per plant (g)	17.53	1.00-100.0	10.52	60.04
13.	Yield (kg/ha)	1141	37-3389	6.64	58.26

Table 2. Performance of Promising genotypes of faba bean based on 2 years data.

No.	Characters	Genotypes	Best Check Value
1.	Days to 50% flowering	IC361496, EC329691, EC550179, EC117724 (< 75.0 days)	PRT-12 (89.10 days)
2.	Days to maturity	VKG29/64, IC361499 (< 152.0 days)	PRT-12 (158.10 days)
3.	Branches per plant (No.)	JBT30/78, JBT42/RP-3/31, VKS18/46, BGR-82, VKG29/91 (> 10.0)	PRT-12 (5.72)
4.	Pods per plant (No.)	JBT42/RP-3/31, EC329725, VKG29/53 (> 58.0)	Vikrant (37.05)
5.	Grains per pod (No.)	JBT30/78 (> 3.85)	Vikrant (2.99)
6.	Pods per cluster (No.)	EC267641, IC346272, JBT42/RP-3/28, EC267648, JBT41/80, JBT42/RP-3/31, IC332102, VKG29/53 (> 1.50)	Vikrant (1.37)
7.	Pod length (cm)	VKS18/46, JBT30/78 (> 6.0 cm)	PRT-12 (4.12 cm)
8.	Leaf width (cm)	EC25192 (>3.50 cm)	PRT-7 (2.93 cm)
9.	100 seed weight (g)	EC343808, EC329679 (> 34.50 g)	PRT-12 (25.15 g)
10.	Yield per plant (g)	EC243756 (> 40.0 g)	PRT-12 (22.80 g)
11.	Yield (kg/ha)	EC243770, EC117792, EC329725 (> 3000 kg/ha)	PRT-12 (1565 kg/ha)

Table 3. Correlations among different agro-morphological traits in Faba bean germplasm.

Characters	Days to 50% Flowering	Days to Maturity	Plant Height (cm)	No. of Branches	Pods/Plant	No. of Grains/Pod.	No. of Pods/Cluster	Pod Length (cm)	Leaf Length (cm)	Leaf Width (cm)	100 Seed Wt. (g)	Yield/Plant (g)	Yield (q/ha)
Days to 50% flowering	1.0000												
Days to maturity	0.4132**	1.0000											
Plant height (cm)	0.1110	0.3080**	1.0000										
No. of Branches	0.1378	-0.1633*	0.1346	1.0000									
Pods/Plant	-0.1197	-0.2667**	0.2558*	0.2590*	1.0000								
No. of grains/pod.	-0.0248	-0.4173**	-0.1619	0.3679**	0.1684*	1.0000							
No. of pods/cluster	-0.0984	-0.3634**	-0.1659*	0.0594	0.3955**	0.2653**	1.0000						
Pod length (cm)	0.1196	0.2545**	0.2929**	0.1410	0.0633	0.0712	-0.1735*	1.0000					
Leaf length (cm)	0.0800	0.1719*	0.1851*	0.0753	-0.0453	0.0845	-0.0305	0.2200**	1.0000				
Leaf width (cm)	0.2706*	0.4728**	0.3402**	-0.0049	-0.0707	-0.1575	-0.1443	0.2613**	0.5475**	1.0000			
100 seed wt. (g)	0.0222	0.4041**	0.4701**	-0.0492	0.2834**	-0.2321**	-0.1190	0.6440**	0.2450**	0.4175**	1.0000		
Yield/plant (g)	-0.0462	0.0398	0.2911**	0.0162	0.4292**	-0.0695	0.0984	0.2534**	0.0737	0.2408**	0.4060**	1.0000	
Yield (kg/ha)	0.0162	-0.0421	0.4229**	0.0812	0.5239**	0.0045	0.1715*	0.2769**	0.0621	0.2158**	0.5058**	0.6586**	1.0000

*=Significant at 5% level, **=Significant at 1% level.

Table 4. Direct and indirect effects of different agro-morphological traits in Faba bean germplasm.

Characters	Days to 50% Flowering	Days to Maturity	Plant Height (cm)	No. of Branches	Pods/Plant	No. of Grains/Pod	No. of Pods/Cluster	Pod Length (cm)	Leaf Length (cm)	Leaf Width (cm)	100 seed wt. (g)	Yield/Plant (g)	Correlation on With Yield (kg/ha)
Days to flowering	**0.1314**	-0.1029	0.0219	-0.0039	-0.0143	-0.0010	-0.006	-0.0076	-0.0059	0.0169	0.0078	-0.0197	0.0162
Days to maturity	0.0543	**-0.2492**	0.0607	0.0047	-0.0318	-0.0170	-0.0240	-0.0161	-0.0127	0.0296	0.1426	0.0170	-0.0421
Plant height (cm)	0.0146	-0.0768	**0.1969**	-0.0038	0.0305	-0.0066	-0.0110	-0.085	-0.0137	0.0213	0.1659	0.1240	0.4228**
No. of branches	0.0181	0.007	0.0265	**-0.0286**	0.0309	0.0149	0.0039	-0.0089	-0.0056	-0.0003	-0.0174	0.0069	0.0812
Pods per plant	-0.0157	0.0665	0.0504	-0.0074	**0.1194**	0.0068	0.0262	-0.0040	0.0034	-0.0044	0.1000	0.1829	0.5239**
No. of grains /pod	-0.0033	0.1040	-0.0319	-0.0105	0.0201	**0.0406**	0.0175	-0.0045	-0.0063	-0.0099	-0.0819	-0.0296	0.0045
No. of pods/cluster	-0.0129	0.0905	-0.0327	-0.0017	0.0472	0.0108	**0.0661**	0.0110	0.0023	-0.0090	-0.0420	0.0419	0.1715*
Pod length (cm)	0.0157	-0.0634	0.0577	-0.0040	0.0076	0.0029	-0.0115	**-0.0633**	-0.0163	0.0163	0.2273	0.1080	0.2769**
Leaf length (cm)	0.0105	-0.0428	0.0364	-0.0022	-0.0054	0.0034	-0.0020	-0.0139	**-0.0741**	0.0342	0.0865	0.0314	0.0620
Leaf width (cm)	0.0356	-0.1178	0.0670	0.0001	-0.0084	-0.0064	-0.0095	-0.0165	-0.0406	**0.0625**	0.1473	0.1026	0.2158**
100 seed weight (g)	0.0029	-0.1007	0.0926	0.0014	0.0338	-0.0094	-0.0079	-0.0408	-0.0182	0.0261	**0.3529**	0.1730	0.5058**
Yield per plant (g)	-0.0061	-0.0099	0.0573	-0.0005	0.0512	-0.0028	0.0065	-0.0160	-0.0055	0.0151	0.1433	**0.4261**	0.6587**

Residual effects=0.3819, Figures in bold indicate direct effects, *=Significant at 5% level, **=Significant at 1% level

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