

ESTIMATION OF GENETIC PARAMETERS AND PARTITIONING OF VARIATION IN FABA BEAN (*VICIA FABA* L.) GENOTYPES FOR YIELD AND ITS CONTRIBUTING TRAITS

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(Received : 21 April 2023; Accepted : 19 May 2023)

SUMMARY

The present investigation was conducted to evaluate the level of genetic variation in the faba bean population for yield and its component traits at Research Farm Area, MAP section, Department of Genetics and Plant Breeding, CCSHAU, Hisar in the *Rabi* season of 2019-20. Sixty faba bean genotypes along with two checks *i.e.*, HFB-1 and Vikrant were evaluated in augmented randomized block design. Analysis of variance showed highly significant differences among checks, between check & genotypes and among genotypes for all the studied traits. High genotypic and phenotypic coefficient of variation was observed for hundred seed weight (21.93%, 23.02%), seed yield per plant (47.53%, 48.25%), biological yield per plant (50.11%, 52.01%) and harvest index (31.92%, 32.25%) suggesting the presence of considerable variation in the faba bean genotypes. High or medium heritability coupled with high genetic advance as percent of mean was observed for the number of pods per plant (32.42%, 20.91%), hundred seed weight (79.93%, 28.46%), seed yield per plant (49.17%, 33.45%) and harvest index (38.51%, 22.45%), indicating these traits could be easily improved through direct selection. The genotypes like EC-10908, EC-361494, HB-89, NDFB-13 was found to performing better in this investigation.

Key words : Faba bean, analysis of variance, genotypic and phenotypic coefficient of variation, broad sense heritability, genetic advance

Faba bean (*Vicia faba* L.) is an important legume crop because of its good nutritive features such as high protein content (average approximately 25%), anti-oxidant capabilities, it is utilised as food for people and feed for animals (Kumar *et al.*, 2022). It has a vital function in crop rotations, nitrogen assimilation, and soil improvement as a legume crop (Musallam *et al.*, 2004; Arya *et al.*, 2020 & 2022a).

Because of its high percentage of cross pollination, the crop has a high amount of genetic diversity (Hanelt and Mettin, 1989). A substantial genetic variability in faba bean had already been identified and used for many features such as seed characteristics, morphological and agronomical traits (Dahiya *et al.*, 2021; Arya *et al.*, 2022 c,d). It is possible to understand that genetic gain through selection is largely dependent on the presence of genetic diversity and, in particular, the heritable component of variation in the base population (Koli *et al.*, 2022). Slower growth rates of faba bean production have been observed in the recent decades because of limited advances in expanding genetic variation (Nedumaran *et al.*, 2015). Faba bean

cultivation using only some high-yielding varieties, leads to increased faba bean production worldwide, but it has also narrowed its genetic diversity. As a result, plant breeders must be aware about the existing variation in the population in order to successfully undertake a breeding programme (Ammar *et al.*, 2015). Therefore, keeping in view of the above discussed facts, this investigation was undertaken to estimate the genetic parameters and study the variation for different yield and its contributing traits in faba bean genotypes.

MATERIALS AND METHODS

Sixty faba bean genotypes were grown in augmented randomized complete block design with two check varieties *i.e.* HFB-1 and Vikrant at Research Farm Area, MAP section, Department of Genetics and Plant Breeding, CCSHAU, Hisar during *Rabi* 2019-20. Sixty genotypes were grown in ten blocks; each block had six genotypes and two check varieties. Genotypes and checks were grown as two rows of 3m length with row to row and plant to plant distances

at 45 cm and 10 cm, respectively. Data was recorded on five randomly selected plants from each plot in every block. The data was collected for this study for the traits *viz.* days to 50% flowering, plant height (cm), days to maturity, number of pods per plant, hundred seed weight (g), seed yield per plant (g), biological yield per plant (g) and harvest index (%). The recorded data was analysed using the open source R software using various suitable packages.

RESULTS AND DISCUSSION

Analysis of variance

Analysis of variance is presented in Table 1, under two heads; ANOVA (Block adjusted) and ANOVA (Treatment adjusted). The ANOVA (Block adjusted) takes into account all the variation that influenced the trait while ANOVA (Treatment adjusted) focus on the treatment variation after deducting for the block influence from the traits. The variability between checks found to be significant for all the studied traits except days to 50 percent flowering. The significant variation was also reported between checks & genotypes for all the studied traits except plant height. The variation among faba bean genotypes were reported to be highly significant for all the traits except days to 50 percent flowering.

The level of variation in other studies like of

Elshafei et al. (2019), Abdullah (2018), Ammar *et al.* (2015), Bishnoi *et al.* (2012) *etc.* were also found significant in the faba bean genotypes indicating there was naturally a lot of variation within the population.

Mean, range and descriptive statistics

The mean performance for different traits of faba bean genotypes is presented in Table 2 and descriptive statistics for the said traits is presented in Table 3.

On the basis of mean performance the faba bean genotypes *viz.* EC-107842, HB-57, EC-361494 took minimum days (56.00 days) to 50 percent flowering followed by HB-54 (57.00 days), EC-243782 (58.00 days), NDFB-11 (58.00 days) *etc.* and the average days taken to reach 50 percent flowering was 63.00 days. It ranged between 56 days to 76 days. Highest plant height (126.86 cm) was recorded in genotype, EC-10908 which was significantly higher in comparison to average plant height of 102.41 cm. The range of plant height in the genotypes was 61.16 cm to 126.86 cm. Days to maturity is an important trait defining the genotypes as early and late cultivars. The earliest maturing genotype found, in this investigation, was HB-93 (135.00 days) and HB-89 (135.00 days) while, other genotypes which were significantly earlier than average days of maturity; EC-32713 (136.00 days), EC-29085 (137.00 days), and

TABLE 1
Analysis of variation of different morphological traits in faba bean genotypes

Source	ANOVA (Block Adjusted)								
	DoF	DF	PH	DM	NPo.P	HSW	SYP	BY.P	HI
Treatment (ignoring Blocks)	151	18.29**	96.97**	36.94**	17.86**	18.39*	264.87*	1668.73*	30.53**
Treatment: Check	1	1.83	15.52*	9.37*	9.63*	28.17**	296.81*	6217.82**	7.59**
Treatment: Test vs. Check	1	31.65*	169.83	21.7*	2.65**	8.72**	162.98**	1937.39**	0.43*
Treatment: Test	149	18.34	97.11**	37.66**	18.26*	18.39*	266.05**	1587.07*	31.43**
Block (eliminating Treatments)	14	5.47	122.19**	33.37**	12.33*	25.3**	348.5**	2405.73**	28.45**
Residuals	14	9.87	100.34	31.28	9.28	17.99	163.58	2599.02	27.47

Source	ANOVA (Treatment Adjusted)								
	DoF	DF	PH	DM	NPo.P	HSW	SYP	BY.P	HI
Block (ignoring Treatments)	14	16.68*	112.83**	36.09**	24.12*	24.83**	385.61**	2360.26*	24.14**
Treatment (eliminating Blocks)	151	16.27*	98.66**	36.45*	15.74*	18.48**	258.18**	1676.93**	31.31**
Treatment: Check	1	1.83	15.52*	9.37**	9.63*	28.17**	296.81*	6217.82*	7.59**
Treatment: Test and Test vs. Check	150	16.51**	100.04**	36.9**	15.84**	18.32**	257.53**	1601.25**	31.71**
Residuals	14	9.87	100.34	31.28	9.28	17.99	163.58	2599.02	27.47

DF: Days to 50% flowering (days), PH: Plant height (cm), DM: Days to maturity (days), NPo.P: Number of pods per plant, HSW: 100-seed weight (g), SYP: Seed yield per plant (g), BY.P: Biological yield per plant (g), HI: Harvest index (%).

TABLE 2
Promising faba bean genotypes for different traits

DF	PH	DM	NPo.P	HSW	SYP	BY.P	HI
EC-107842 (56.00)	EC-10908 (126.86)	HB-89 (135.00)	EC-361494 (44.30)	EC-10908 (50.63)	HB-89 (102.40)	HB-89 (334.25)	EC-107842 (42.48)
EC-361494 (56.00)	HB-62 (126.26)	HB-93 (135.00)	HB-43 (41.90)	HB-20 (46.53)	NDFB-12 (94.12)	EC-249791 (323.05)	EC-5106 (41.48)
HB-57 (56.00)	EC-29085 (125.66)	EC-32713 (136.00)	RFB-3 (41.70)	EC-32713 (41.33)	EC-117705 (92.22)	EC-243782 (283.45)	NDFB-13 (41.18)
HB-54 (57.00)	EC-361494 (120.51)	EC-29085 (137.00)	HB-31 (39.50)	EC-243709 (40.88)	EC-17761 (84.12)	HB-57 (275.85)	EC-29085 (41.03)
EC-243782 (58.00)	EC-243724 (120.26)	HB-11 (137.00)	EC-3289 (39.30)	HB-27 (40.63)	RFB-3 (80.72)	HB-176 (274.35)	EC-117705 (39.78)

TABLE 3
Descriptive statistics of the different studied traits in faba bean genotypes

Trait	Minimum	Maximum	Mean	CV	Skewness	Kurtosis
DF	55.9	76.40	63.00	5.02	0.88**	3.37
PH	61.16	126.86	102.41	9.81	-0.41	3.34
DM	135.37	162.37	147.00	3.81	0.18	2.27
NPo.P	18.1	44.3	32.30	9.46	-0.05	3.37
HSW	22.23	50.63	32.95	7.87	0.57	4.05
SYP	24.72	102.40	59.11	9.24	0.16	2.18
BY.P	119.05	334.25	209.90	8.70	0.32	2.7
HI	13.13	42.48	27.83	7.59	0.22	2.83

DF: Days to 50% flowering (days), PH: Plant height (cm), DM: Days to maturity (days), NPo.P: Number of pods per plant, HSW: 100-seed weight (g), SYP: Seed yield per plant (g), BY.P: Biological yield per plant (g), HI: Harvest index (%).

HB-11 (137.00 days). The genotypes took 135.00 days to 162.00 days for maturation.

Seed yield in faba bean is controlled by many traits such as pod numbers, hundred seed weight and biological yield. The highest number of pods per plant was observed in EC-361494 (44.30) followed by HB-43 (41.90) and RFB-3 (41.70) which was comparatively higher population than mean value of 32.30 pods per plant. The range of number of pods per plant was from 18.10 to 44.30. Hundred seed weight was found highest for the genotype; EC-10908 (50.63 g) followed by HB-20 (46.53 g), EC-32713 (41.33 g). Seed yield per plant showed a mean weight of 59.11 g with maximum yield reported for HB-89 (102.40 g) followed by NDFB-13 (94.12 g) and EC-117705 (92.22 g). These genotypes were performing far better than check varieties *i.e.* HFB-1 (68.40 g) and Vikrant (59.93 g). Biological yield per plant was highest in HB-89 (334.25 g) followed by EC-249791 (323.05 g), EC-243782 (283.45 g) and HB-57 (275.85 g). Harvest index represented the efficiency of cultivar to convert the photosynthates into economical yield. Mean harvest index was found to be 27.83 percent

and the best performing genotype was EC-107842 with a harvest index of 42.48%. Harvest index ranged from 13.13 percent to 42.48 percent. Similar findings were also reported by Arya *et al.*, 2018 & 2019.

Genetic variability parameters of yield and its contributing traits

Genetic variability parameters of this investigation are presented in Table 4 and as graphical representation (Fig. 2). The genotypic and phenotypic coefficient of variation is found to be high for hundred seed weight (21.93%, 23.02%), seed yield per plant (47.53%, 48.25%), biological yield per plant (50.11%, 52.01%) and harvest index (31.92%, 32.25%) while medium for days to maturity (11.72%, 14.17%), number of pods per plant (18.28%, 20.23%) and low for days to 50% flowering (4.62%, 6.80%), plant height (8.96%, 9.62%), respectively. Phenotypic coefficient of variation was found slightly higher than the genotypic coefficient of variation due to influence of environmental factors. The difference between genotypic and phenotypic coefficient of variation was

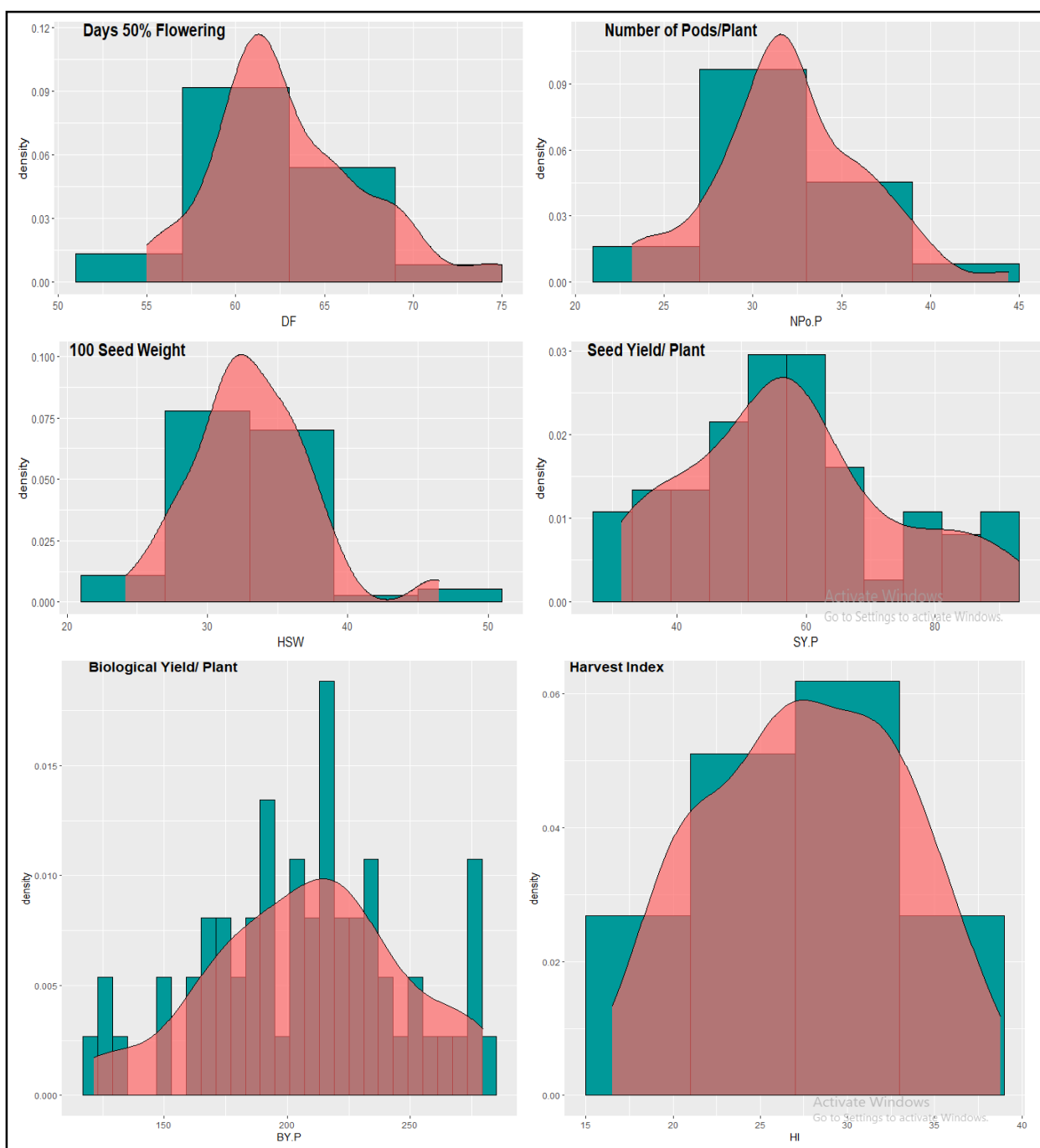


Fig. 1. Pictorial representation of traits' density distribution for the faba bean genotypes.

not significant. Hence, the observed variability was mainly due to the genetic differences among studied faba bean genotypes. Similar findings were also reported by Chaurasia *et al.*, 2022; Raiger *et al.*, 2022; Arya *et al.*, 2022b.

Broad sense heritability is one of the most important parameter for assessing the breeding value of the genotypes for possible transfer of the traits to the progeny. The high values of broad sense heritability

was measured for traits *viz.* days to 50% flowering (73.42%), plant height (61.57%), hundred seed weight (79.93%) and it was found medium for remaining traits. The high value of broad sense heritability showed the presence of large heritable variation for the trait suggesting that the selection would be rewarding for the breeder.

The genetic advance as percent of mean coupled with the broad sense heritability presents

TABLE 4
Genetic variability parameters of the studied traits in faba bean genotypes

Trait	GCV		PCV		h ² bs		GAM	
DF	4.62	Low	6.8	Low	73.42	High	12.62	Medium
PH	8.96	Low	9.62	Low	61.57	High	19.86	Medium
DM	11.72	Medium	14.17	Medium	57.21	medium	15.27	Medium
NPo.P	18.28	Medium	20.23	Medium	32.42	medium	20.91	High
HSW	21.93	High	23.02	High	79.93	High	28.46	High
SYP	47.53	High	48.25	High	49.17	Medium	33.45	High
BY.P	50.11	High	52.01	High	50.16	Medium	11.48	Medium
HI	31.92	High	32.25	High	38.51	Medium	22.45	High

DF: Days to 50% flowering (days), PH: Plant height (cm), DM: Days to maturity (days), NPo.P: Number of pods per plant, HSW: 100-seed weight (g), SYP: Seed yield per plant (g), BY.P: Biological yield per plant (g), HI: Harvest index (%).

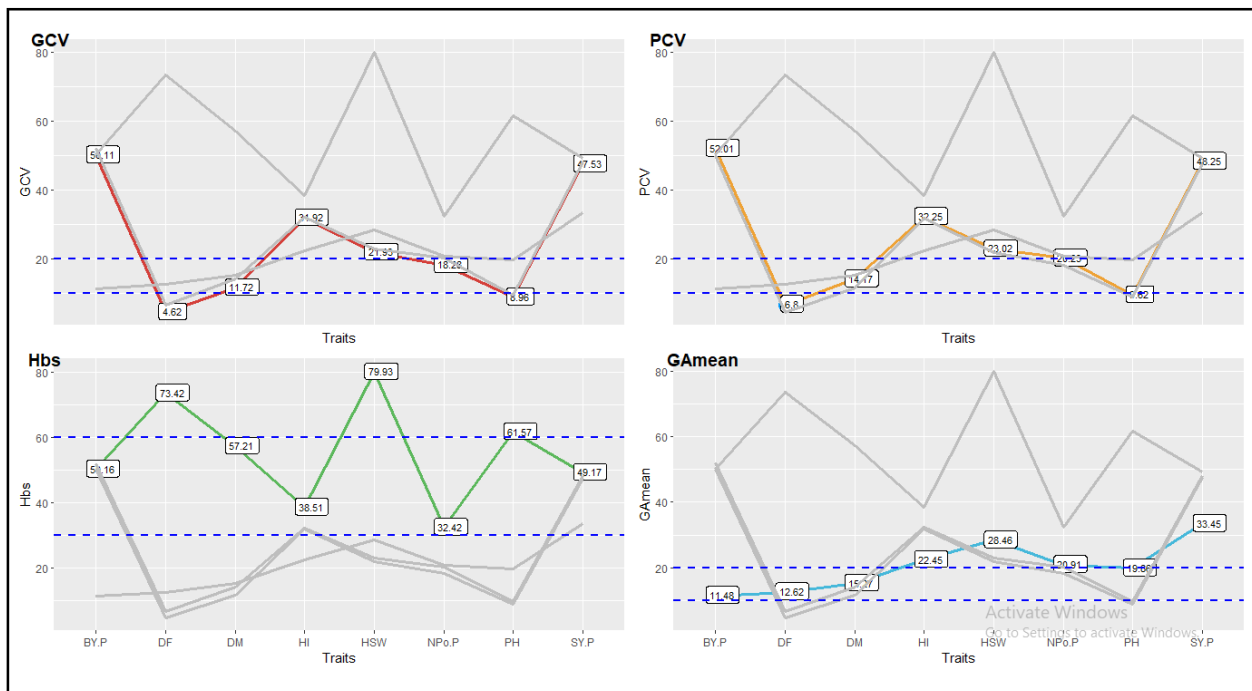


Fig. 2. Graphical representation of genetic variability paprameters of different studied traits in faba bean germplasm lines.

the true picture for the exploitation of variability either through selection or hybridization. It was established in earlier studies that the high heritability coupled with high genetic advance as percent of mean is due to the presence of additive gene effects which could help in direct selection for the trait. While, high heritability coupled with low genetic advance as percent of mean showed the dominance of non-additive gene effects. The traits with high heritability and low genetic advance as percent of mean could be improved through hybridization. In this study, high value of genetic advance percent of mean was measured for the traits *viz.* number of pods per plant (20.91%), hundred seed weight (28.46%), seed yield per plant (33.45%) and harvest

index (22.45%) while, medium values were found for the remaining traits. High broad sense heritability coupled with high genetic advance was found for hundred seed weight showed the presence of additive gene effects.

Genetic variability parameters were very important for ascertaining the genotype contribution and environment influence on the morphological response of the trait (Nguyen *et al.*, 2019). These could help to establish the gene effects that were influencing the expression of the trait (Arya *et al.*, 2021). The influence of environmental factors on the studied traits in this investigation was found to be minimum or negligible which had concurrence with studies of Abo-Hegazy (2022), Waly (2021), Hamza (2017) *etc.*

CONCLUSION

The faba bean genotypes had significant amount of variation for all the studied trait except for days to 50 percent flowering. The selection would be beneficial for improvement in traits viz. number of pods per plant, hundred seed weight and seed yield per plant. On the basis of mean performance genotypes like HB-89, EC-10908, EC-361494, NDFB-13 were performing at par or significantly higher than the check varieties.

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