Original Research Article

Evaluation of genetic variability, heritability, and genetic advance in broad bean (*Vicia faba*.L)

ABSTRACT

The study investigated the phenotypic and genotypic coefficient of variation (PCV and GCV) and heritability estimates for various agronomic and nutritional traits in Broad bean (*Vicia faba*). The analysis aimed to identify traits with optimum variability and heritability, as well as to explore the potential presence of additive genetic variance in specific characteristics.The 18 genotypes were grown in randomized block design with the 3 replication during *Rabi* season in the year 2021-22 at the Research Farm- 1, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Vidya-Vihar, Raebareli Road, Lucknow-226025 (U.P.). The results revealed that the number of seed per plant, number of pod per plant and seed yield per plant exhibited high estimates of both PCV and GCV, indicating the presence of adequate variability for these particular characters within the population. Additionally, the heritability for the characters of 100 seed yield, number of seed per plant, titratable acidity (g/l), total soluble solids (TSS) and genetic advance for the number of seed per plant, number of pod per plant, seed yield per plant, 100 seed weight per plant were found to be significant indicating that these characters were predominantly governed by additive gene action. The findings of this study hold significant implications for future breeding programs and genetic improvement strategies. The identified high heritability and genetic advance for the above-mentioned characters suggest that these characteristics can be effectively manipulated through selective breeding to develop improved and high-yielding plant varieties.

Keywords: [Broad Bean, GCV, PCV, Heritability, Genetic advance}

1. INTRODUCTION

The broad bean (*Vicia faba* L.) 2n = 2x = 12, 14) is a tropical to temperate grain legume vegetable. It is commercially grown for green pod and dried seeds. It is locally known as Broad bean, fava bean, field bean, bell bean, tic bean, kala matar and bakala are two terms used in India.(Singh *et al*., 2013). The broad bean belongs to the family Fabaceae. It is originated in Mediterranean region. It's also cultivated in Australia, South America, Mexico, Brazil, and Andes. The faba beans is a underutilized legume vegetable in India. In Indian condition, it is cultivated under rainfed conditions in Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh, and Uttarakhand, as well as in other parts of South and North India. Pulses are famous as a health food that provides nutritional security to the millions of malnourished people throughout the world, particularly in South Asia and Africa.

Broad bean seeds contain relatively high proteins, carbohydrates, vitamins B, antioxidants and minerals. Protein content in different varieties varies from 26% to 41% (Picard, 1977). Carbohydrate contents varies from 51% to 68%, of which major proportion is contributed by starch (41–53%) (Cerning et al., 1975). The antioxidant properties of phenolic compounds may provide excellent dietary source for natural antioxidants for prevention of chronic diseases and health promotion (Oomah*et al*., 2006). Pulses are an essential source of nutritional protein in vegan diets, particularly in impoverished nations.

After soybean (*Glycine max* L.) and pea (*Pisum sativum* L.), it is the third most significant legume green vegetable in worldwide.According to Department of Agriculture and Farmers Welfare,

Directorate of Economics and Statistics targeted to total pulse production in 2020-21 was estimated at 25.60 million tonnes but the production was 25.58 million tons. (Anonymous, 2021).
Winter season varieties have 4-6 stems/plant and the spring season varieties have 1-2 stems/plant. The root is typical tap root with secondary roots and nodules due to *Rhizobium leguminosarum*v. *vicie.* Stem growth is indeterminate. There are leaves upto 5th to 10th node followed by raceme of 2-12 flowers in the leaf axils. There are 2 leaflets/leaf at the bottom and 6-8 leaflets/leaf at the top. Flowers, 2-3 cm long at anthesis, have a typically papilionaceous structure. They can be completely white, brown or violet. In most cases they concentrate their colour on black or brown melanin spots on the wings. Pods are short and erected in minor and paucijuga types (3-4 ovules pod) and long and hanging in major types (8-12 ovules per pod). Seed colour can be yellow, green, brown, black or violet and the seed may sometimes carry punctuations, brown spots or stripes around the hilum. The hilum can be black or clear. (Ram, 2019). The annual herb faba bean has coarse and erect stalks. The blooms are big, white with dark purple patterns and borne in bunches on short pedicles. The fruit is a large, leathery pod that starts off green and becomes blackish-brown as it ripens. Through biological nitrogen fixation, it can contribute to the long-term sustainability or augmentation of total soil nitrogen fertility (Lindemann *et al.,* 2003).

2. MATERIAL AND METHODS

The present investigation was carried out during *Rabi* season in the year 2021-22 at the Research Farm- 1, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Vidya-Vihar, Raebareli Road, Lucknow-226025 (U.P.). Lucknow is situated in the Gangetic alluvial plain of eastern Uttar Pradesh located at 26^0 50 North latitude and 80^0 52 East longitude and an altitude of 111 meter above mean sea level (MSL). The topography of the experimental field is plain. This region comes under Agro climatic zone $5^{th}$of Uttar Pradesh. (ICAR). The 18 genotypes of broad bean (*Vicia faba* L.) were planted in a Randomized Block Design during *Rabi* season year 2021-22 under Lucknow condition. There were 3 replication, each having has 18 blocks and each block have 1 germplasm. The spacing row to row were 45x45 and plant to plant spacing 15x15. The observation were recorded germination percent, plant height(cm), number of branches per plant, days to first flowering, days to 50% flowering, days to first fruit set, number of pod per plant, number of seed per pod, pod length (cm), pod diameter (mm), pod volume (ml), specific gravity, titratable acidity (g/l), total soluble solids(%), number of seed per plant, days to maturity, 100 seed weight (gm), seed yield per plant (gm)**.**

2.1 Statistical Analysis

The phenotypic (PCV) and genotypic coefficient of variation (PCV) were calculated standard procedure proposed by Burton and DeVane (1953).The categories for genotypic (GCV) and phenotypic coefficients of variation (PCV) given by Siva subramanian and Menon (1973) as low (0-10%), moderate (10-20%), and high (20% and above) were adopted in the present investigation also. Heritability in a broad sense was calculated by using the formula suggested by Allard, (1960). The estimates of broad sense heritability ($h^2_{(b)}$) were also classified into three categories as suggested by Robinson *et al.* (1949). Genetic advance was calculated by using the formula suggested by Lush (1949). Genetic advance as percent mean was also classified into 3 categories viz., low (0- 10%), moderate (10-20%), and high (20% and above) as suggested by Johnson et al. (1955).

3. RESULTS AND DISCUSSION

The estimate of genotypic coefficient of variation is of prime importance to breeder because of genetic variation alone. It does not allow discussion as to which characters were showing the highest degree of variability, therefore, accurate relative comparison can be made with the help of genotypic and phenotypic coefficient of variation. In general phenotypic coefficient of variability were higher than the genotypic coefficient of variability for all the characters under study which indicates that the environment plays vital role in expression of the characters.

3.1 Estimation of Phenotypic and Genotypic Variance

The table explained that phenotypic variance was higher as compare to genotypic variance for all traits during search experiment. The maximum variability was reported for 100 seed weight (407.14)

followed by number of seed per plant (192.33), germination percent (145.38), plant height (95.45), pod volume (69.51).
The phenotypic variance for all characters under investigation were recorded higher compare to genotypic variances Ojha *et al*. (2010) and Singh *et al*.(2015) in dolichos bean. The influences of environmental factors in expression of these characters which perform a significant contribution in the demonstration of these traits. The vast range of phenotypic and genotypic variance were recorded in the all evaluated germplasm for all the traits under experiment programme. The highly phenotypic and genotypic variance showed by the characters viz., 100 seed weight, number of seed per plant, germination % , plant height, pod volume. These result also reported by *Mulualem et al., (2013)* while low phenotypic variance observed for number of branches per plant, number of seed per pod, specific gravity, titratable acidity. However, these traits should be given importance during selection process.

3.2 PCV and GCV

3.2.1 Phenotypic coefficient of variation

The phenotypic coefficient of variation was high for the characters number of seed per plant(46.40), number of pod per plant (37.13), seed yield/plant (35.41), 100 seed weight(32.99), pod volume (28.37), number of seed per pod (19.97), specific gravity (18.86), titratable acidity (18.86), days to first fruit set (18.58), number of branches per plant (18.20), germination % (16.97), Total soluble solids (16.62), pod length (16.17), pod diameter (12.58), plant height (11.80), days to first flowering (11.11), days to 50% flowering(9.53), days to maturity(5.40) exhibited low PCV. In the present findings phenotypic coefficient of variations were observed to be higher than corresponding genotypic coefficient of variations for all the characters studied, however, the differences were narrow which implied their relative resistance to environmental variation. It also described that genetic factors were predominantly responsible for expression of those attributes and selection could be made effectively on the basis of phenotypic performance. The findings were similar to Kaliya *et al*. (2003), Fatih and Hamza. (2017).The magnitude of phenotypic and genotypic coefficient of variation ranged from 5.40 (%) to 46.40 (%) and 4.13(%) to 45.95 (%). The findings were similar to Afeta*et al.* (2020), Mulualem*et al*.(2013).

3.2.2 Genotypic coefficient of variation

It is revealed from Table that genotypic coefficient of variation range was recorded 4.13 (Days to maturity) to 45.95 (Number of seed per plant) for different characters under study. High genotypic coefficient of variation was observed in number of seed per plant (45.95), number of pod per plant (35.97), seed yield per plant (34.34), 100 seed weight (32.77), pod volume (27.43), number of seed per pod (18.92), acidity (18.57) days to first fruit set (17.01), number of branches per plant (16.96), specific gravity (16.96), germination percent (16.57), Total soluble solids (16.28), pod length (12.85), pod diameter (11.18) plant height (11.17), days to first flowering (8.34), days to 50% flowering (8.02), days to maturity (4.13) exhibited low GCV %.The genotypic and phenotypic coefficient of variation was high for the characters number of seed per plant, number of pod per plant, seed yield per plant, 100 seed weight pod volume, number of seed per pod, titratable acidity, days to first fruit set, number of branches, specific gravity, germination, total soluble solids, pod length, pod diameter, plant height, days to first flowering, days to 50 % flowering, days to maturity, The finding were similar tokaliya*et al*., (2003), Mulualem*et al*.(2013),Lal *et al*., (2019) , Fatih and Hamza.(2017).

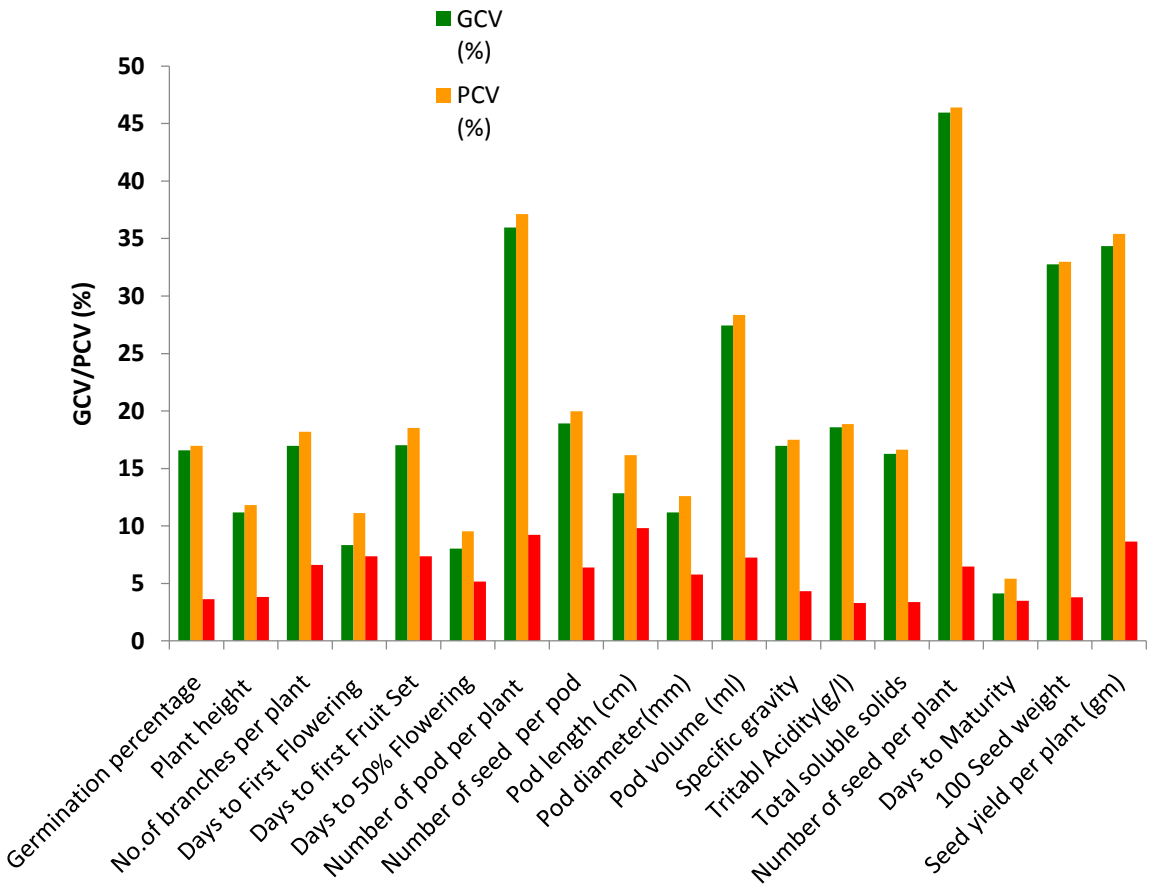

Fig.No.1 GCV (%) and PCV (%) of different Characters of broad bean (*Vicia faba*L).

3.3 Heritability

Results indicated that the heritability estimates were observed very high for 100 seed yield (98.69) followed by number of seed per plant (98.06), titratable acidity (96.97) Total soluble solids (95.87), germination percent (95.43), seed yield per plant (94.04), specific gravity (93.91), number of pod per plant (93.84) and volume (93.47), Result indicate that the heritability estimate were observed high for number of seed per pod (89.79), plant height (89.48), number of branches per plant (86.84), days to first fruit set (84.27), pod diameter (78.97) and days to 50% flowering (70.90).Result indicate that the heritability estimate were observed moderate for pod length (63.14), days to maturity (58.40), days to first flowering (56.30).The estimates of heritability in broad sense (h^2 b) and genetic advance in per cent of mean estimated for eighteen characters have been presented in table. Heritability ranged from 56.30 (days to first flowering) to 98.69 (100 seed weight). Very high estimates of broad sense heritability (>90%) was estimated for 100 seed yield (98.69), number of seed per plant (98.06),titratable acidity (96.97) total soluble solids (95.87), germination percent (95.43), seed yield per plant (94.04), specific gravity (93.91), number of pod per plant (93.84), pod volume (93.47). the high estimates of heritability (70-90%) were observed for number of seed per pod (89.79), plant height (89.48), number of branches (86.84), days to first fruit set (84.27), pod diameter (78.97), days to 50% flowering (70.90).The similar result were findings by Kaliya *et al*. (2003).The moderate estimates of heritability (50-70%) for pod length (cm) (63.14), days to maturity (58.40), days to first flowering (56.30), The similar result were findings by Mulualem*et al*.(2013).

3.4 Genetic advance

Genetic advance is defined as the difference between the mean genotypic value of the selected lines and the mean genotypic value of the parental population. In the present study, GAM (Genetic advance as per cent of mean) was observed to benumber of seed per plant (93.74%), number of pod per plant (71.77%), seed yield per plant (68.60%), 100 seed weight (67.06%), pod volume (54.63%), titratable acidity (37.67%). Number of seed per pod (36.93%), specific gravity (33.87%), germination percent (33.35%), Total soluble solids (32.83%), number of branches per plant (32.56%), days to first fruit set (32.16%), plant height (21.76%), pod length (21.03%) and pod diameter (mm) (20.47%). Medium estimates of GA as percent of mean was recorded for days 50% flowering (13.92%), days to first flowering (12.88%) and the lowest GA was recorded in days to maturity (6.49%).The high estimates of genetic advance in per cent of mean (>20%) were recorded High estimates of GA as per cent of mean was recorded for number of seed per plant (93.74%), number of pod per plant (71.77%), seed yield per plant (68.60%), 100 seed weight(67.06%), pod volume (54.63%), titratable acidity (37.67%). Number of seed per pod (36.93%), specific gravity (33.87%), germination percent (33.35%), total soluble solids (32.83%), number of branches per plant (32.56%), days to first fruit set (32.16%), plant height (21.76%), Pod length (cm) (21.03%), Pod diameter (20.47%) The similar result were findings by *Fikreselassie and Seboka(2012).* Medium estimates of GA as percent of mean (>10-20%)was recorded for days 50% flowering (13.92%), days to first flowering (12.88%) and the lowest GA was recorded in days to maturity (6.49%).The similar result were findings by Afeta *et al.,(*2020),

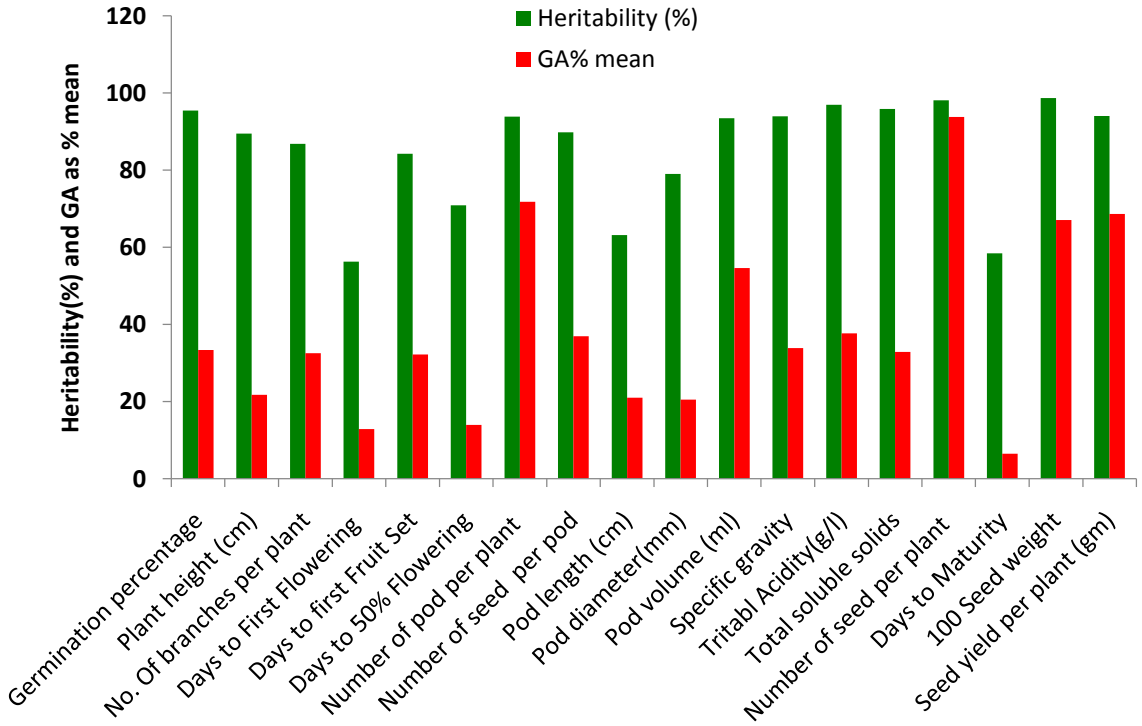

Fig.No.2 Heritability and GA (%) in different Characters of broad bean (*Vicia faba*L).

Table1 :- Mean Range, Genotypic and Phenotypic variation , Heritability, Genetic Advance percent mean , and Genotypic and Phenotypic coefficient of variation

Charecters	Mean	Min	Max	var (g)	var (p)	Heritability (%)	GA% mean	GCV (%)	PCV (%)
Germination Percentage	71.07	44.58	93.75	138.74	145.38	95.43	33.35	16.57	16.97
Plant Height (cm)	82.77	67.23	101.73	85.41	95.45	89.48	21.76	11.17	11.80
Number of branches	5.12	3.55	6.33	0.75	0.87	86.84	32.56	16.96	18.20
Days to first flowering	58.82	48.66	68.22	24.04	42.71	56.30	12.88	8.34	11.11
Days to first fruit Set	19.96	13.67	25.00	11.53	13.68	84.27	32.16	17.01	18.53
Days to 50% Flowering	61.59	50.00	70.67	24.42	34.44	70.90	13.92	8.02	9.53
Number of pod per plant	11.34	5.00	20.44	16.64	17.73	93.84	71.77	35.97	37.13
Number of seed per pod	2.82	1.80	3.80	0.29	0.32	89.79	36.93	18.92	19.97
Pod length (cm)	6.72	5.57	9.30	0.75	1.18	63.14	21.03	12.85	16.17
Pod diameter(mm)	14.91	11.91	18.37	2.78	3.52	78.97	20.47	11.18	12.58
Pod volume (ml)	29.39	24.00	55.00	64.97	69.51	93.47	54.63	27.43	28.37
Specific gravity	0.87	0.66	1.21	0.02	0.02	93.91	33.87	16.96	17.51
Titratable Acidity(g/l)	0.40	0.26	0.54	0.01	0.01	96.97	37.67	18.57	18.86
Total soluble solids	6.96	5.40	9.30	1.28	1.34	95.87	32.83	16.28	16.62
Number of seed per plant	29.89	11.93	60.15	188.60	192.33	98.06	93.74	45.95	46.40
Days to Maturity	122.65	112.33	132.33	25.60	43.84	58.40	6.49	4.13	5.40
100 Seed weight	61.17	38.62	110.20	401.81	407.14	98.69	67.06	32.77	32.99
Seed yield/ plant (gm)	16.89	6.53	29.51	33.63	35.76	94.04	68.60	34.34	35.41

4. CONCLUSION

It was concludedthat the number of seed per plant, number of pod per plant and seed yield per plant exhibited high estimates of both PCV and GCV, indicating the presence of adequate variability for these particular characters within the population. Additionally, the heritability for the characters of 100 seed yield, number of seed per plant, titratable acidity (g/l), total soluble solids (TSS) and genetic advance for the number of seed per plant, number of pod per plant, seed yield per plant, 100 seed weight per plant were found to be significant indicating that these characters were predominantly governed by additive gene action. The findings of this study hold significant implications for future breeding programs and genetic improvement strategies. The identified high heritability and genetic advance for the above-mentioned characters suggest that these characteristics can be effectively manipulated through selective breeding to develop improved and high-yielding plant varieties.

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