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EVALUATION OF BROAD BEAN GENOTYPES FOR YIELD AND QUALITY TRAITS UNDER LUCKNOW AGRO CLIMATIC CONDITIONS

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ABSTRACT

The present investigation was conducted to assess the performance of eighteen broad bean (*Vicia faba* L.) genotypes for growth, yield and quality traits under Lucknow conditions during the Rabi season of 2021–22. The experiment was laid out in a Randomized Block Design with three replications at the Research Farm-1, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow. Observations were recorded on eighteen characters including germination percentage, plant height, number of branches, flowering and maturity parameters, pod and seed traits, yield components, and quality attributes. Analysis of variance revealed highly significant differences among genotypes for all the characters studied, indicating wide genetic variability. Germination percentage ranged from 44.58 to 93.75%, number of pods per plant from 5.00 to 20.44 and seed yield per plant from 6.53 to 29.51 g. Genotype EC-628940 exhibited the highest seed yield per plant, followed by EC-841580 and EC-628934. Considerable variation was also observed for pod length, pod diameter, pod volume, number of seeds per pod and 100-seed weight. The identified superior genotypes may be utilized for yield improvement and future breeding programmes of broad bean under North Indian agroclimatic conditions.

Keywords: variability analysis, quality traits, genotypes, yield attributes, genetic variability.

Introduction

The broad bean (*Vicia faba* L.) 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, and tic bean, kala katar 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 vary 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.

Winter cultivars have 4-6 stems/plant and the spring cultivars have 1-2 stems/plant. The root is typical tap root with secondary roots and nodules due to *Rhizobium leguminosarum v. viciae*. Stem growth is indeterminate. There are leaves up to 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).

Materials 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°50 North latitude and 80°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 Agroclimatic zone 5th 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 replications, each

having 18 plots and each plot replace by has 1 germplasm. The spacing row to row were 45 cm and plant to plant spacing 15 cm. The observation were recorded to determination 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).

Table 1 : List of broad bean genotypes used in the study and their source.

S. No.	Genotypes	Source
1	EC-841540	ICAR- IIVR, Varanasi
2	EC-628934	ICAR- IIVR, Varanasi
3	EC-841595	ICAR- IIVR, Varanasi
4	EC-628940	ICAR- IIVR, Varanasi
5	EC-1521	ICAR- IIVR, Varanasi
6	EC-841532	ICAR- IIVR, Varanasi
7	EC-841587	ICAR- IIVR, Varanasi
8	EC-591828	ICAR- IIVR, Varanasi
9	EC-841577	ICAR- IIVR, Varanasi
10	EC-841580	ICAR- IIVR, Varanasi
11	EC-841563	ICAR- IIVR, Varanasi
12	EC-841597	ICAR- IIVR, Varanasi
13	EC-841603	ICAR- IIVR, Varanasi
14	EC-841617	ICAR- IIVR, Varanasi
15	EC-628939	ICAR- IIVR, Varanasi
16	EC-841579	ICAR- IIVR, Varanasi
17	EC-628930	ICAR- IIVR, Varanasi
18	EC-841571	ICAR- IIVR, Varanasi

Statistical Analysis

The experimental data collected in respect of 18 characters on 18 broad bean genotypes during 2021-22 was compiled by taking the mean values of selected plants in each plot and subjected for following statistical analysis. For analysis of data, statistical methods selected are given below

Analysis of variance

The Analysis of variance (ANOVA) of the observations recorded on different characteristics was carried out as per the standard procedure is given by Panse and Sukhatme (1967). The significance was tested by referring to the values of F table (Fisher and Yates, 1963).

Estimation of mean and range

The mean value of each character was estimated by dividing the sum total by the corresponding number of observations.

$$\text{Mean } (\bar{x}) = \frac{\sum x}{N}$$

Where, $\sum x$ = sum of all observation for each character in each replication

N = number of observations

Range: It was taken as the difference between the highest and lowest mean value for each character.

$$\text{Range} = [X_n - X_1]$$

Where X_n = highest mean value of the character

X_1 = lowest mean value of the character

Results and Discussion

The analysis of variance (ANOVA) for yield and its contributing characters under study are presented in table 2. The mean sum of squares for genotypes found to be significant for the traits viz, germination percent, plant height number of branches per plant, days to first

flowering, days to first fruit set, days 50 %flowering, number of pod per plant, number of seed per pod, pod length, pod diameter, pod volume, specific gravity, titratable acidity, total soluble solids, number of seed per plant, days to maturity, 100 seed weight seed yield per plant. The character wise mean performance of genotype presented table-3.

Analysis of variance

The analysis of variance for 18 different plant growth characters is presented in Table-2 It is revealed from the data that there were highly significant differences among the broad bean genotypes for all the 18 growth characters under study, showing wide range of variation.

Table 2: Analysis of variance for different characters of broad bean (mean sum of squares)

S.N.	Source of variation	Replication	Treatment	Error	Total
1	Germination percent	4.95	422.86**	6.64	140.08
2	Plant height(cm)	9.50	266.27**	10.04	92.21
3	No. of branches	0.31	2.38**	0.11	0.85
4	Days to first flowering	0.19	90.80**	18.67	41.11
5	Days fifty % flowering	18.30	83.28**	10.02	33.83
6	Days to first fruit set	2.07	36.74**	2.15	13.24
7	Days to maturity	70.30	95.04**	18.24	44.84
8	Number of pods per plant	0.87	51.02**	1.09	17.10
9	Pod length (cm)	0.06	2.67**	0.43	1.14
10	Pod diameter (mm)	0.68	9.08**	0.74	3.41
11	Pod volume (ml)	16.89	199.46**	4.54	67.53
12	Specific gravity	0.0015	0.0668**	0.0014	0.0223
13	Titratable acidity (g/l)	0.0020	0.0171**	0.0002	0.0056
14	Total soluble solid	0.01	3.90**	0.06	1.29
15	Number of seed per pod	0.17	0.89**	0.03	0.31
16	Number of seed per plant	3.04	569.53**	3.72	185.18
17	100 seed weight	0.38	1210.75**	5.34	391.79
18	Seed yield per plant	2.12	103.02**	2.13	34.49
	Degrees of freedom	2	17	34	53

Mean Performance

Range (maximum and minimum) and mean performance of genotypes of broad bean for all the characters are presented in Table 3.

The germination percentage varied from 44.58 to 93.75, with an overall mean performance of 71.07 followed by on the basis of mean performance, the minimum germination occurred in EC-841587 (44.58) followed by EC-628929 (53.33), EC-841579(57.92) and EC-841532 (61.30) where highest germination was recorded in EC-841580 (93.75) followed by EC-841571(86.67), EC-841603(81.25) and EC-628930 (79.17). Similar variability in germination among faba bean genotypes has been reported earlier, attributing it

to genetic constitution and seed quality differences (Singh *et al.*, 2015).

The plant height varied from 67.23 to 101.73, with an overall mean performance of 82.77 On the basis of mean performance, the lowest plant height was recorded in EC-841617 (67.23) followed by EC-841532 (70.63), EC-628939(70.95) and EC-841597 (73.26) where highest plant height was recorded in EC-628934(101.73) followed by EC-841595 (99.67), EC-841587 (93.97) and EC-628940 (89.66). . These findings are in conformity with earlier studies reporting a positive association between vegetative traits and yield components in faba bean (Kumar *et al.*, 2017; El-Sayed *et al.*, 2020).

Number of branches per plant varied from 3.55 to 6.33, with an overall mean performance of 5.12. On the basis of mean performance, the minimum branches was recorded in EC-841532 (3.55) followed by EC-841603 (3.67), EC-628939 (4.33) and EC-841597 (4.44) whereas, the highest branches recorded in EC-628940 (6.33), EC-841580 (6.33) followed by EC-841563 (6.11) and EC-628934 (6.22).

Days to first flowering varied from 48.66 to 68.22, with an overall mean performance of 58.82. On the basis of mean performance, the earlier days to first flowering was recorded in EC-841577 (48.66), followed by EC-628930 (50.66), EC-841579 (51.11), and EC-628939 (54.78) whereas, the days to first flowering in EC-841540 (68.22) followed by EC-841580 (66.22) and EC-628940 (65.89) occurred at last.

Days to 50% flowering varied from 50.00 to 70.67, with an overall mean performance of 61.59 on the basis of mean performance, the earliest 50% flowering was recorded in EC-841577 (50.00) followed by EC-628930 (52.33), EC-628929 (57.67) and EC-841579 (58.63) whereas, the 50% flowering occurred very late in EC-628940 (70.67) followed by EC-841580 (66.67) and EC-841571 (65.67). Similar observations emphasizing the role of earliness in adaptation and yield stability have been reported by Bakry *et al.* (2016).

Days to first fruit set from flowering varied from 13.67 to 25, with an overall mean performance of 19.96. On the basis of mean performance, the earlier days to first fruit setting from flowering was recorded in EC-841540 (13.67), EC-628940 (13.67), followed by EC-841580 (15.00), EC-841595 (15.67) whereas, the days to first fruit setting from the flowering in EC-591828 (25.00) followed by EC-628930 (23.67) and EC-841617 (23.00) occurred at last.

Number of pods per plant varied from 5.00 to 20.44, with an overall mean performance of 11.34. On the basis of mean performance, the minimum number of pods per plant occurred in EC-841579 (5.00) followed by EC-841571 (5.55) and 628930 (6.44), and whereas highest number of pods was recorded in EC-628940 (20.44) followed by EC-841532 (16.67), EC-628934 (15.67) and EC-841580 (15.44). Pod number is widely regarded as the most important yield component in faba bean, and similar associations have been reported by Alghamdi (2009) and Mahmoud *et al.* (2018).

Days to maturity varied from 112.33 to 132.33, with an overall mean performance of 122.65. On the basis of mean performance, the earlier days to maturity was recorded in genotype EC-84177 (112.33) followed by EC-841563 (122.67) and EC-841579 (115.00) whereas, the maximum days to maturity was observed in EC-841540 (132.33) followed by EC-1521 (129.00) and EC-628939 (128.33).

Pod length varied from 5.57 to 9.30 with an overall mean performance of 6.72. On the basis of mean performance, the minimum pod length was found in genotype EC-841577 (5.57), followed by EC-628929 (6.07), EC-841563 (6.07), and EC-841617 (6.13) whereas, maximum pod length were observed in genotype EC-841577 (9.30) followed by EC-628934 (8.40), EC-841595 (7.73) and EC-84180 (7.20). Larger pod size is an important quality attribute influencing market preference and yield. Comparable ranges and variability in pod traits have been reported earlier in broad bean by Singh and Bharadwaj (2015) and El-Naim *et al.* (2017).

Pod diameter varied from 11.91 to 18.37 with an overall mean performance of 14.91. On the basis of mean performance, the minimum pod diameter was found in genotype EC-628940 (11.91), followed by EC-591828 (12.81), EC-841580 (12.84) and EC-1521 (12.93) whereas, maximum pod diameter was observed in genotype EC-841577 (18.37) followed by EC-841579 (18.09), EC-628939 (16.43) and EC-628934 (16.32). Variability in specific gravity and related physical quality traits in faba bean pods has also been reported by Ghobary and Mohamed (2014).

Pod volume varied from 24 to 55.00 with an overall mean performance of 29.39. On the basis of mean performance, the minimum pod volume was found in genotype EC-628939, EC-841571, EC-841597, EC-591828, EC-628940 (24ml), followed by EC-841580 (25ml) and EC-841617 (27ml), whereas, maximum pod volume was observed in genotype EC-841577 (55ml) followed by EC-841595 (45ml), EC-841563 (32ml) and EC-841579 (32ml).

Specific gravity varied from 0.66 to 1.21 with an overall mean performance of 0.87. On the basis of mean performance, the minimum specific gravity was found in genotype EC-841540 (0.66), followed by EC-1521 (0.68), EC-591828 (0.72), EC-591828, and EC-841577 (0.74), whereas, maximum specific gravity was observed in genotype EC-841579 (1.12) followed by EC-628934 (1.07), EC-841597 (1.06) and EC-628939 (1.04).

Table 3 : Mean performance eighteen genotypes of broad bean and eighteen characters.

S.N. Genotypes	Germination %	Plant height (cm)	No. of branches /plant	Days to First Flowering	Days to 50% Flowering	Days to first Fruit Set	Number of pods per plant	Pod length (cm)	Pod diameter (mm)	Pod volume (ml)	Specific gravity	Titratable Acidity (g/l)	Total soluble solids	Days to Maturity	Number of seed per pod	Number of seed per plant	100 Seed weight	Seed yield /plant (gm)
1 EC-841540	65.83	82.65	4.66	68.22	70.33	13.67	9.78	6.20	14.53	30.00	0.66	0.26	6.00	132.33	2.40	23.09	51.25	11.83
2 EC-628934	71.05	101.73	6.22	59.77	61.33	20.33	15.67	8.40	16.32	26.00	1.07	0.38	7.60	125.00	3.40	46.40	48.82	23.68
3 EC-841595	77.50	99.67	5.66	56.11	59.67	15.67	12.33	7.73	16.27	45.00	0.80	0.31	7.30	118.33	2.80	26.84	59.52	17.15
4 EC-628940	78.08	89.66	6.33	65.89	70.67	13.67	20.44	6.23	11.91	24.00	0.81	0.33	7.80	126.67	3.20	60.15	46.32	29.51
5 EC-1521	69.33	76.53	5.22	58.11	60.33	21.33	11.66	6.20	12.93	25.00	0.68	0.28	5.90	129.00	3.80	30.33	38.62	17.11
6 EC-841532	61.30	70.63	3.55	59.89	64.00	22.00	16.67	6.73	14.67	28.00	0.91	0.41	6.50	126.67	2.40	37.41	50.48	17.02
7 EC-841587	44.58	93.97	4.55	58.78	62.33	21.67	9.55	5.57	14.61	26.00	0.86	0.46	5.70	122.33	2.40	23.94	82.05	19.23
8 EC-591828	75.42	83.78	5.22	59.44	62.33	25.00	10.11	6.17	12.81	24.00	0.72	0.49	5.90	126.67	3.00	17.60	44.52	13.49
9 EC-841577	70.00	82.29	5.99	48.66	50.00	22.00	9.11	9.30	18.37	55.00	0.74	0.44	7.80	112.33	1.80	41.00	110.20	21.73
10 EC-841580	93.75	80.04	6.33	66.22	66.67	15.00	15.44	7.20	12.84	25.00	0.90	0.54	5.60	123.33	3.80	55.22	51.55	26.67
11 EC-841563	68.00	85.20	6.11	57.89	61.33	22.00	14.55	6.07	14.76	32.00	0.79	0.38	7.30	112.67	3.00	30.67	47.37	14.12
12 EC-841597	69.33	73.26	4.44	62.89	64.33	20.00	13.44	6.00	15.45	24.00	1.06	0.41	6.30	121.33	3.40	25.00	48.32	16.75
13 EC-841603	81.25	80.24	3.67	61.44	62.00	21.33	11.22	7.17	14.60	30.00	0.75	0.49	6.40	124.33	2.80	23.75	51.28	13.96
14 EC-841617	76.67	67.23	5.66	55.00	59.00	23.00	9.55	6.13	14.27	27.00	0.90	0.46	7.60	125.00	2.40	35.51	83.25	18.86
15 EC-628939	53.33	70.95	4.33	54.78	57.67	22.67	7.66	6.07	16.43	24.00	1.04	0.36	8.50	128.33	2.60	18.86	82.45	15.41
16 EC-841579	57.92	85.24	4.44	51.11	58.67	16.67	5.00	6.60	18.09	32.00	1.21	0.41	5.40	115.00	2.20	11.93	87.31	8.93
17 EC-628930	79.17	85.01	4.55	50.66	52.33	23.67	6.44	6.50	15.22	28.00	0.83	0.44	8.30	119.00	2.60	15.82	74.12	12.02
18 EC-841571	86.67	81.83	5.22	64.00	65.67	19.67	5.55	6.67	14.28	24.00	0.93	0.46	9.30	119.33	2.80	14.42	43.57	6.53
Mean	71.07	82.77	5.12	58.82	61.59	19.96	11.34	6.72	14.91	29.39	0.87	0.40	6.96	122.65	2.82	29.89	61.17	16.89
Min	44.58	67.23	3.55	48.66	50.00	13.67	5.00	5.57	11.91	24.00	0.66	0.26	5.40	112.33	1.80	11.93	38.62	6.53
Max	93.75	101.73	6.33	68.22	70.67	25.00	20.44	9.30	18.37	55.00	1.21	0.54	9.30	132.33	3.80	60.15	110.20	29.51
SE(d)	2.10	2.59	0.28	3.53	2.59	1.20	0.85	0.54	0.70	1.74	0.03	0.01	0.19	3.49	0.15	1.58	1.89	1.19
C.D.	4.29	5.28	0.56	7.20	5.28	2.45	1.74	1.10	1.43	3.55	0.06	0.02	0.39	7.12	0.30	3.22	3.85	2.43
C.V.	3.63	3.83	6.60	7.35	5.14	7.35	9.21	9.82	5.77	7.25	4.31	3.15	3.38	3.48	6.38	6.46	3.78	8.68

Titrateable acidity varied from 0.26 to 0.54 with an overall mean performance of 0.40. On the basis of mean performance, the minimum titrateable acidity was found in genotype EC-841540(0.26), followed by EC-841595 (0.31), EC-628940 (0.33) and EC-628939 (0.36) whereas, maximum titrateable acidity were observed in genotype EC-841580(0.54) followed by EC-591828, EC-841603(0.49) and EC-841587, EC-841617, EC-841571(0.46). Similar genotypic variation in acidity and biochemical traits of faba bean pods has been reported by Yadav *et al.* (2020)

Total soluble solids varied from 5.40 to 9.30 with an overall mean performance of 6.96. On the basis of mean performance, the minimum TSS was found in genotype EC-841579(5.40), followed by EC-841580 (5.60) and EC-841587(5.70) whereas, maximum TSS were observed in genotype EC-841571(9.30) followed by EC-628939(8.50) and EC-628930(8.30). Similar variability for quality traits in faba bean has been reported earlier (Ghobary and Mohamed, 2014; Yadav *et al.*, 2020).

Number of seed per pod varied from 1.80 to 3.80, with an overall mean performance of 2.82. On the basis of mean performance, the minimum number of seed per pod was found in genotype EC-841577(1.80), followed by EC-841579 (2.20) and EC-841617 (2.40), whereas, maximum number of seed per pod were observed in genotype EC-841580 (3.80) and EC-1521(3.80) followed by EC-828934 (3.40) and EC-841597(3.40). These findings agree with earlier reports indicating that seed number and seed size are major determinants of yield in faba bean (Suso *et al.*, 2016; Khan *et al.*, 2019).

Number of seed per plant varied from 11.93 to 60.15, with an overall mean performance of 29.89. On the basis of mean performance, the minimum number of seed per plant was found in genotype EC-841579(11.93), followed by EC-841571 (14.42) and EC-628930 (15.82), whereas, maximum number of seed per plant were observed in genotype EC-628940 (60.15) followed by EC-841580(55.22) and EC-628934 (46.40). Seed number is widely recognized as one of the most important yield-determining components in faba bean. Similar findings have been reported by Mahmoud *et al.* (2018) and Suso *et al.* (2016).

100 seed weight varied from 38.62 to 110.20, with an overall mean performance of 61.17. On the basis of mean performance, the minimum 100 seed weight was recorded in genotype EC-1521(38.62gm) followed by EC-841571(43.57gm) and EC-591828(44.52gm) whereas, the maximum 100 seed weight observed in

EC-841577(110.20gm) followed by EC-841579(87.31gm) and EC-841617(83.25gm). The influence of seed weight on yield and market value in faba bean has also been highlighted by Khan *et al.* (2019).

Seed yield per plant varied from 6.53 to 29.51, with an overall mean performance of 16.89. On the basis of mean performance, the minimum seed yield per plant was recorded in genotype EC-841571(6.53) followed by EC-841579 (8.93) and EC-841540(11.83gm) whereas, the maximum seed yield per plant observed in EC-628940 (29.51) followed by EC-841580 (26.67) and EC-628934(23.68). Similar conclusions regarding the cumulative effect of yield attributes on seed yield in faba bean have been reported by Alghamdi (2009) and Kumar *et al.* (2017).

Conclusion

The study revealed significant genetic variability among the eighteen broad bean (*Vicia faba* L.) genotypes for all growth, yield and quality traits under Lucknow conditions. Genotypes EC-628940, EC-841580, and EC-628934 exhibited superior performance for seed yield and associated characters. The observed variability provides ample scope for selection and the identified promising genotypes may be utilized in future breeding programs and further evaluated under multilocation trials.

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