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Exploring genetic variability, heritability and genetic advance in faba bean (*Vicia faba* L.) at Chhattisgarh

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Abstract
An experiment was conducted during in 2022-23 at Hi-Tech-Nursery, Dau Kalyan Singh College of Agriculture and Research Station, Bhatapara, Indira Gandhi Krishi Vishwavidyalaya, (Chhattisgarh). The result of analysis of variance revealed highly significant difference among 43 genotypes and 4 check varieties indicated presence of good amount of variability–AFB-22-2, AFB-22-1 and HB-53 was superior among all the genotype for number of primary branches, day to 50% flowering, marketable pod weight, pod length (cm), number of pods per plant, number of seeds per pod and marketable pod yield per plant (g). The estimates of phenotypic coefficient of variation were marginally higher than the corresponding genotypic coefficient of variation. Marginal value of marketable pod yield per plant (g) was estimated to be highest among all the characters as well as in case of heritability and genetic advance it was estimated highest among all.

Keywords: Variability, GCV, PCV, heritability, genetic advance

Introduction
Faba bean (*Vicia faba* L.) is commonly known as the Bakala, kala Matar, broad bean, fava bean or horse bean and belongs to the family Fabaceae and its chromosome number is 2n =2x = 12, 14. The Near East Asia is considered a center of origin for faba bean (Cubero, 1974) [4]. It is a self-pollinating annual plant that is stiffly straight and grows from 0.5 to 1.8 m tall. It is an effective source of levodopa (L-dopa), a precursor to dopamine and a source of lysine-rich protein, both of which have the potential to be used as Parkinson disease treatments (Oplinger, 1982; Vered *et al*., 1997) [9, 17]. It is used as a vegetable, green or dried, fresh or canned (Bond *et al*., 1985) [2]. The production of faba beans increased by about 25% from 4.35 million metric tonnes in 1990 to 5.43 million metric tonnes in 2019 from 2.55 million ha. China is responsible for about 60% of global output. The faba bean is a popular pulse in areas of West Asia and North Africa, but it is classified as a potential legume in India (Arya *et al*., 2019) [1]. At present, global collection of faba bean germplasm kept in various seed/field gene bank of the respective country is more than 30000 accessions (Singh and Bhatt, 2012) [14]. Considering the importance and high demand for faba beans, there is a critical need to enhance them in hopes of improving output and productivity. For effective selection of superior genotypes, understanding of genetic variability in the available varieties is a requirement. As a consequence, the faba bean needs to be improved for the Chhattisgarh area.

Materials and Methods
The present investigation was carried out during 2022-23 at Hi-Tech-Nursery, Dau Kalyan Singh College of Agriculture and Research Station, Bhatapara, Indira Gandhi Krishi Vishwavidyalaya, (Chhattisgarh). The research was carried out in Augmented Design which was suggested by federer (1956) [5] involving 47 genotypes (43 germplasm and 4 checks VIKRANT, GIZA-4, HFB-1 and HFB-2). Observation were recorded on 5 randomly selected plants for each genotype for plant height (cm), number of branches per plant, days to first flowering, days to 50% flowering, marketable pod weight, 100 seed weight (g), pod length (cm), number of seeds per pod, number of pods per plant and marketable pod yield per plant (g). The GCV and PCV were calculated using the following formula as suggested by Burton and Devane (1953) [3]. The improvement in the mean genotypic value of a selected plant over its parental population is referred to as genetic advance. It is a measurement of genetic improvement due to selection. By using the formula provided by Johnson *et al*. (1955) [6].

Estimation of heritability in a broad sense was suggested by the Robinson (1966) [11].

Results and Discussion

The mean sum of square due to genotypes was found significant for nine quantitative characters under study. Significant variation was observed among the genotypes for all characters except one (pod length). The genotypic and error mean sum squares were further used for analysis of genotypic and phenotypic variances. Analyses of variance are given Table 1.

Mean performance of genotypes

The observed of mean performance are given in Table 2. Mean performance of various genotypes showed wide range of variation for most of the traits studied. But some traits showed more variation like plant height (39.90 to 54.44 cm), number of primary branches per plant (2.8 to 8.6), days to 50% flowering (59.8 to 79), 100 seed weight (g) (22.15 to 42.25), number of pods per plant (10 to 31.8) and marketable pod yield per plant (28.22 to 136.28 g) indicates sufficient variation among the genotypes for above traits. AFB-22-2 followed by AFB-22-1 and HB-53 was superior among all the genotype for number of primary branches, pod length, number of pods per plant, number of seeds per pod and marketable pod yield per plant was observed in AFB-22-2 whereas significantly minimum marketable pod yield per plant was observed in ET-226474.

Phenotypic and genotypic coefficient of variation (PCV and GCV): The estimates of PCV and GCV are given in Table 3. The phenotypic coefficients of variation were higher than the corresponding genotypic coefficient. The highest phenotypic coefficient of variation was recorded for marketable pod yield per plant (g) followed by number of pods per plant, marketable pod weight and number of primary branches per plant. The highest genotypic coefficient of variation was high for marketable pod yield per plant (g) followed by number of pods per plant, marketable pod weight, and number of primary branches per plant. Similar results were found by Mulualem *et al*. (2013) [8], Osman (2013) [10] and Sheelamary and Shivani (2015) [13].

Heritability (h^2) and genetic advance

The estimates of heritability (h2) and genetic advanced are given in Table 3. The highest heritability was observed for marketable pod yield per plant (g) (98.37%) followed by number of pods per plant (98.06%), plant height (cm) (97.5%), and number of primary branches per plant (97.47%). Similar results were reported by Toker (2004) [16], Sharifi (2015) [12], Kalia and Sood (2004) [7]. Genetic advance as percentage of mean showed higher values for marketable pod yield per plant (g) (77.49) followed by number of pods per plant (65.44), marketable pod weight (46.80), and number of primary branches per plant (45.58). Whereas, genetic advance as percentage of mean was observed moderate for days to first flowering (19.71) and pod length (cm) (16.51). Highest genetic advance as percentage of mean was estimated for marketable pod yield per plant (g) followed by number of pods per plant, marketable pod weight, and number of primary branches per plant. Whereas, moderate genetic advance as percentage of mean was observed for days to first flowering and pod length (cm). Similar result was found by Solieman and Ragheb (2014) [15].

Table 1: Analysis of variance for marketable pod yield and its attributing traits in Faba bean genotypes

		Mean sum of square		
S. No.	**Traits (d.f.)**	**Block (1)**	**Treatment (46)**	**Error (3)**
1	Plant height (cm)	417.816	15.785 **	0.545
2	Number of primary branches per plant	28.247	1.054 **	0.038
3	Days to first flowering	207.698	18.845 *	1.03
4	Days to 50% flowering	119.152	24.065 *	1.341
5	Marketable pod weight	2.972	0.879 *	0.047
6	100 Seed weight (g)	7.27	14.016 **	0.352
7	Pod length (cm)	2.901	0.284	0.065
8	Number of seeds per pod	1.694	0.350 *	0.034
9	Number of pods per plant	1342.24	17.039 *	0.81
10	Marketable pod yield per plant (g)	21158.9	337.499 **	12.103

Table 2: Mean performance of the genotypes for marketable pod yield and its component characters in Faba bean

Genotypes	A	B	C	D	E	F	G	H	I	J
ET- 2264	44.06	3.40	52.60	74.40	5.60	26.80	5.98	3.60	13.60	76.66
ET- 226411	50.60	5.00	46.00	67.60	2.86	22.90	6.08	2.00	10.40	30.08
ET- 226423	39.76	3.80	41.20	65.20	2.52	29.30	4.64	1.40	12.40	34.68
ET- 226425	40.52	4.20	52.40	73.40	2.56	30.95	4.28	2.40	11.80	30.68
ET- 226434	39.48	3.80	43.60	65.60	2.48	25.95	4.26	2.00	10.80	31.92
ET- 226464	43.22	5.00	52.80	78.40	3.20	28.10	5.30	2.20	15.00	46.50
ET- 226468	40.04	4.80	39.40	68.40	2.60	26.80	4.98	2.40	13.40	36.74
ET- 226472	41.50	4.80	55.80	75.40	5.28	29.80	5.64	3.00	11.80	58.10
ET- 226474	41.88	3.8.00	54.00	79.00	3.58	27.15	5.16	3.20	11.80	28.22
ET- 226480	44.54	4.60	52.20	71.60	5.50	28.90	6.10	4.00	10.00	56.68
ET- 226481	39.10	4.80	40.40	65.00	2.96	23.00	5.32	2.60	13.80	36.32
ET- 226487	38.86	3.40	53.60	74.40	3.18	26.30	4.64	2.60	10.20	33.64
ET- 2265	36.90	4.60	42.20	64.40	4.34	30.40	5.12	3.00	12.20	44.90
ET- 226528	39.64	3.20	50.40	75.40	3.42	24.00	4.98	3.20	12.60	39.42

ET- 226532	42.28	5.20	50.20	74.40	4.56	29.25	5.04	3.20	14.00	63.42
ET- 226568	37.00	2.80	55.20	76.60	3.96	25.55	5.06	2.80	10.60	38.92
ET- 252885	43.54	3.80	43.20	66.40	3.22	26.60	6.00	2.00	14.40	40.04
ET- 252887	38.22	3.60	52.00	74.80	2.62	30.50	4.94	2.00	12.80	31.64
RFB-15	43.32	4.40	41.40	70.20	3.42	22.45	5.86	3.40	22.60	73.60
RFB-35	47.62	6.60	42.80	69.20	3.94	24.20	5.04	3.00	23.80	88.28
RFB-37	49.18	6.40	41.60	66.40	4.28	27.10	6.48	4.20	24.80	88.46
RFB-38	48.88	5.80	46.00	64.40	2.46	26.75	5.68	3.20	24.00	63.86
RFB-39	52.94	6.40	45.60	69.80	4.20	27.90	6.08	3.60	26.20	92.44
RFB-40	51.90	6.20	47.00	63.60	4.34	30.80	5.44	3.00	18.40	79.40
RFB-43	48.52	6.20	40.20	63.40	4.34	28.25	6.38	3.40	22.60	89.14
RFB-44	42.68	6.40	41.00	65.80	3.32	22.15	5.60	3.60	21.60	73.26
RFB-45	46.88	6.40	39.40	69.00	4.34	24.10	5.90	3.40	22.20	78.20
HB-2	52.14	5.60	45.80	66.20	4.02	25.75	5.68	2.60	24.20	93.40
HB-14-36	47.60	5.80	43.80	74.40	3.14	25.80	6.02	3.60	28.00	87.80
HB-15-04	54.44	6.80	43.00	73.20	3.08	26.35	5.58	3.00	25.20	74.52
HB-15-21	47.28	5.80	40.20	66.40	4.06	25.80	5.10	2.80	25.60	94.30
HB-15-22	50.60	6.80	44.80	67.40	3.20	26.00	5.50	3.00	25.80	81.52
HB-15-34	47.20	5.60	39.00	68.60	3.56	31.75	5.50	3.00	26.20	88.48
HB-15-55	49.70	6.80	43.20	64.40	3.70	27.40	5.90	3.80	26.60	95.62
HB-16-03	49.70	5.60	45.00	68.40	3.76	25.70	5.30	3.00	27.60	97.52
HB-16-07	48.38	6.80	41.60	64.60	4.20	23.35	5.18	2.40	26.60	94.56
HB-16-15	51.40	6.80	44.80	65.20	4.84	26.55	6.06	3.00	28.80	112.32
HB-16-16	49.98	6.20	42.20	64.40	3.44	23.95	5.72	3.80	24.80	82.40
HB-53	53.74	4.60	42.00	59.80	6.46	42.25	6.54	3.20	28.00	128.16
HB-70-52	51.88	6.40	42.00	63.80	3.48	38.40	6.32	2.80	28.20	93.48
FB-04	51.04	6.40	41.40	58.80	5.22	29.80	5.22	2.20	23.80	106.70
AFB-22-1	44.20	7.40	43.60	63.20	4.56	22.95	6.24	3.20	29.00	116.08
AFB-22-2	46.00	8.60	43.20	65.20	6.28	27.75	6.78	4.00	31.80	136.28
HFB-1	42.40	4.40	41.90	60.20	4.30	23.90	5.60	3.40	16.00	60.00
Giza-4	43.30	5.90	44.80	63.70	4.40	27.80	6.00	3.46	17.50	63.10
VIKRANT	44.70	5.00	41.20	60.70	4.10	26.80	5.60	3.46	16.10	66.90
HFB-2	42.60	4.60	47.30	64.90	4.30	28.20	5.40	3.10	16.40	67.80
Mean	45.77	5.38	45.29	68.51	3.86	27.33	5.54	2.97	19.95	71.35
CD	2.34	0.61	3.23	3.68	0.69	1.88	0.81	0.58	2.86	11.07
CV	3.21	0.84	4.42	5.04	0.94	2.58	1.11	0.80	3.92	15.15

A - Plant height (cm)
B - Number of primary branches per plant
C - Days to first flowering
D - Days to 50% flowering
E - Marketable pod weight
F - 100 Seed weight (g)
G - Pod length (cm)
H - Number of seeds per pod
I - Number of pods per plant
J - Marketable pod yield per plant (g)

Table 3: Mean, genetic variability, heritability and genetic advance

S. No.	Character	General Mean	Coefficient of Variability		h^2 (broad Sense) %	Genetic Advance	Genetic Advance as % of Mean
			GCV %	PCV %			
1	Plant height (cm)	45.77	10.08	10.20	97.5	9.38	20.50
2	Number of primary branches per plant	5.38	22.41	22.70	97.47	2.45	45.58
3	Days to first flowering	45.29	9.81	10.07	95.05	8.93	19.71
4	Days to 50% flowering	68.51	6.54	6.76	93.75	8.94	13.06
5	Marketable pod weight	3.86	23.37	24.03	94.51	1.80	46.80
6	100 Seed weight (g)	27.33	12.86	13.04	97.24	7.14	26.13
7	Pod length (cm)	5.54	9.00	10.10	79.31	0.91	16.51
8	Number of seeds per pod	2.97	18.57	19.58	89.94	1.07	36.29
9	Number of pods per plant	19.95	32.08	32.39	98.06	13.05	65.44
10	Marketable pod yield per plant (g)	71.35	37.92	38.23	98.37	55.29	77.49

Conclusion

The analysis of variance revealed highly significant variation among the genotypes for nine characters studied. High estimates phenotypic coefficient of variation and genotypic coefficient of variation were observed in marketable pod yield per plant and number of pods per plant. Highest heritability was observed for marketable pod yield per plant (g). Genetic advance as percentage of mean was observed highest in character marketable pod yield per plant (g).

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