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Performance of Promising Common Bean (*Phaseolus vulgaris* L.) Germplasm At Kalam-Swat

[1]Amanullah, [1]Asad Ali Khan, [2]Khalid Nawab and [3]Quahir Sohail
[1]Department of Agronomy, NWFP Agricultural University, Peshawar, Pakistan
[2]Department of Extension Education and Communication, NWFP Agricultural University, Peshawar, Pakistan
[3]Institute of Biotechnology and Genetic Engineering, NWFP Agricultural University, Peshawar, Pakistan

Abstract: More than 50 germplasm of common beans (*P. vulgaris* L.) collected from FATA (Federally Administered Tribal Areas) and neglected pockets of NWFP were evaluated at the sub-Research Station of Kalam-Swat during summer 1999. The grain yield performance of 25 each yielding germplasm including 9 from Swat (CB-01, 03, 07, 09, 11, 13, 16, 17 and 39), 4 each from Tirah (CB-15, 31, 32 and 33) and Gilgit (CB-08, 18, 19 and 25), 3 from Dir (CB-02, 06 and 14), 2 each from North Waziristan (CB-05 and 15) and Chitral (CB-10 and 20) and one from Mansehra (CB-04) in relation to other important agronomic characters was tested again at the sub-Research Station of Kalam-Swat during summer 2000. Based on the grain yield potential, the germplasm were divided into three groups in descending order. Germplasm CB-16 ranked first by producing maximum yield of 3457 kg ha^{-1}, followed by germplasm CB-09 with 3086 kg ha^{-1} while, minimum yield of 1111 kg ha^{-1} was obtained by germplasm CB-25. Average grain yield in groups decreased in descending order from 3003 kg ha^{-1} in group I to 2356 kg ha^{-1} in group II and then further decreased to 1609 kg ha^{-1} in group III. Similarly the average values of 100-seed weight, pods per plant and harvest index decreased in descending order and showed positive relationship with grain yield. Plant height and branches per plant showed positive association with dry matter yield.

Key words: Common bean, germplasm, grain yield

INTRODUCTION

Malnutrition one of the major problem in Pakistan is mainly due to protein deficiency in our diet. Pulses are the major and cheaper source of protein as compared to animal protein. The production of pulses which are high yielding, disease resistant and environmentally adaptable is the key to overcome the malnutrition problem. The development of such cultivars need an ample and diversified gene bank of pulses germplasm. The poor yields and overall production of many food legumes (pulses) in Pakistan may be attributed to several major constraints which include; strong competition from other food and cash crops which gave better economic returns, lack of effective research programmes and shortage of experienced personnel and so the inevitable constraints on varietal improvement, plant introduction and germplasm evaluation, lack of production technologies designed to maximize resource use and so ineffective crop management, inadequate extension services whereby information about new technologies can be channeled to the farming community and the poor state of seed multiplication, certification and distribution systems.

Common bean (*Phaseolus vulgaris* L.) is called with several common names viz., french beans, frijoles garden bean, green bean, italian bean, kidney bean, pole bean, romano bean, summer bean, runner bean, snap bean, string bean, yellow bean, wax bean, dry bean or navy bean (Srinives, 1993). Arnon (1972) reported that field bean (*Phaseolus vulgaris* L.) are very susceptible to frost and can be grown in spring only when the soil has warmed up sufficiently. High summer temperatures on the other hand, cause a considerable amount of flower shedding and poor seed set In Pakistan it is grown only in Kalam and Kaghan valleys. Amanullah and Hatam (1999) tested more than 50 common bean (*Phaseolus vulgaris* L.) germplasm collected from Swat, Dir, Parachinar, Tirah, Gilgit, Mansehra, North Waziristan and Chitral were tested at the Agriculture sub-station at Kalam-Swat during summer 1999. They observed significant variation in all the parameters studied. Based on the rain yield potential, the germplasm were divided into three groups in descending order. Group I consisted of 10 germplasm (2166-3310 kg ha^{-1}) gave 42% higher yield than group II which consisted of 12 germplasm (1133-1977 kg ha^{-1} and 72% higher yield than group III

Corresponding Author: Dr. Amanullah, Department of Agronomy, NWFP Agricultural University Peshawar, Pakistan
Tel: 0300-5741363

which consisted of 11 germplasm (333-944 kg ha^{-1}). Common bean has promising future and attempt should be made to improve yields through development of the specific varieties and better agronomic practices. It provides a highly nutritious and palatable protein-rich food. They reported that despite its potential and importance no research have been reported in Pakistan, there is need for development of high yielding varieties which are resistant to major pests and diseases. Research on management practices, such as fertilizer requirements, time of planting and plant population and on nutritive value is needed. Research on nitrogen fixation also needs attention. Appropriate production technology will increase production on one hand and decrease import on the other to save foreign exchange. Improvement in production will lead to attain self sufficiency which will decrease malnutrition and protein deficiency in diets and particularly will decrease dependence on costly animals proteins.

Amanullah *et al.* (2000) reported the positive relationship of grain yield with dry matter and harvest index. Amanullah and Hatam (2000) found positive relationship of grain yield with branches and pods per plant, pod length, seeds per pod, 100-seed weight, dry matter yield and harvest index. Ahmad *et al.* (2000) reported positive association of grain yield with branches and pods per plant, plant height, biological yield, seeds per pod, 100-seed weight and harvest. Hassan *et al.* (1995) reported high heritability (91%) for pod length and 1000-seed weight (81%) and low heritability (48%) for pods per plant and very low for grains per pod. Muhammad *et al.* (1994) reported that yield variation was mainly due to number of pods/plant and number of seeds/pod. Choudhry *et al.* (1991) noted maximum heritability for dry matter and green fodder yield. Highly significant and positive correlation was noted for green fodder yield, crude protein, dry matter, leaf area and number of leaves/plant except for branches/plant which showed negative association. Jatasra and Dahiya (1988) reported that forage yield was significantly and positively correlated with leaf weight, stem weight, plant height and branch number. Stem weight showed the highest direct effect on both green fodder and dry matter yields, followed by leaf weight. Thiyagarajan and Rajasekaran (1993) reported that the high yielding genotypes which were mostly medium to tall and had medium to high values for primary branches/plant, pods/plant, pod length, seeds/pod and 100-grain weight. Ellis *et al.* (1994) reported that in TVu1188, rate of progress towards flowering was affected by both temperature and photoperiod. Ram *et al.* (1994) found high heritability and high genetic advance for plant height, seed yield/plant and pods/plant. Seed yield was correlated with pods/plant, plant height and branches/plant. Sawant (1994) reported high phenotypic and genotypic coefficients of variation for plant height, seed yield/plant, pods/plant, inflorescence/plant and 10-seed weight. High heritability and high genetic advance was observed for plant height, seed yield/plant, pods/plant, 100-seed weight, inflorescence/plant, branches/plant and pod length. Seed yield was significantly and positively correlated with branches/plant and inflorescence/plant. Pods/plant had the highest positive direct effect on seed yield followed by 100-seed weight, seeds/pod, days to 50% flowering, inflorescence/plant, harvest index, plant height and pod length.

As the consumption of common bean in Pakistan is more than its production, therefore large amount is spent on its import every year. Identification of higher yielding germplasm will lead to self sufficiently on one hand and will decrease its import on the other hand to save foreign exchange; enhance the living standard of the farmers of the NWFP in gerneral and Kalam, Parachinar and Tirah valley in particular. Keeping in view the importance of common bean the present study was therefore initiated to find out high yielding germplasm, to maintain and conserve the selected germplasm to prevent their possible extinction and to supply the selected germplasm to users for various research purposes.

MATERIALS AND METHODS

An experiment consisting of 25 germplasm of common bean (*P. vulgaris* L.) was carried out at the Agric. sub-station Kalam (Swat) during summer 2000.

Each germplasm was considered as treatment and planted in randomized complete block design with three replications by assigning each germplasm to a plot of 3 m^2. Each plot consisted of 3 rows, 2 m long and 50 cm apart. Seedbed was prepared at proper vattar condition. A basal dose of 25 kg N and 64 kg P_2O_5 per hectare was applied as DAP and incorporated into the soil during ploughing. Irrigation was applied when required. Weeds were controlled manually.

Data were collected on days to maturity, plant height (cm), branches per plant, pods per plant, seeds per pod, pod length (cm), 100-seed weight (g), grain yield (kg ha^{-1}), dry matter yield (kg ha^{-1}) and harvest index (%). Data were analysed statistically and means were compared using LSD test.

RESULTS AND DISCUSSION

It was very difficult to correlate the performance of individual germplasm in grain yield with other agronomic characters, therefore, the germplasm were first arranged in descending order and then divided into three groups on the basis of grain yield (kg ha^{-1}) to interpret meaningful results. Group I consisted of 7, group II consisted of 9 and group III consisted of 9 germplasm having grain yield of 28840 to 3457, 2099 to 2613 and 1111 to 1985 kg ha^{-1}, respectively.

Days to maturity: Days to maturity varied significantly from 82-103 days (Table 1). Average values in groups increased from 92.6 in group II to 96.4 in group I and then further increased to 99.7 days in group III. The difference in days to maturity could be due to photoperiod, because different germplasm respond differently to a particular photoperiod. Ellis *et al.* (1994) reported that in some of the genotypes of cowpea the rate of progress towards flowering was affected by temperature and photoperiod. Early flowering, pod initiation and maturity indicate adoptability of germplasm in a new set of environment which might have resulted early termination of vegetative phase and initiation of reproductive phase in the prevailing favorable environment as compared to germplasm which took longer time to flowering, pod initiation and maturity indicating less adoptability in the prevailing environment.

Plant height (cm): Persual of the data in Table 1 showed that plant height varied significantly from 27 to 103 cm. Maximum plant height of 103 cm was obtained by germplasm CB-39, followed by CB-11 with 93 cm, while minimum height of 27 cm was recorded for germplasm CB-07. Average values in groups decreased from 66 cm in group II to 61 cm in group I and then further decreased to 57 cm in group III. As these germplasm were collected from different climatic conditions, so the rate of acclimatization of a germplasm may be considered the possible cause of this variation. Similar results were reported by Wadan *et al.* (1993). Moreover, this variation in plant height could be due to the genetic variability of different germplasm. High heritability and high genetic advance was reported for plant height by Sawant (1994) and Ram *et al.* (1994).

Branches per plant: In Table 1 branches per plant varied significantly from 5.3 to 9.7 in different germplasm. Maximum number of branches were recorded for germplasm CB-11 (9.7), followed by CB-32 (9.3), while minimum number of branches (5.3) were recorded for germplasm CB-13 and CB-33 each. Average values in groups decreased from 8 in group II to 7 each in group I and group III. As these germplasm were collected from different climatic conditions, so the rate of acclimatization of a germplasm may also be considered the possible cause of this variation. Variation in branches per plant might be due to the genetic variability of different germplasm. Sawant (1994) found high heritability and high genetic advance for branches per plant.

Pod length (cm): Pod length varied significantly from 7.3 to 18.7 cm (Table 1). Maximum pod length of 18.7 cm was obtained by germplasm CB-39, followed by CB-32 with 16.7 cm, while minimum pod length of 7.3 cm was recorded for germplasm CB-06. Average values in groups decreased from 11 in group II to 10 in group I and then further decreased to 9 in group III. Genetic variability of germplasm might be responsible for this variation. Hassan *et al.*(1995) reported high (91%) heritability for pod length.

Dry matter yield (kg ha^{-1}): Statistical analysis of the data in Table 1 show that dry matter yield varied significantly from 4321 kg ha^{-1} each for germplasm CB-04 and CB-08 to 12350 kg ha^{-1} for germplasm CB-39. Average values in groups decreased from 7408 kg ha^{-1} in group II to 6737 kg ha^{-1} in group I and then further decreased to 5994 kg ha^{-1} in group III. Dry matter yield showed positive association with plant height and branches/plant. Similar results were reported by Amanullah and Hatam (2000), Amanullah *et al.* (2000) and Jatasra and Dahiya (1988). Moreover this variation might be due to the genetic variability of different germplasm. Choudhry *et al.* (1991) reported maximum heritability for dry matter yield.

Seeds per pod: It is clear from Table 2 that seeds per pod varied significantly from 4.7 (CB-33) to 7.7 cm (CB-32). Average values in groups decreased from 6.3 in group II to 6.2 in group III and then further decreased to 5.7 in group I. Genetic variability of germplasm might be responsible for this variation. Hassan *et al.* (1995) reported low (30%) heritability seeds per pod.

100-seed weight (g): One hundred seed weight varied significantly from 19.5 to 61.5 g (Table 2). Maximum weight of 61.5 g as obtained by germplasm CB-13, followed by CB-16 with 59.4 g, while minimum weight of 19.5 g was recorded for germplasm CB-08, followed by CB-20 with 22.4 g. Average values in groups decreased in descending order from 44.5 g in group I to 32.6 g in group II and then further decreased to 29.5 g in group III. This variation could be due to the genetic variability of different germplasm. Hassan *et al.* (1995) reported high (81%) heritability for 1000-seed weight.

Table 1: Days to maturity, plant height (cm), branches/plant, pod length (cm) and dry matter yield (kg ha^{-1}) of common bean germplasm planted at Kalam-Swat during kharif-2000

Acc. No.	Group	Days to maturity	Plant height	Branches/plant	Pod length	DM (kg ha^{-1})
CB.16	I	83e	35j	5.7de	1.1de	6420b-e
CB.09		98bc	65de	6.3de	8.7g-j	7778bc
CB.06		103a	62d-f	7.3b-d	7.3jk	7407b-d
CB.01		102a	58ef	9.0ab	8.0hij	6790b-e
CB.15		98bc	65de	6.0de	13.7c	6173b-e
CB.31		93d	88bc	8.7a-c	11.7d	6173b-e
CB.13		98bc	55fg	5.3e	10.0efg	6420b-e
Mean group I		96.4	61	7	10.0	6737
CB.33	II	82e	35j	5.3e	6.0k	5556cde
CB.07		82e	27k	6.3de	7.7ij	4568de
CB.39		99b	103a	9.0ab	18.7a	12350a
CB.03		102a	65de	8.3a-c	8.3h-j	8642b
CB.05		98bc	62d-f	8.3a-c	8.0h-j	7778bc
CB.32		103a	82c	9.3a	16.7b	7407b-d
CB.17		99b	85c	8.3a-c	10.0e-g	6173b-e
CB.11		98bc	93b	9.7a	15.0c	8642b
CB.19		103a	43hi	7.3b-d	8.0h-j	5556c-e
Mean group II		96.2	66	8	11.0	7408
CB.02	III	103a	60ef	9.7a	8.3h-j	8642b
CB.18		97c	48gh	7.0c-e	9.3f-h	5185c-e
CB.04		103a	40ij	6.0de	9.0g-i	4321e
CB.10		99b	68d	7.0c-e	10.7d-f	6790b-e
CB.20		103a	58ef	7.3b-d	9.0g-i	4938c-e
CB.14		99b	85c	8.3a-c	8.3h-j	8642b
CB.08		98bc	62d-f	5.7de	8.7g-j	4321e
CB.12		97c	43hi	7.0c-e	9.0g-i	6173b-e
CB.25		99b	55fg	7.3b-d	8.7g-j	4938c-e
Mean group III		99.7	57	7	9.0	5994
LSD at 5%		1.385	8.142	1.879	1.579	2853

Mean values carrying similar letter(s) in the same column donot differ significantly at 5% level of probability

Table 2: Seeds per pod, 100-seed weight (g), pods per plant, grain yield (kg ha^{-1}) and harvest index (%) of common bean germplasm planted at Kalam-Swat during kharif-2000

Acc. No.	Group	Seeds/pod	100-seed weight (g)	Pods/plant	Grain yield (kg ha^{-1})	Harvest index (%)
CB.16	I	5.0fg	59.4ab	26a	3457a	53.7ab
CB.09		5.7d-f	53.3f-h	25a-c	3086ab	42.8a-g
CB.06		5.7d-f	27.1n	26ab	3003abc	40.5a-h
CB.01		5.7d-f	26.9n	22a-e	2906a-d	43.4a-f
CB.15		5.0fg	58.2b	17d-i	2873a-d	46.7a-d
CB.31		7.0ab	43.4c	19b-h	2856a-d	53.5ab
CB.13		5.3e-g	61.5a	17d-i	2840a-d	49.5abc
Mean group I		5.6	44.5	22	3003	47.1
CB.33	II	4.7g	30.4lm	19b-h	2613a-e	49.4a-c
CB.07		6.3b-d	40.4d	20a-f	2593abc	55.0a
CB.39		7.0ab	36.9e-g	16e-i	2469b-f	20.0hi
CB.03		6.7bc	27.6n	19e-i	2455b-f	28.9c-i
CB.05		6.3b-d	31.9j-l	23a-d	2346b-g	31.5c-i
CB.32		7.7a	34.1k-j	21a-e	2255b-g	31.1c-i
CB.17		6.0c-e	32.8i-k	18d-i	2239b-g	38.3a-i
CB.11		6.7bc	30.5lm	20a-g	2222b-g	26.0e-i
CB.19		5.7bc	28.9mn	17d-i	2099c-h	38.9a-i
Mean group II		6.3	32.6	19	2365	32.0
CB.02	III	6.7bc	29.0mn	20a-g	1985d-i	22.8f-i
CB.18		7.0ab	23.9a	17d-i	1975d-i	41.7a-g
CB.04		6.7bc	30.2lm	13hi	1852e-i	45.2a-e
CB.10		5.7d-f	37.9e	12i	1728e-i	26.1d-i
CB.20		6.0c-e	22.4o	14ghi	1638f-i	33.9b-i
CB.14		5.3e-g	34.7g-i	18d-i	1605f-i	18.3i
CB.08		6.3b-d	19.5p	13hi	1358ghi	31.1c-i
CB.12		6.0c-e	37.2ef	16e-i	1234hi	20.7hi
CB.25		6.3bcd	30.6k-m	14f-i	1111i	22.5g-i
Mean group III		6.2	29.5	15	1609	29.1
LSD at 5%		0.983	2.249	6.444	946.5	20.70

Mean values carrying similar letter(s) in the same column donot differ significantly at 5% level of probability

Pods per plant: Pods per plant varied significantly from 12 (CB-10) to 27 (CB-16). It ranged from 17-27 in group I, 17-23 in group II and 12-20 in group III. Average values in groups decreased in descending order from 22 in group I to 19 in group II and then further decreased to 15 in group III. The rate of acclimatization of a germplasm may also be considered the possible cause of this variation. Moreover, this variation could be due to the genetic variability of different germplasm. Sawant (1994) and Ram *et al.* (1994) reported high heritability and high genetic advance for pods per plant. However, Hassan *et al.* (1995) reported low (48%) heritability for pods per plant.

Grain yield (kg ha^{-1}): Grain yield varied significantly from 1111 to 3457 kg ha^{-1}. Maximum yield of 3457 kg ha^{-1} was obtained by germplasm CB-16, followed by CB-09 with 3086 kg ha^{-1}, while minimum yield of 1111 kg ha^{-1} was recorded for germplasm CB-25. It ranged from 2840 to 3457 kg ha^{-1} in group I, 2099 to 2613 kg ha^{-1} in group II and 1111 to 1985 kg ha^{-1} in group III. Average values in groups decreased in descending order from 3003 kg ha^{-1} in group I to 2365 kg ha^{-1} in group II and then further decreased to 1609 kg ha^{-1} in group III. Grain yield showed positive association with pods/plant (Amanullah and Hatam, 2000; Ahmad *et al*., 2000; Amanullah *et al*., 2000; Thiyagarajan and Rajasekaran, 1993; Muhammad *et al*., 1994; Ram *et al*., 1994; Sawant, 1994), 100-seed weight (Amanullah and Hatam, 2000; Ahmad *et al*., 2000; Amanullah *et al*., 2000, Thiyagarajan and Rajasekaran, 1993; Sawant, 1994) and harvest index (Amanullah and Hatam, 2000; Ahmad *et al*., 2000; Amanullah *et al*., 2000.

Harvest index (%): Harvest index varied significantly from 18.3 to 55%. Maximum harvest index of 55% was obtained by germplasm CB-07, followed by CB-31 with 53.5%, while minimum harvest index of 18.3% was recorded for germplasm CB-14, followed by CB-39 with 20%. Average values in groups decreased in descending order from 47.1% in group I to 32% in group II and then further decreased to 29.1% in group III. Harvest index (%) showed direct proportionality with grain yield. Similar results were reported by Amanullah and Hatam (2000), Ahmad *et al.* (2000) and Amanullah *et al.* (2000).

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