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AGRO-MORPHOLOGICAL EVALUATION OF SOME EXOTIC COMMON BEAN (*PHASEOLUS VULGARIS* L.) GENOTYPES UNDER RAINFED CONDITIONS OF ISLAMABAD, PAKISTAN

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Abstract

Thirteen exotic and local genotypes of common bean (*Phaseolus vulgaris* L.) were evaluated for various agronomic and morphological characters under rainfed conditions of Islamabad, Pakistan during February-May, 2010. Significant differences were found among genotypes for grain yield plant^{-1}, 100-seeds weight, seeds pod^{-1} and pods plant^{-1}. Local Kashmir excelled all genotypes in grain yield (24.5 g plant^{-1}) while minimum yield (1 g plant^{-1}) was also produced by indigenous cultivar Local Balakot. Exotic cultivars differ significantly for grain yield with maximum 11.4 g plant^{-1} for Ducato and minimum 1.2 g plant^{-1} in case of Varigated and 2a-(GB 44004.1-1999). Non significant differences among genotypes were observed for days to maturity. The correlation coefficients illustrate the positive and significant association of grain yield with flowering duration, number of pods^{-1}, and number of seeds plant^{-1}, therefore, these traits should be considered for genetic improvement through selection. Cluster analysis based on different agro-morphic parameters revealed important classification regarding genetic diversity for studied traits among genotype. Local Kashmir and Ducato were proved best among indigenous and exotic genotypes, respectively. The genotypes with high grain yield, biological yield and 100-seed weight were grouped into same clusters and these genotypes could prove useful resources for common bean genetic improvement program through hybridization and as direct introduction after further evaluation in different agro-ecological zones of the country especially in the mountainous areas.

Introduction

Common bean (*Phaseolus vulgaris* L.) originated in Latin America and domesticated in Mexico more than 6000 years ago. It spread from Latin America to Europe, Africa and other parts of the world. It grows well in area of medium rainfall from the tropics to the temperate regions. In Pakistan, it performs well in drier areas where conditions are suitable for the cultivation of maize (Alghamdi, 2007). Common bean is a warm season food legume crop and cannot grow well under temperature below than 20^{o}C. The optimum mean temperature for common bean is 20 to 25^{0}C. High temperatures interfere with seed setting while low temperature adversely affects its growth (Alghamdi & Ali, 2004).

Beans are well suited to small-scale production because they are relatively easy to manage (Amanullah & Muhammad, 2011). Production of common bean in Pakistan is insufficient to meet the domestic requirements; therefore large amount is spent on its import every year. Identification of high yielding germplasm will lead us to self sufficiency on one hand and to save foreign exchange on the other, while enhancing the living standard of our farmers (Amanullah *et al*., 2006).

Dry matter production is directly related with agro-morphic characters of plants (Amanullah & Muhammad, 2011). Positive associations were recorded between pod length and pod height, seeds pod^{-1}, seed weight, seed length and seed height while evaluating phenotypic variation in core collection of common beans. Correlation Coefficients between 14 characters in common bean relate growth habit with number of pods plant^{-1}, pod length and number of seeds pod^{-1} positive and flowering time was positively associated with ripening time, pods plant^{-1} and pod color intensity. Similarly ripening time was positively interrelated with pod length and pod color intensity, break length and seed characters like weight, length and height (Amanullah, 2010).

Cluster analysis on the basis of agro-morphic characters provides information regarding similarity among genotypes by employing Euclidean distance. Kumar *et al.*, (Chakmaki *et al*., 2003) grouped common bean accessions with greater morphological similarity by performing Cluster analysis. Euclidean distance based dendrogram clearly separated different common bean genotypes indicating better response toward yield and yield related traits. Cluster of a particular group could be selected for further evaluation and or hybridization program.

Common bean yield depends on seed related factors like genetic makeup and quality along with agronomic factors such as sowing method, pesticide treatment (Chaudhry *et al*., 2006), crop rotations, tillage, cropping system, weed control, irrigation and fertilizer application (Kumar *et al*., 2009). Very few cultivars of common bean are available in Pakistan. So introduction of new highly productive germplasm is much needed which must be highly adaptable as well (Miles *et al*., 2007). Present work aimed evaluating common bean germplasm locally in order to generate additional information for common bean utilization and adaptation.

Material and Methods

Thirteen genotypes of common bean from different origins were obtained and evaluated at experimental area of Pulses Research Program at NARC, Islamabad, Pakistan (33° 42' N, 73º 10 E) in a randomized complete block design with three repeats. Each experimental unit consists of 4 rows measuring 4 meters in length. Row to

row distance was kept at 50 cm and plant to plant distance at 10 cm, respectively.

Data were recorded for agro-morphic characters like days to maturity (DM), Days to flowering (DF), flowering duration (FD), plant height (PH), number of branches plant^{-1} (NB), pod length (PL), number of seeds pod^{-1} (NOS), 100-seed weight, Grain yield (GY) and biological yield (BY). The morphological characters were leaf shape (LS), flower color (FC), growth habit (GH), seed shape (SS), seed color (SC), according to the descriptor of common bean (IBPGR, 1982).

The mean values of these traits were used for statistical analysis. The mean standard deviation and standard error were computed. Correlation coefficients were calculated as described by (Salehi *et al*., 2010). Dendrogram was generated using Ward's method in statistical software, Statistica 6.0.

Results

There were six genotypes GB 4404.3-1999, GB 4404.3-1999, GB 44004.1-1999, GB 4404.3-1999, GB 4404.4-1999 and Long Red Bean of Chinese origin, two genotypes Variegated, Local Balakot were from Pakistan and origin of two genotypes Ducato and Bravo was not known, Local Kashmir belonged to India while Polista and Milds Maxi Netherland and Germany. Leaves of local Kashmir and all Chinese genotypes are rectangular in shape except 2a-(GB 44004.4-1999) while remaining genotypes possessed deltoid shape of leaves. Among all the tested genotypes seven showed purple flower color while ducato, polista, bravo, local balokot, local red bean and 2a-(GB 44004.4-1999) bear white flowers. Genotypes ducato, polista, bravo and mild maxi showed erect type of growth habit and others showed tendrel and erect type growth except local balakot which showed semi erect type growth habit. Comparing seed shape and color kidney shaped beans have maroon color except local Kashmir while cuboid shaped seed shows cream color except variegated, while only one genotype milds maxi bear brown colored seeds with truncate fastigiated shape (Table 2).

Data regarding prevailing weather conditions during crop growth and development is presented in Table 5. Mean data of 11 traits for 13 common bean genotypes is presented in (Table 1). Days to flowering varied from 45 (milds maxi and ducato) to 66 (Local balakot) and days to maturity ranged from 90 to 100. Most of genotypes matured in 100 days. There was great variation in plant height, genotype Bravo reaches at height of 31.6cm while 2f-long red bean measured 118cm. Number of branches varied from 4-10, pods plant^{-1} showed variation from 3.8-23.2. Longest pod length was observed in 2c-(GB-4404.3-1999) which was 35.6 cm. While the pods length of genotypes ducato, polista and local Balakot was recorded 6.0cm, local Kashmir had maximum number of seeds pod^{-1} i.e., 8.0 and local Balakot had minimum 2.0 seeds pod^{-1}. Weight of 100-seeds ranged from 5-42g. There was great variation regarding grain yield plant^{-1} as the grain yield recorded for local Balakot was 1.0g and local Kashmir showed 24.5g. Biological yield varied from 22.2-82.8g. Maximum biological yield was recorded in local Kashmir.

Correlation coefficients among traits are given in (Table 3). Days to flowering had no relation with other traits, however, following duration showed significant positive correlation with plant height, pod length, number of seeds pod^{-1}, grain yield plant^{-1}, and biological yield plant^{-1}. Highest positive correlation of 0.82 was found between flowering duration and pod length. Days to maturity had significant positive correlation with plant height (0.62) while significant negative correlation with number of branches plant^{-1} (-0.83). Plant height also positively correlates with pod length. Grain yield plant^{-1} showed significant positive interrelationship with flowering duration (0.70), number of pod plant^{-1} (0.63) and number of seeds pod^{-1} (0.86). Correlation between biological yield plant^{-1} and flowering duration, pod length, number of seeds pod^{-1} and grain yield plant^{-1} were found to be significant and positive.

Table 2. Morphological parameters of common bean (*Phaseolus vulgaris* L.) germplasm,

Genotypes	Origin	Leaf shape	Flower color	Growth habit	Seed shape	seed color
(GB 4404.3-1999)	China	Rectangular	Purple	T. Spreading	Kidney	Maroon
(GB 4404.3-1999)	China	Rectangular	Purple	T. Spreading	Kidney	Maroon
Ducato	Unknown	Deltoid	White	Erect	Cuboid	Cream
Bravo	Unknown	Deltoid	White	Erect	Kidney	Maroon
Polista	Netherland	Deltoid	White	Erect	Cuboid	Cream
Milds Maxi	German	Deltoid	Purple	Erect	Truncate fastigiate	Brown
Variegated	Pakistan	Deltoid	Purple	T. Spreading	Cuboid	Varigated
Local Balakot	Pakistan	Deltoid	White	Semi erect	Cuboid	Red
(GB 44004.1-1999)	China	Deltoid	White	T. Spreading	Cuboid	Cream
(GB 4404.3-1999)	China	Rectangular	Purple	T. Spreading	Cuboid	Cream
(GB 4404.4-1999)	China	Rectangular	Purple	T. Spreading	Kidney	Maroon
Long Red Bean	China	Rectangular	White	T. Spreading	Kidney	Maroon
Local Kashmir	India	Rectangular	Purple	T. Spreading	Kidney	Cream

T. spreading= Tendrel spreading

Table 1. Mean values of different agro-morphological parameters of common bean (*Phaseolus vulgaris* L.) genotypes.

Genotypes	DF	FD	DM	PH(cm)	NB	NP	PL(cm)	NOS	100-SW	GY	BY
2c-(GB 4404.3-1999)	48	54	100	63.5	6.5	9.0	35.6	6.91	17	10.6	60.0
2d-(GB 4404.3-1999)	55	47	100	96.2	5.7	8.6	33.3	7.1	18	11.3	67.0
Ducato	45	34	90	36.2	9.5	23.2	6.0	3.5	14	11.4	39.5
Bravo	46	35	90	31.6	7.8	10.4	7.25	3.0	8	3.1	25.8
(Polista)	57	24	90	44.3	7.3	3.8	6.0	2.8	6	1.4	28.8
Milds Maxi	45	35	100	48.7	5.7	5.3	13.0	3.4	42	8.8	41.3
Variegated	50	27	100	65.5	5.8	4.2	5.4	2.2	5	1.2	22.2
Local Balakot	66	42	100	64.6	5.8	4.2	6.0	2.0	6	1.0	39.5
2a-(GB 44004.1-1999)	65	25	100	60.0	5.6	4.4	5.2	2.2	5	1.2	36.4
2b-(GB 4404.3-1999)	56	45	100	57.3	4.0	11.3	21.4	5.0	16	11.0	62.3
2e-(GB 4404.4-1999)	49	53	100	64.6	4.3	8.0	35.3	5.5	24	10.6	71.1
2f-Long Red Bean	60	48	100	118	4.6	6.2	29.0	3.3	15	3.1	45.8
Local Kashmir	52	58	100	108	5.5	14.6	20.3	8.0	21	24.5	82.8
Mean ± S.E.	53.4±1.98	40.5±3.16	97.7±1.21	66.0±7.31	6.00±0.41	8.70±1.51	17.2±3.45	4.21±0.57	15.1±2.85	7.62±1.87	47.8±5.25
Range	45.0-66.0	24.0-58.0	90.0-100	31.6-118	4.00-9.50	3.80-23.2	5.2-35.6	2.00-8.00	5.00-42.0	1.00-24.5	22.2-82.75
Phenotypic Variance	51.42	130.27	19.23	695.03	2.24	29.77	155.49	4.23	105.97	45.79	358.99
Std. Dev.	7.17	11.41	4.38	26.36	1.49	5.45	12.46	2.05	10.29	6.76	18.94

DF = Days to flowering, FD = Flowering duration, DM =Days to maturity, PH= Plant height, NB = Number of branches, PL= Pod length, NOS= Number of seeds pod^{-1}, 100-SW=100-seed weight, GY= Grain yield, BY = Biological yield

Table 3. Correlation co-efficient among 10 traits in 13 common bean (*Phaseolus vulgaris* L.) cultivars

	FD	DM	PH	NB	NP	PL	NOS	100-SW	GY	BY
DF	-0.12	0.32	0.36	-0.40	-0.49	-0.14	-0.30	-0.50	-0.40	-0.06
FD		0.48	0.60*	-0.43	0.28	0.82*	0.81*	0.42	0.70*	0.88*
DM			0.62*	-0.83*	-0.39	0.49	0.31	0.32	0.20	0.50
PH				-0.57*	-0.11	0.56*	0.47	0.12	0.35	0.56*
NB					0.50	-0.50	-0.22	-0.26	-0.09	-0.48
NP						0.04	0.38	0.13	0.63*	0.32
PL							0.76*	0.44	0.47	0.77*
NOS								0.43	0.86*	0.90*
100-SW									0.54	0.48
GY										0.84*

*Significant at 5% probability level

DF = Days to flowering, FD = Flowering duration, DM =Days to maturity, PH= Plant height, NB = Number of branches, PL= Pod length, NOS= Number of seeds pod^{-1}, 100-SW=100-seed weight, GY= Grain yield, BY = Biological yield

The germplasm used in this study was grouped in cluster, I, II and III in (Fig. 1) which respectively holds 7, 3 and 3 genotypes. Means of various traits for each character showed that genotypes with minimum days to flowering, maximum pod length and 100-seed weight were found in cluster III. Genotypes with maximum days to flowering, flowering duration, days to maturity, plant height, number of pods plant^{-1}, number of seeds pod^{-1}, grain yield plant^{-1} and biological yield plant^{-1} were placed together in cluster II. Genotypes with maximum number of branches plant^{-1} were placed in cluster I (Table 4).

Discussion

Common bean is an important worldwide legume crop because of its nutritional value like, protein and carbohydrates etc. in Pakistan where majority of people suffer from malnutrition, pulses are chief sources of protein for them. As pulses production fluctuates year to year, there is a need of introduction of new sources of protein like common beans. In Pakistan common beans are cultivated at very small area and hilly tracks are its main areas of cultivation. To introduce new exotic common bean germplasm its evaluation is most important step. Thirteen genotypes of common bean from diverse origin were evaluated under rain fed conditions of Islamabad, 6 genotypes with high grain yield plant^{-1}, acceptable 100-seed weight, Number of seeds plant^{-1}, number of branches plant^{-1}, and biological yield could be utilized for further evaluation. Although most of the parameters showed high phenotypic variance, this indicates the sufficient variability for these traits and selection could be performed for improvement of these traits. However some parameters like number of branches plant^{-1}, number of seeds plant^{-1} and days to maturity showed limited variability. Further splitting of variance into genetic and phenotypic components could be useful in studying the influence of environment on these traits. Alghamdi (2007) concluded environmental effects significantly affected the performance of faba bean (*Vicia faba*) genotypes, Salehi *et al.,* (2008) also found significant and positive correlations between number of seeds pod^{-1}, number of pods plant^{-1}, and pod length with grain yield.

The association of quantitative traits is important in revealing the relative contribution of various yield components towards yield. In the present studies grain yield has positive and significant correlation with flowering duration, number of pods plant^{-1} and number of seeds plant^{1}, it is indicated that these characters are efficient in yield determination, so selection could be done considering these traits. Alghamdi (2007) also stated yield is closely related with number of pods plant^{-1}, number of seeds and weight of seeds in field beans. Saleem *et. al.,* (2013) and Khawarzimi *et. al.,* (2012) also stated yield attributes like, plant height, grain yield, number of pods and number of branches is good selection criteria for genotypes to involve them in breeding program for further improvement.

Number of branches plant^{-1} showed negative relationship with days to maturity and plant height and ultimately with grain yield. So the selection of genotypes with low number of branches, which might mature earlier and also produces high grain yield, could be further tested in different agro ecological zones where early maturity and high yield are main objectives. Alghamdi (2007) studied genetic behavior of some selected faba bean genotypes and found negative and significant correlation between number of branches plant^{-1}, Grain yield and maturity, while Alghamdi & Ali (2004) stated contradictory results that a positive significant correlation between seed yield and plant height. Biological yield exhibited strong positive correlation with number of seeds plant^{-1} and grain yield. It indicates longer flowering duration results in more number of seeds plant^{-1} ultimately enhancing grain and biological yield. These findings are in certainty with Salehi *et al.,* (2010) found positive and significant correlations between number of seeds pod^{-1}, number of pods $^{-1}$ and pod length with grain yield. Amanullah *et al.,* (2006) found positive

relationship between grain yield, plant height and number of branches per plant among 50 common bean lines. Cakmakci *et al.,* (2003) found strong positive correlation between seed yield and biological yield. He also noted that increasing number of pods plant^{-1} were related to more number of fertile flowers and suitable environmental conditions during flowering and pod formation and other photosynthetic plant parts which transmit food to economical sections of plants directly increasing seed yield.

The cluster analysis provides important information regarding extent of genetic diversity that is of practical use in crop improvement Sultana *et al.,* (2006). The genotypes used in this study were grouped into three clusters. Cluster I consists of seven genotypes local and European genotypes with minimum days to flowering, maturity flowering duration, less 100-seed weight and grain yield were groped in cluster I. genotypes from China and India were grouped in cluster II and cluster III. These genotypes had maximum grain yield, biological yield, 100-seed weight and flowering duration. Ghafoor *et. al.,* (2012) also found that cluster analysis exploit a portion of genetic diversity for improvement in blackgram that should broaden by involving diverse parents selected from various clusters.

Table 4. Cluster analysis regarding agro-morphological parameters of common bean (*Phaseolus vulgaris* L.)

Traits	Cluster I (7)	Cluster II (3)	Cluster III (3)
Days to flowering	53.42	55.66	51.00
Flowering duration	31.71	51.00	50.60
Days to maturity	95.71	100.0	100
Plant height (cm)	50.13	107.4	61.81
No. of branches plant^{-1}	6.77	5.26	4.93
No. of pods plant^{-1}	7.92	9.80	9.41
Pod length (cm)	6.97	27.51	30.75
No. of seeds pod^{-1}	2.72	6.12	5.80
100-Seed weight (g)	12.28	18.00	19.0
Grain yield (g)	4.01	12.97	10.72
Biological yield (g)	33.36	65.16	64.48

Table 5. Metrological data during crop growth period, 2010.

Month	Max Temp (C^{o})	Min Temp (C^{o})	Rainfall (mm)
February	19.2	7.0	88.49
March	28.5	12.4	32.46
April	33.8	16.4	45.25
May	36.9	19.2	23.31

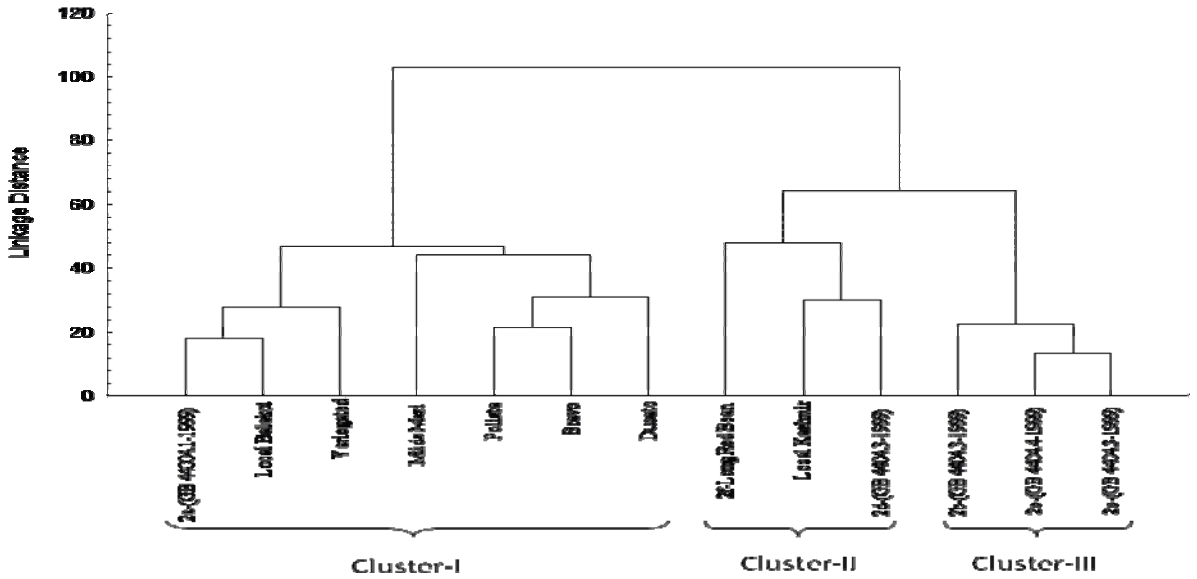

Fig. 1. Dendrogram showing clustering pattern of 13 common bean genotypes based on Euclidean Coefficient values obtained from agro-morphic data.

Conclusion

Results regarding common bean will contribute towards better exploitation of the germplasm and generate information for research and development purpose including better races and their agronomic and morphological behavior. High yielding common bean indigenous genotypes like local Kashmir and exotic genotype Ducato and 2d-(GB 4404.3-1999) are recommended for cultivation under rainfed conditions of Islamabad and further evaluation in different ecological zones of Pakistan.

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