Evaluation of Pole Bean Varieties for Autumn Season Production in the Western Hills of Nepal

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ABSTRACT

Eleven pole bean (Phaseolus vulgaris L.) genotypes (Four Season, LB-31, LB-39, Madhav, Trishuli, Chinese Long, Makwanpur, Samjhana, Myagdi, Syangja and Tarbare)) were evaluated during autumn seasons of 2010 and 2011 at the Agriculture Research Station, Malepatan, Pokhara (848 msl) to assess the variability in the genotypes and their potential utilization in improvement programs. The experiment was conducted in randomized complete block design (RCBD) with three replications. The variability was significant among the genotypes in adaptation, vegetative growth, floral and pod characteristics and fresh pod yield. The highest number of branches and nodes per plant were produced by Syangja (9.2 and 44.0, respectively), while the lowest number of branches (3.7) and nodes (24.4) were produced by LB-39. Makwanpur was the earliest in flowering (37.5 days) and Syangja was lattest in flowering (72.2 days). The tallest plants were found in Chinese Long (278.3cm) and the shortest in LB-31 (212.6cm). Makwanpur produced the highest number of flower buds per inflorescence (5.7) and the lowest flower bud producer was Myagdi (3.4). Pod length and width were the highest in Chinese Long and Myagdi (20.7cm and 33.5 mm, respectively), and the lowest in Tarbare and Makwanpur (7.6cm and 8.5 mm, respectively) genotypes. Four Season produced the highest fresh pod yield (30.3 t/ha, which was followed by Makwanpur (28.0 t/ha) and the lowest fresh pod yielder was Myagdi (7.9 t/ha). The range of diversity among the evaluated genotypes showed the possibility of their utilization in variety selection for commercial production.

Keywords: Pole bean, genetic variability, pod yield, germplasm evaluation.

INTRODUCTION

French bean (*Phaseolus vulgaris* L.), known as "meat of the poor" is an important vegetable of Nepal and is cultivated in a wide range of agro-climatic conditions from plains at 300 m to the high hills of 2500 m altitude. in different seasons (Neupane *et al.,* 2008). It contributes essential protein to the undernourished people living in the hills. In Nepal, green bean pods are used as fresh vegetable and the dried seeds as pulse while the foliage is used as fodder and as well as to restore soil fertility. It is widely cultivated in the temperate, subtropical, tropical regions and is one of the important legumes worldwide for human consumption (Singh, 1999).

Red kidney beans, cultivated during the winter season, are an integral part of the cuisine as a socio-cultural identity in the plains (below 500m asl) of Nepal. Different genotypes of red kidney bean (Indian Rajma) have been cultivated as monocrop in plain areas of Nepal. In the mid hills (500–1600m asl), both pole and bush-type french beans are cultivated for green pods during summer and autumn seasons. Green stringless French-bean (snap bean) is a very popular vegetable crop among the hill people. Pole beans are grown as a mono crop in the commercialized periurban areas using staking or as inter-crop with maize in rain-fed condition in the hills. High

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quality dried bean grains produced from summer to autumn in the high hills and mountains (1600–2500m asl) that find their market in cities and are also the major source of protein cash income for households. Hill and mountain farmers grow a number of landraces with varying morphologies (Neupane and Vaidya, 2002). Thus, the current research was undertaken to evaluate various exotic and indigenous germplasms in the midhills of western Nepal so that they could be utilized for varietal improvement and commercial cultivation.

MATERIALS AND METHODS

French bean germplasms were collected from government farms, markets and farm households. A total of 11 genotypes; Samjhana, Madhav, Chinese Long, Four Season, Trishuli, LB-39, Makwanpur, LB-31, Syangja, Myagdi and Tarbare were collected and evaluated for two consecutive years at the Agriculture Research Station (Horticulture), Malepatan, Pokhara for agro-morphological characteristics and fresh pod yield. The station is situated at a latitude of 28°13'6.18" N and a longitude of 83°58'27.72" E at an elevation of 848 m asl and is characterized by a sub-tropical climate. The experiment was conducted from August to December 2010 and 2011 and was arranged in a randomized complete block design (RCBD) with three replications. Spacing was maintained at 75 × 45cm and experimental plot sizes were 3.6 × 1.1 m. The crop was planted on 24 August in both years. Manure and fertilizer were applied as compost (20 t/ha) and 40:60:50 kg NPK /ha, respectively. Scoring of agro-morphological characters was done following Descriptors for *Phaseolus vulgaris* (IBPGR, 1982). The data were analyzed using Genstat software (version 12.1 VSN International, Hemel Hempstead, UK). The plant survivability was recorded in percentage and square root transformation method in parenthesis and analyzed separately.

Days to flowering was recorded when 50% of plants had set flowers. Node number was recorded after flower set from base to top inflorescence, The number of flower buds per inflorescence was recorded from the lateral (third inflorescence from the apex). The number of branches was recorded from the base to the first inflorescence and averaged based on measurements from five randomly selected plants. Plant height was measured at the green pod maturity stage from the cotyledon scar to the highest tip of the plant. Height was recorded in centimeters and the measurements from five randomly selected plants were averaged. Pod length and pod width were measured on the largest, fully expanded, immature, green pod and measurements were averaged from 10 randomly selected plants. Fresh pods were harvested five times at 10 days interval when the pods were fully expanded, immature and green stage.

RESULTS AND DISCUSSION

Plant survival

Plant survivability at 15 days was highest (100%) in Myagdi, as compared to other varieties (Table 1). At harvest the survivability of plants was highest in Four Season (96.5%) and Myagdi (95.84%). The lowest percentage of plant survival was found in Syangja with an average of 79.17% and 65.63% at 15 days and at harvest, respectively. Plant survival of the crop varieties is one of the important parameters for seasonal and off-season production of vegetables, which determines the resistance and tolerance of the variety to a particular environment. Pandey (2004) reported that the survivability of a particular variety of cauliflower is affected by adverse climatic

conditions and it is obvious that the genetic characters show resistance and susceptibility to a particular environment.

Number of Branches

The number of branches per plant in different genotypes differed significantly (Table 1). The highest number of branches was produced by Syangja with an average of 9.2 per plant, whereas the lowest number of branches was produced by LB-39 and Four Season with an average of 3.7 per plant. Plant growth including the number of branches is the result of a variety's genetic potential interacting with the environment and farming practices. Environmental conditions (mainly air temperature and rainfall) greatly affect the growth and development of bean plants. Brewster (1983) reported that temperature influences the responses of many plant species to photoperiod, growth, tuber development and flowering. The temperature is just as important as day length in influencing growth and flowering (Herath and Ormrod, 1979). Alghamdi (2007) also reported in a study of faba beans that the genotypes differ significantly for the number of branches per plant.

Table 1 Plant survivability and plant characteristics of pole bean genotypes at different stages during autumn seasons 2010-2011.

SN	Genotypes	Plant survival at 15 days	Plant survival at harvest	Number of branches	Number of nodes	Plant height (cm)
1	Four Season	97.93 (9.9)	96.50 (9.8)	3.7	28.2	246.2
2	LB-39	81.25 (9.0)	78.13 (8.8)	3.7	24.4	238.3
3	Madhav	97.57 (9.9)	94.79 (9.7)	4.4	27.1	228.7
4	Trishuli	98.13 (9.9)	93.04 (9.6)	3.8	26.4	239.7
5	Chinese Long	98.97 (9.9)	91.67 (9.6)	5.2	33.4	278.3
6	Makwanpur	97.23 (9.9)	87.50 (9.4)	4.8	28.7	249.0
7	Samjhana	97.93 (9.9)	91.67 (9.6)	5.3	28.4	254.9
8	LB-31	96.18 (9.8)	87.50 (9.4)	5.1	31.4	212.6
9	Tarbare	93.75 (9.7)	80.13 (9.0)	8.7	42.7	254.5
10	Syangja	79.17 (8.9)	65.63 (8.1)	9.2	44.0	243.9
11	Myagdi	100.00 (10.0)	95.84 (9.8)	6.7	43.7	271.3
	Mean	94.37 (9.7)	87.49 (9.3)	5.5	32.6	247.0
	P-value	<0.001	<0.001	<0.001	<0.001	<0.001
	LSD (0.05)	7.03 (0.37)	5.99 (0.33)	0.41	1.65	8.83
	CV (%)	4.4 (2.3)	4.0 (2.1)	4.4	3.0	2.1

Note: The figures in parenthesis are square-root transformed

Node number

The number of nodes per plant produced by selected genotypes was significantly different (Table 1). The highest number of nodes was produced by Syangja (44.0 nodes per plant), whereas the lowest number of nods was produced by LB-39 (24.4 nodes per plant). The results showed that the node number was affected by the genotype and the growing environment. Long days and high temperatures changed the growth habit of the normally determinate lablab bean (*Lablab purpureus*) plant to indeterminate (Kim and Okubo, 1995). They also reported that the plants of indeterminate growth habit showed an increased number of nodes and a greater length of internodes with high temperature and day length (13 h at 25°C or 10–11 h at 30°C). Similar results have been reported by Islam *et al.* (2010) who reported that the genotypes of hyacinth bean showed considerable variation for most morpho-physical traits. They found that the number of nodes per raceme ranged from 2.33 to 14.1 in different genotypes.

Plant height

The plant height (vine length) differed significantly among the genotypes (Table 1). The tallest and the shortest plants were found in Chinese Long and LB-31 with an average of plant height 278.3cm and 212.6cm, respectively. Neupane *et al.* (2008) reported that the plant height in beans was influenced by the genotype. They recorded the plant height from 28 to 144cm in different bean genotypes that were planted at the same date. Similar results were also reported by other researchers. Alghamdi (2007) reported that faba bean genotypes significantly differed in flowering date and plant height.

Days to flowering

Days to 50% flowering of a particular variety describes the earliness, medium or late to mature. The days to flowering in different genotypes differed significantly (Table 2). The earliest flowering genotype was Makwanpur with an average of 37.50 days after sowing. The latest flowering genotype was Syangja with an average of 72.2 days after sowing. The flowering and fruiting days were influenced by genotypes, daylength and temperature. In most of the vegetable crops, early flowering and maturing genotypes are preffered. White and Laing (1989) reported that adaptation of the common bean is strongly affected by photoperiod and there is considerable genetic variation for photoperiod response in the bean species. Neupane *et al.* (2008) reported that the flowering days in beans were influenced by the genotype. They reported that flowering varied from 40 to 84 days depending on the bean genotype. Variety and environment interaction in common bean for days to flowering and the length of flowering period has also been reported by Wallace *et al.* (1991).

Flower buds

The number of flower buds per inflorescence was significantly different among the genotypes (Table 2). The highest number of flower buds was produced by Makwanpur (5.7 flower buds) and the lowest number of flower buds was produced by Myagdi (3.4 flower buds). Neupane *et al.* (2008) reported that the number of flower buds per inflorescence in bean was influenced by the genotype. All the genotypes were planted on the same date but varied in the number of flower buds from 1.8 to 18 depending on the bean genotype. Peksen (2007) also reported large differences among common bean genotypes for the number of flowers per plant.

Pod length

The pod length among the genotypes was significantly different (Tables 2). The combined analysis over the years showed that the longest pods were produced by Chinese Long (20.7cm) and the shortest pods by Tarbare (7.6cm). The results revealed that the pod length was influenced by the genotype. Neupane *et al.* (2008) reported that the pod length in beans was influenced by the genotype. They found that all the genotypes planted on the same date produced varying pod lengths (6.7 to 17.4cm). Similar results were also reported by other researchers. Islam *et al.* (2010) reported that the genotypes of hyacinth bean showed considerable variation in pod length varying from 3.96cm to 18.20cm.

Pod width

The pod width among the genotypes differed significantly (Table 2). The combined analysis over the years showed that the widest pods were produced by Myagdi (33.5 mm) and the narrowest pods by Makwanpur (8.5 mm). Neupane *et al.* (2008) reported

that the pod width in beans was influenced by the genotype. They recorded pod widths ranging from 10 to 30 mm in different genotypes which were planted on the same date. Islam *et al.* (2010) also reported that the genotypes of hyacinth bean showed considerable variation in pod width that ranged from 1.5cm to 4.46cm.

Table 2 Floral and pod characteristics and fresh pod yield of pole bean genotypes during autumn seasons 2010-2011.

SN	Genotypes	Days to 50% flowering	No. of flower buds/inflorescence	Pod length (cm)	Pod width (mm)	Fresh pod yield (t/ha)
1	Four Season	44.5	5.4	19.6	9.6	30.3
2	LB-39	44.2	5.0	18.7	10.3	21.8
3	Madhav	46.3	5.0	18.9	9.9	21.6
4	Trishuli	48.0	5.4	16.6	9.8	27.4
5	Chinese Long	42.8	5.5	20.7	9.1	22.8
6	Makwanpur	37.5	5.7	18.3	8.5	28.0
7	Samjhana	42.3	5.5	20.1	9.5	19.5
8	LB-31	43.0	5.2	17.3	9.3	20.7
9	Tarbare	68.5	4.5	7.6	32.7	8.6
10	Syangja	72.2	4.5	13.3	27.5	8.9
11	Myagdi	69.2	3.4	11.5	33.5	7.9
	Mean	50.8	5.1	16.6	15.4	19.8
	P-value	<0.001	<0.001	<0.001	<0.001	<0.001
	LSD (0.05)	3.46	0.39	2.07	1.87	3.51
	CV (%)	4.0	4.6	7.3	7.1	10.4

Pod yield

The fresh pod yield among the genotypes differed significantly (Table 2). The combined analysis over the years showed that the highest fresh pod yield was produced by Four Season (30.3 t/ha) followed by Makwanpur (28.0 t/ha). The lowest fresh pod yield was produced by Myadi (7.9 t/ha) followed by Tarbare (8.6 t/ha). The results revealed that the fresh pod yield was influenced by the genotype. Similar results were also reported by other researchers. Neupane *et al.* (2008) reported that the pod and dry seed yield in beans was influenced by the genotype. They found that all the genotypes planted on the same date produced varying pod number/plant and seed yield (g/m^2) ranging from 5 to 32 and 5.9 to 306.5, respectively. Smittle (1986) reported that the genotypes of lima bean showed considerable variation in pod yield. Ndegwa *et al.* (2001) reported that the fresh pod yield of snap bean was influenced by the genotype ranging from 5443 to 10636 kg/ha.

The highest fresh pod yield was produced by Four Season, Makwanpur and Trishuli. The results show that the pod yield is not directly correlated with the pod length and pod width but it shows the relation with the number of flower buds per inflorescence. In principle, pod yield is correlated with the number of flowers, number of bunches, number of pods, seed to flesh ratio, pod length and pod width. The results revealed that pod length and width are not the determinant factors in fresh pod yield of French bean.

CONCLUSION

The agro-morphological variation observed in the genotypes shows that there is enough scope for selection of suitable genotypes for various production systems. The result revealed that the genotypes with high adaptability during the season were Four Season, Myagdi, Madhav, Trishuli, Chinese Long and Samjhana. Local genotypes i.e., shelling type (Syangja, Myagdi and Tarbare) beans have better vegetative growth

than green or snap beans. The green type beans are earlier in flowering and harvesting and produced more number of flower buds than shelling type beans. Exotic snap beans produced the longest pods with narrow width and the shelling beans produced the shortest but widest pods. The highest fresh pod yield was produced by Four Season, Makwanpur and Trishuli whereas the lowest pod yield was produced by shelling beans. Fresh pod yield was not influenced by other floral and pod characteristics. The results show that the pod yield is not directly correlated with the pod length and pod width but it shows the relation with the number of flower buds per inflorescence. In principle, pod yield is correlated with the number of flowers, number of bunches, number of pods, abortive flowers, seed to flesh ratio, pod length and pod width. The results revealed that pod length and width are not only the determinant factors in fresh pod yield of French bean. It could be concluded from the result that Four Season, Makwanpur and TRishuli could successfully be grown during autumn season in the western mid hills of Nepal. Four Season, Trishuli and Makwanpur which are already in farmer's fields, could be profitably used for scaling up in the target area.

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