RESPONSE OF POLE TYPE FRENCH BEAN (*Phaseolus vulgaris* L.) GENOTYPES TO SOWING DATES IN THE MID HILLS OF WESTERN NEPAL

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ABSTRACT

Three bush-type French bean (Phaseolus vulgaris L.) genotypes (Arka Komal, Arka Suvidha and Mallika) were sown in different three dates i.e., August 16, 31 and September 15 during autumn seasons of 2010 and 2011 at the Agriculture Research Station, Malepatan, Pokhara (848 msl) to assess the fresh pod yield and yield attributes of the genotypes in different sowing dates. The experiment was conducted in randomized complete block design with three replications. The temperature ranged from 14^0 to 32^{0}C during the growth period. The results showed significant variations in fresh pod yield and yield attributes. Flowering was earliest in Arka Komal where 50% plants flowered within 32.83 days while it took more than 35.70 days for Mallika. Tallest plants were produced by Arka Komal (33.93 cm) and shortest by Mallika (31.08 cm). The pod length was highest (12.67 cm) in Arka Suvidha and the lowest in Mallika (9.31 cm). Pod width was highest in Arka Komal (10.79 mm) and the lowest in Mallika (9.31 mm). Number of branches, nodes/plant and flower buds/inflorescence were recorded highest in Arka Komal at 7.43, 27.04 and 5.12 respectively. Highest fresh pod yield was produced by Arka Suvidha (10.75 t/ha) followed by Arka Komal (10.17 t/ha) and the lowest by Mallika (6.88 t/ha). Sowing date also showed significant effect on yield and yield attributes. Sowing on 16 August showed better results in early flowering (33.11 days), tallest plants (35.99 cm), longest pods (12.56 cm) and widest pods (11.25 mm). Highest number of branches, nodes/plant and flower buds/inflorescence were recorded in 16 August sown condition at 7.40, 27.81 and 5.26 respectively. The highest fresh pod yield (11.16 t/ha) was recorded in 16 August sowing followed by 31 August (10.19 t/ha) and the lowest (6.45 t/ha) in 15 September sown condition. Arka Suvidha sown on 16 August produced the highest fresh pod yield with an average of 13.08 t/ha. The result revealed that Arka Suvidha is the best genotype and mid August is the appropriate sowing time for higher fresh pod yield of French bean in the mid hills of western Nepal.

Key words: *French bean, bush type, genotypes, sowing dates, fresh pod yield*

INTRODUCTION

French bean (*Phaseolus vulgaris* L.), a native crop of central and South America (Swaider *et al.* 1992), is one of the oldest cultivated plants. Due to varying climatic adaptability, it can be cultivated from tropical to temperate regions. Bean is one of the important legumes worldwide for human consumption (Singh, 1999) and sometime called as "meat of the poor" because of cheap source of protein for poor people. Bean is an important vegetable of Nepal and is cultivated in a wide range of agro-climatic conditions from 300 m to 2,500 m asl in different seasons (Neupane *et al.*, 2008). In Nepal, green bean pods are used for fresh vegetable and the dried seeds for pulse purpose while the foliage is used as fodder for animal. Bean cultivation is also beneficial for animals and for restoring soil fertility.

French bean is a tender, warm season vegetable that cannot tolerate frost. Its seeds do not germinate below 15^{0}C and plants drop blossoms in hot or rainy weather. A mean air temperature of 20^0-25^{0}C is optimum for its growth and better productivity. Extreme high temperatures interfare pod filling, while low temperatures are unfavorable for vegetative growth (ICAR, 2003). In a favorable situation the crop can be grown throughout the year. Sowing time has profound effect on the productivity of this crop. The optimum sowing time of beans varies with the type of varieties, growing season, location, etc. In Terai and inner Terai, it can be profitably grown as a winter crop. In the hills, it is predominantly grown as a rainy season crop. Under irrigated conditions, vegetable types are grown from spring to autumn depending on elevation. Strong interaction effect of genotypes and sowing time on pod and seed yield has been reported by Ali (1989) and Begum *et al.* (2003). Most vegetable crops are highly perishable and the market price fluctuation of fresh vegetables is very high. The price difference within a week is very high in Nepalese market. More profit to the farmers is determined not only by more quantity produced but also by high market price. Providing such information to the farmers, they could be benefited more by supplying fresh pods to the right market in the right time.

A study was conducted at Malepatan, Kaski during the year 2010 to evaluate 19 exotic and indigenous French bean genotypes in spring, summer, rainy and autumn seasons. Among tested genotypes Trishuli, Four season and Makawanpur showed the best performance in autumn season (Pandey *et al.* ,2011). This study was, therefore, undertaken to evaluate aforesaid 3 genotypes of beans, so that recommendations could be made for commercial cultivation of this crop in this area as well as others having similar climatic situation.

MATERIALS AND METHODS

The experiment was conducted at the Agriculture Research Station (Horticulture), Malepatan, Pokhara. 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 in two consecutive years 2010 and 2011 in two factors factorial randomized complete block design and each treatment combination was replicated three times. The temperature during the growing period ranged from 14^0 to 32^0C. Based on the previous study, three high yielding genotypes viz Arka Komal, Arka Suvidha and Mallika were used as first factor and dates of sowing viz. 16th August, 31st August and 15th September as 2nd factor.

Spacing was maintained at 75×45 cm and the experimental plot size was 3.0×1.8 m. Manures and fertilizers were applied as compost (20 t/ha) and 40:60:50 kg NPK /ha, respectively from chemical fertilizers. 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). Days to flowering was recorded when 50% of the plants had set flowers. Plant height was measured in five randomly selected plants at the green pod maturity stage from the cotyledon scar to the highest tip of the plant. Pod length and width were measured on the largest, fully expanded, immature, green pod and measurements were averaged from 10 randomly selected plants (followed descriptors). Fresh pods were harvested five times (harvestings) in the first date of sowing, four harvestings in the second and three harvestings in the third date of sowing at 10 days interval when the pods were fully expanded, immature and green stage.

RESULTS AND DISCUSSION

Number of branches per plant

Number of branches per plant differed significantly among the genotypes and sowing dates (Table 1). The highest and the lowest number of branches (7.43 and 6.39 per plant) were produced by Arka Komal and Mallika, respectively. The highest number of branches (7.40/plant) were recorded when the crop was sown on 16th August whereas the lowest (6.59/plant) were produced by sowing the crop on 15th September. The result showed that the number of branches produced by all genotypes reduced in later sowings. First sowing showed better results than later sowings. The interaction of genotypes and sowing dates was not significantly different. Plant growth including the number of branches is the result of a variety's genetic potential interacting with the environment and farming practices. The results showed that the number of branches was affected by the genotype and growing environment.

Table 1 Effect of sowing dates on number of branches of different bush bean genotypes at Malepatan, Kaski, 2010 – 2011.

Genotypes	Date of sowing			Mean of genotypes	F value of genotypes
	16 August	31 August	15 September		
Arka Komal	7.82	7.44	7.01	7.43^{a1}	
Arka Suvidha	7.69	7.46	6.90	7.35^{a}	
Mallika	6.70	6.62	5.85	6.39^{b}	
Mean of sowing dates	7.40^{a}	7.17^{a}	6.59^{b}	7.06	54.48**
F – value of sowing date				28.78**	
LSD				0.23	
$LSD_{0.05}$ (int.)				ns	
CV (%)				3.3	

[1] Mean values in the same column followed by a common letter are not significantly different at $P < 0.05$ level by Duncan's new multiple range test.

** = Highly significant at $P < 0.01$ and ns = non significant

Number of nodes per plant

Number of nodes per plant differed significantly among the genotypes and sowing dates but the interaction of genotypes and sowing date was not significant (Table 2). Arka Komal and Mallika produced the highest (27.04/plant) and the lowest (25.03/plant) number of nodes, respectively. The highest number of nodes in bush beans (27.81/plant) was recorded in the first sowing date on 16th August and the lowest number of nodes (21.41/plant) was produced in the last sowing date on 15th September. The result showed that the number of nodes produced by all genotypes was the lowest in the last sowing date on 15th September. Early sowing showed better results than the later sowings.

Table 2: Effect of sowing dates on number of nodes of different bush bean genotypes at Malepatan, Kaski, 2010 – 2011.

Genotypes	Date of sowing			Mean of genotypes	F value of genotypes
	16 August	31 August	15 September		
Arka Komal	29.15	28.72	23.27	27.04^{a1}	
Arka Suvidha	26.47	25.93	20.77	24.39^{c}	
Mallika	27.80	27.10	20.20	25.03^{b}	
Mean of sowing dates	27.81^{a}	27.25^{a}	21.41^{b}	25.49	46.54**
F – value of sowing date				304.37**	
LSD				0.61	
$LSD_{0.05}$ (int.)				ns	
CV (%)				2.4	

[1] Mean values in the same column followed by a common letter are not significantly different at the $P < 0.05$ level by Duncan's new multiple range test.

** = Highly significant at $P < 0.01$ and ns = non significant

Days to flowering

Days to 50% flowering of a particular variety indicates the earliness, medium or late to mature. The flowering days in different genotypes and sowing dates differed significantly (Table 3). The interaction of genotypes and sowing dates was non significant. The earliest flowering genotype was Arka Komal which flowered within 32.83 days after sowing followed by Arka Suvidha at 33.07 days and the latest was Mallika with an average of 35.70 days after sowing. Arka Komal flowered in 32.10, 32.70 and 33.68 days sown on 16, 31 August and 15 September, respectively. Early flowering was observed in early sowing. The earliest flowering (33.11 days) was recorded in the first sowing date on 16th August and the latest (34.77 days) was recorded in the last sowing date on 15th September. In most of the vegetable crops, early flowering and maturing genotypes are considered preferable.

Table 3: Effect of sowing dates on 50% flowering of different bush bean genotypes at Malepatan, Kaski, 2010 – 2011.

Genotypes	Date of sowing			Mean of genotypes	F value of genotypes
	16 August	31 August	15 September		
Arka Komal	32.10	32.70	33.68	32.83^{b1}	
Arka Suvidha	32.37	32.97	33.88	33.07^{b}	
Mallika	34.87	35.50	36.73	35.70^{a}	
Mean of sowing dates	33.11^{b}	33.72^{b}	34.77^{a}	33.87	49.91**
F – value of sowing date				13.79**	
LSD				0.68	
$LSD_{0.05}$ (int.)				ns	
CV (%)				2.0	

[1] Mean values in the same column followed by a common letter are not significantly different at the $P < 0.05$ level by Duncan's new multiple range test.

** = Highly significant at $P < 0.01$ and ns = non significant

Plant height

The plant height differed significantly among the genotypes and also affected by sowing dates but the interaction of genotypes and the sowing dates was not significant (Table 4). The tallest and the shortest plants were recorded in Arka Komal and Mallika with an average of 33.93 cm and 31.08 cm, respectively. Similarly, the tallest and the shortest plants were recorded in earliest sowing (16th August) and the latest sowing (15th

September) with an average of 35.99 cm and 25.50 cm, respectively. The result showed that the plant height was reduced with late sowing in all the genotypes. French bean sown late, i.e. 15 September, produced the shorter plants due to sudden temperature reduction during its vegetative growth period.

Flower buds per inflorescence

The number of flower buds per inflorescence was significantly different among the genotypes and sowing dates (Table 5). The highest and the lowest number of flower buds per inflorescence were produced by Arka Komal and Mallika with an average of 5.12 and 4.67, respectively. The highest number of flower buds (5.26) per inflorescence was produced in the first sowing date (16th August) and the lowest (4.54) in the last sowing date (15th September). The result showed that more number of flower buds per inflorescence was produced in the first sowing date and it was reduced in the lateral sowing dates. The reason might be due to the ambient temperature and humidity during the vegetative and reproductive growth period. The temperature was reduced during the vegetative and reproductive phase of later sowing of the crop. The interaction among the genotypes and sowing dates was not significantly different. However, Arka Komal sown on 16th August produced the highest number of flower buds per inflorescence (5.51). @@@@@@@@@@@@@@

Table 4: Effect of sowing dates on plant height (cm) of different bush bean genotypes at Malepatan, Kaski, 2010 – 2011.

Genotypes	Date of sowing			Mean of genotypes	F value of genotypes
	16 August	31 August	15 September		
Arka Komal	38.07	37.53	26.20	33.93[a1]	
Arka Suvidha	34.93	34.57	25.92	31.81[b]	
Mallika	34.97	33.90	24.38	31.08[b]	
Mean of sowing dates	35.99[a]	35.33[a]	25.50[b]	32.27	23.12**
F – value of sowing date				363.54**	
LSD				0.92	
$LSD_{0.05}$ (int.)				ns	
CV (%)				2.9	

[1] Mean values in the same column followed by a common letter are not significantly different at the $P < 0.05$ level by Duncan's new multiple range test.
** = Highly significant at $P < 0.01$ and ns = non significant

Table 5: Effect of sowing dates on number of flower buds of different bush bean genotypes at Malepatan, Kaski, 2010 – 2011.

Genotypes	Date of sowing			Mean of genotypes	F value of genotypes
	16 August	31 August	15 September		
Arka Komal	5.51	5.15	4.69	5.12[a1]	
Arka Suvidha	5.31	4.84	4.62	4.92[b]	
Mallika	4.98	4.71	4.32	4.67[c]	
Mean of sowing dates	5.26[a]	4.90[b]	4.54[c]	4.90	18.33**
F – value of sowing date				47.12**	
LSD				0.16	
$LSD_{0.05}$ (int.)				ns	
CV (%)				3.2	

[1] Mean values in the same column followed by a common letter are not significantly different at the $P < 0.05$ level by Duncan's new multiple range test.
** = Highly significant at $P < 0.01$ and ns = non significant

Pod length

The pod length among the genotypes and sowing dates were significantly different while the interaction effect was not significant (Table 6). The combined analysis over the years showed that the longest pods were produced by Arka Suvidha with an average of 12.67 cm and the shortest by Mallika (9.31 cm). Similarly, the longest pods were produced when the crop was sown on 16th August (12.56 cm) and the shortest (9.16 cm) on 15th. The

length was found higher in early sowing as compared to late sowing. During the growth period of fresh pods, the temperature was suddenly low and affected the growth of green pods of all genotypes.

Table 6: Effect of sowing dates on pod length (cm) of different bush bean genotypes at Malepatan, Kaski, 2010 – 2011.

Genotypes	Date of sowing			Mean of genotypes	F value of genotypes
	16 August	31 August	15 September		
Arka Komal	13.17	12.90	9.88	11.98[b][1]	
Arka Suvidha	14.13	13.73	10.13	12.67[a]	
Mallika	10.37	10.08	7.47	9.31[c]	
Mean of sowing dates	12.56[a]	12.24[a]	9.16[b]	11.32	158.65**
F – value of sowing date				176.76**	
LSD				0.42	
$LSD_{0.05}$ (int.)				ns	
CV (%)				3.7	

[1] Mean values in the same column followed by a common letter are not significantly different at the $P < 0.05$ level by Duncan's new multiple range test.
** = Highly significant at $P < 0.01$ and ns = non significant

Pod width

The genotypes and sowing dates had significant effect on pod width but the interaction of genotypes and the sowing dates was not significant (Table 7). The combined analysis over the years showed that the widest pods were produced by Arka Komal with an average of 10.79 mm and the narrowest by Mallika with an average of 9.31 mm. Similarly, the widest pods were produced when the crop was sown on 16th August with an average of 11.25 mm and the narrowest (8.69 mm) by 15th September sown ones. During the growth period of fresh pods, the temperature was suddenly low and affected the growth of green pods of all genotypes. The width was found higher in early sowing as compared to late sowing. The reason might be the effect of low temperature which retarded the plant and pod growth.

Table 7: Effect of sowing dates on pod width (mm) of different bush bean genotypes at Malepatan, Kaski, 2010 – 2011.

Genotypes	Date of sowing			Mean of genotypes	F value of genotypes
	16 August	31 August	15 September		
Arka Komal	11.87	11.45	9.07	10.79[a][1]	
Arka Suvidha	11.63	11.23	9.22	10.69[a]	
Mallika	10.25	9.88	7.80	9.31[b]	
Mean of sowing dates	11.25[a]	10.86[b]	8.69[c]	10.27	50.99**
F – value of sowing date				140.42**	
LSD				0.35	
$LSD_{0.05}$ (int.)				ns	
CV (%)				3.4	

[1] Mean values in the same column followed by a common letter are not significantly different at the $P < 0.05$ level by Duncan's new multiple range test.
** = Highly significant at $P < 0.01$ and ns = non significant

Pod yield

The fresh pod yield among the genotypes differed significantly and it was highly affected by the date of sowing. The interaction between genotypes and the sowing dates was not significant (Table 8). The combined analysis over the years showed that the highest fresh pod yield was produced by Arka Suvidha with an average of 10.75 t/ha followed by Arka Komal with an average of 10.17 t/ha. The lowest fresh pod yield was produced by Mallika with an average of 6.88 t/ha. Date of sowing had greater effect on the yield of fresh pod. The highest fresh pod yield was produced when the crop was sown on 16th August with an average of 11.16 t/ha followed by 31st August sowing (10.19 t/ha) and the lowest fresh pod yield (6.45 t/ha) was recorded in 15th September sowing. It is obvious from the above results that delayed sowing resulted in severe decline of fresh pod yield. The lower pod yield in delayed sown crop was mainly due to poor growth of the plants and production of smaller pods. Lower temperature at later stage could be the reason for poor plant growth, production of smaller pods and less number of pods pickings (harvestings). From this study it can be concluded that Arka Suvidha is

the best genotype and mid august is the appropriate sowing time of French bean in the mid hills of western Nepal.

Table 8: Effect of sowing dates on fresh pod yield (t/ha) of different bush bean genotypes at Malepatan, Kaski, 2010 – 2011.

Genotypes	Date of sowing			Mean of genotypes	F value of genotypes
	16 August	31 August	15 September		
Arka Komal	12.13	11.29	7.08	10.17^{a1}	
Arka Suvidha	13.08	11.78	7.40	10.75^{a}	
Mallika	8.28	7.51	4.85	6.88^{b}	
Mean of sowing dates	11.16^{a}	10.19^{b}	6.45^{c}	9.27	82.71**
F – value of sowing date				117.96**	
LSD				0.69	
$LSD_{0.05}$ (int.)				ns	
CV (%)				7.4	

[1] Mean values in the same column followed by a common letter are not significantly different at the $P < 0.05$ level by Duncan's new multiple range test.

** = Highly significant at $P < 0.01$ and ns = non significant

CONCLUSION AND RECOMMENDATION

Bush bean genotypes Arka Suvidha and Arka Komal are the best for autumn season production and 16th August is the appropriate date of sowing for better growth and fresh pod yield production in the mid-hills of western Nepal.

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