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Effect of Sowing Dates on Growth, Flowering and Yield of Indian Bean Varieties under Agroclimatic Conditions of Malwa Plateau in Madhya Pradesh

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ABSTRACT

A field experiment was carried out at research field, College of Horticulture, Mandsaur (M.P.) during *kharif* season, 2018-19. Twenty treatment combinations comprising of four dates of sowing (D_1 - 20th July, D_2 - 5th August, D_3 - 20th August and D_4 - 5th September) and five varieties (V_1 - Arka Vijay, V_2 - Konkan Bhushan, V_3 - Arka Visthar, V_4 - Arka Adarsh and V_5 - Arka Prasidhi) were evaluated in factorial randomized block design with three replications. The findings of the investigation revealed that among the dates of sowing, D_1 (20th July) recorded significantly higher growth parameters, yield parameters and yield. There was highest protein content, dry matter content and fibre content in edible pods under D_1 (20th July) and lowest with D_4 (5th September) date of sowing. Earliest first flowering, 50% flowering and first picking of pod was noted with D_4 (5th September) date of sowing. Among the varieties, variety V_3 (Arka Visthar) showed superiority for growth parameters and yield parameters *viz*., number of spikes plant^{-1}(116.21), pod width (23.04mm), weight of 10 pods (96.19g), pod yield plant^{-1} (2579.1g), pod yield ha^{-1} (339.6q) and harvest index (39.4%). Earliest first flowering (41.5 days) and first picking (63.7 days) was observed with V_2 (Konkan Bhushan). Highest spike length (31.49cm) was measured with variety V_2 (Konkan Bhushan). Highest pod length (14.05cm) and number of pods plant^{-1} (340.6) were recorded with variety V_5 (Arka Prasidhi). Highest protein content (2.80%), fibre content (1.94%) and dry matter content (16.20%) were obtained under the variety V_1 (Arka Vijay).

Key words: Flowering, Growth, Indian bean, Quality, Sowing, Varieties, Yield.

INTRODUCTION

Indian bean (*Lablab purpureus* L.) belongs to the family Fabaceae, is commonly known as Field bean, Hyacinth bean, Country bean, Dolichos bean, Egyptian bean, Sem, Wal, Avare, Avarai, etc. (Shivashankar and Kulkarni, 1989). It has been originated in India as wild forms of this bean are found in this country. From India, it was introduced to China, Western Asia, Egypt and other tropical countries of South and South-east Asia and Africa. In India, dolichos bean is primarily cultivated in Karnataka and adjoining districts of Tamil Nadu andhra Pradesh, Maharashtra and Madhya Pradesh. It is used as vegetable (immature green soft pods and immature grains) and forage.

The crop is grown for tender pods as vegetable and mature seeds as pulse and play an important role in the nutritional security of the region. The crop is also known for its richness in protein (3.6%) and fibre (1.8%). However, dry seed contain 23.0 - 28.0% protein. The pods are also rich in phenol (1.7- 9.67 mg/100 g) which is a potential antioxidant (Rai *et al*., 2014). It is very important for the fleshy and soft textured green pod, which supplies a good amount of protein, minerals and dietary fiber in vegetarian diet. Its seeds also contain water soluble polysaccharides comprised of rhamnose, xylose, arabinose, galactose, glucose, uronic acid, unidentified sugars and proteins (Basu *et al*., 2002).

Sowing at different dates or staggered sowing increases the availability of produce in the market thereby protects the consumers from paying higher prices. Sowing date is one of the most important factors which have tremendous effect on growth, development and biological yield of a crop species (Fagnano *et al*., 2009; Compant *et al*., 2010).

A great range of variation exists in the plant and pod characters of the Indian bean cultivars grown all over the country (Peter and Kumar, 2008). Both photo and thermo-sensitive types are dominant and insensitive type is rarely found in India. Photo-insensitive genotype, which does not require any specific short day conditions for flowering and pod set, can be grown as a remunerative off-season crop during summer and rainy season. Determinate type cultivars have relatively more synchronous flowering and hence have more uniform pod maturity facilitating cost-effective harvesting. Therefore, concerted efforts are required to

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develop or identify a variety having semi-determinate to determinate growth habit, early flowering and a pod quality suitable for vegetable purpose and do not require costly supporting system.

MATERIALS AND METHODS

A field experiment was conducted at research field, College of Horticulture, Mandsaur (Madhya Pradesh) during *kharif* season, 2018-19. Mandsaur is situated at Malwa plateau in Western part of Madhya Pradesh at North latitude of 23.45° to 24.13° and 74.44° to 75.18° East longitudes and at an altitude of 435.02 meters above mean sea level. The topography of the experimental field was plain. This region lies under 10th Agro climatic zone of the state. It belongs to sub-tropical and semi-arid climatic conditions having a temperature range of minimum 4°C and maximum 44°C in winter and summer, respectively. South–West monsoon is responsible for major part of annual precipitation. In this region maximum rainfall is received during mid-June to September with occasional shower in winter. The average rainfall is 576.6 mm. The soil of the experimental field was light alluvial soil having sandy loam texture with uniform topography.

Twenty treatment combinations comprising of four dates of sowing (D_1 - 20th July, D_2 - 5th August, D_3 - 20th August and D_4 - 5th September) and five varieties (V_1 - Arka Vijay, V_2 - Konkan Bhushan, V_3 - Arka Visthar, V_4 - Arka Adarsh and V_5 - Arka Prasidhi) were evaluated in factorial randomized block design with three replications. The seed was sown in lines at a spacing of 45 x 25 cm (Bush type) and 1 x 0.75 m (Pole type). Observations were recorded on randomly selected plants from each treatment for growth (plant height, number of primary branches plant^{-1} and SPAD value), phenological (days to first flowering, days to 50% flowering and days to first picking), yield (spike length, number of spikes plant^{-1}, pod length, pod width, number of pods plant^{-1}, weight of 10 pod, pod yield plant^{-1}, pod yield hectare^{-1} and harvest index) and quality characters (crude protein content (%) in fresh pod, fibre content (%) in fresh pod and dry matter content (%) in edible pods. Crude protein content was determined by multiplying the nitrogen (%) content of pods with the factor 6.25. The data obtained under various observations for each treatment were subjected to “Analysis of variance” as recommended by Panse and Sukhatme (1984).

RESULTS AND DISCUSSION

Growth parameters

The results presented in Table 1 showed significant influence of dates of sowing on plant height at all the stages under study. There was increase in plant height with advancement of growth stage. Maximum plant height of 79.1, 123.4, 167.7 and 233.6 cm was found with sowing on D_1 (20th July) at 30, 45, 60 DAS and last harvest stage, respectively. It was significantly superior over the rest of the dates of sowing. It was followed by $D_2 > D_3 > D_4$ in descending order under study. This may be due to the fact that plants in late sown condition get lesser period for growth before flowering and did not pass the juvenile phase fully or the thermal requirement was not met. Similar results were also reported by Joshi and Rahevar (2015), Kharbamon *et al.* (2015) and Pramoda and Sajjan (2018).

Highest number of primary branches plant^{-1} (6.12) were noted with D_1 (20th July), which was followed by D_2 (5th August) with 5.78 plant^{-1} and D_3 (20th August) with 5.41 plant^{-1} in descending order. Minimum number of primary branches (4.92) plant^{-1} was counted under D_4 (5th September) date of sowing. This might be due to availability of favourable environmental conditions to early sown crop which encouraged uptake of nutrients, increased photosynthesis of individual plant which led to higher dry matter accumulation plant^{-1} and ultimately resulted in higher number

Table 1: Effect of dates of sowing and varieties on growth parameters of Indian bean.

Treatment	Plant height (cm)				Primary branches	SPAD value			
	30 DAS	45 DAS	60 DAS	At harvest	At last harvest	30 DAS	45 DAS	60 DAS	At harvest
Dates of sowing (D)									
D_1	79.1	123.4	167.7	233.6	6.12	36.1	42.5	48.5	32.4
D_2	76.4	118.6	160.8	226.9	5.78	34.5	41.3	47.9	31.1
D_3	68.5	111.7	155.0	218.4	5.41	33.2	40.2	46.0	29.6
D_4	59.4	103.8	148.1	206.0	4.92	30.7	37.8	43.6	28.0
S.Em ±	0.95	1.08	1.24	1.57	0.20	0.50	0.54	0.57	0.47
CD at 5%	2.72	3.09	3.54	4.50	0.58	1.43	1.53	1.64	1.35
Varieties (V)									
V_1	27.6	51.3	75.0	87.9	4.11	32.1	38.6	45.1	28.4
V_2	30.6	54.9	79.2	96.2	5.03	33.1	39.6	45.8	29.4
V_3	101.5	160.1	218.8	315.2	6.52	35.3	42.2	48.2	32.2
V_4	95.1	150.0	204.8	299.7	5.91	33.6	40.7	46.4	30.3
V_5	99.4	155.6	211.7	307.1	6.22	34.1	41.2	47.1	31.1
S.Em ±	1.06	1.21	1.38	1.76	0.22	0.56	0.60	0.64	0.53
CD at 5%	3.04	3.46	3.96	5.03	0.64	1.60	1.71	1.83	1.51

of branches plant^{-1}. The results corroborate with the findings of Joshi and Rahevar (2015) and Kharbamon *et al.* (2015).

SPAD value was significantly influenced with dates of sowing in Indian bean. There was increase in SPAD value up to 60 DAS there after it declined at harvest stage. Maximum SPAD value of 36.1, 42.5, 48.5 and 32.4 was found with D_1 (20th July) date of sowing at 30, 45, 60 DAS and last harvest, respectively. It was followed by D_2 > D_3 in descending order at all growth stages. Minimum SPAD value was noted under D_4 (5th September) date of sowing at all the stages under study. Leaf chlorophyll content is an indicator of the physiological status of a plant which is an indicator of photo-synthetically active light transmittance characteristics of the leaf and dependent on the unit amount of chlorophyll (chlorophyll density) per unit leaf area. Similar findings were reported by Pramoda and Sajjan (2018).

Amongst varieties, maximum plant height of 101.5, 160.1, 218.8 and 315.2 cm was measured with variety V_3 (Arka Visthar) at 30, 45, 60 DAS and at last harvest, respectively which was followed by variety V_5 > V_4 > V_2. Minimum plant height of 27.6, 51.3, 74.9 and 87.9 cm was recorded with V_1 (Arka Vijay) at 30, 45, 60 DAS and at last harvest, respectively. Differential response of varieties to plant height might be due to their genetic character and adaptability to growing environment. Similar variations in plant height of Indian bean genotypes were reported by Yadav *et al.* (2015) and Choudhary *et al*. (2016).

Primary branches were significantly differed in varieties. Variety V_3 (Arka Visthar) had recorded highest primary branches (6.52) plant^{-1}. It was followed by V_5> V_4 > V_2 >V_1. Similar variations for branches in Indian bean genotypes were reported by Verma *et al*. (2015).

The variety V_3(Arka Visthar) had recorded highest SPAD value of 35.3, 42.2, 48.2 and 32.2 at 30, 45, 60 DAS and at last harvest, respectively which was followed by variety V_5 > V_4 > V_2 in descending order under the study. Lowest SPAD value of 32.1, 38.6, 45.1 and 28.4 was observed under V_1 (Arka Vijay) at 30, 45, 60 DAS and at last harvest, respectively. Genetic variations might have imparted the differences in SPAD value in varieties.

Table 2: Effect of dates of sowing and varieties on phenological parameters of Indian bean.

Treatment	Days to first flowering	Days to 50% flowering	Days to first picking
Date of sowing (D)			
D_1	45.1	51.6	94.5
D_2	43.9	50.0	89.5
D_3	43.1	48.8	84.6
D_4	41.8	47.3	81.2
S.Em ±	0.54	0.59	0.80
CD at 5%	1.56	1.69	2.30
Varieties (V)			
V_1	45.2	53.2	71.9
V_2	41.5	49.1	63.7
V_3	42.6	47.1	99.2
V_4	43.3	48.1	99.8
V_5	44.8	49.5	102.5
S.Em ±	0.61	0.66	0.90
CD at 5%	1.74	1.89	2.57

Phenological parameters

Days to first flowering was noted from the date of sowing to the first flower appearance in a plant under each treatment. Data presented in Table 2 indicated significant effect of dates of sowing on days to first flowering. Maximum days to first flowering (45.1 days) were noted under D_1 (20th July) date of sowing. It was followed by D_2 > D_3> D_4 with 43.9, 43.1 days and 41.8 days, respectively. The reason for variation in days to first flowering may be attributed to variation in growing environment particularly the temperature available to the plants under different dates of sowing. Days taken to first flowering decreased with delay in sowing. Similar results were also reported by Yadav *et al.* (2015) and Pramoda and Sajjan (2018).

Days to 50% flowering was noted as number of days from sowing date to the date when 50% plants in a plot have at least one flower appearance. Data presented in Table 2 indicated significant influence of dates of sowing on days to 50% flowering. Maximum days to 50% flowering (51.6 days) were noted under D_1 (20th July) sowing. It was followed by D_2 > D_3 with 50.0 and 48.8 days, respectively. Minimum days to 50% flowering i.e. 47.3 days were taken under D_4 (5th September) date of sowing. These results are in accordance with the findings of Laxmi *et al.* (2015) and Pramoda and Sajjan (2018).

Days to first picking were determined by counting the days from date of sowing to the date of first harvesting of pods. Findings (Table 2) revealed significant effects of dates of sowing on days to first picking. Maximum days to first picking (94.5 days) were noted under D_1 (20th July). It was followed by D_2 > D_3 > D_4 with 89.5, 84.6 and 81.2 days, respectively. The possible reason for early pod picking in late sown crop might be due to early termination of vegetative phase and initiation of reproductive stage as compared to early sown crop. Similar results were elucidated by Joshi and Rahevar (2015) and Pramoda and Sajjan (2018).

Among the varieties, maximum days to first flowering (45.2 days) were taken by the variety V_1 (Arka Vijay). It was followed by V_5> V_4 > V_3 with 44.8, 43.3 and 42.6 days, respectively. Minimum days to first flowering (41.5 days) were taken by the variety V_2 (Konkan Bhushan). The early flowering in a variety might be due to its suitability to the growing environment and higher capacity of plants to make available assimilates to the reproductive site during sensitive phase before initiation. Similar results were reported by Uddin *et al.* (2007).

Earliest 50% flowering (47.1 days) was noted with variety V_3 (Arka Visthar). It was followed by V_4 < V_2 < V_5 with 48.1, 49.1 and 49.5 days, respectively. Last 50% flowering (53.2 days) was commenced under variety V_1 (Arka Vijay).

Table 3: Effect of dates of sowing and varieties on yield parameters and yield in Indian bean.

Treatment	Spike length (cm)	Number of spikes plant^{-1}	Pod length (cm)	Pod width (mm)	Number of pods plant^{-1}	Weight of 10 pods (g)	Pod yield plant^{-1} (g)	Pod yield ha^{-1} (q)	Harvest index (%)
Date of sowing (D)									
D_1	17.75	79.03	11.56	18.17	224.1	70.93	1613.6	255.6	35.8
D_2	16.88	74.54	10.97	17.64	208.0	67.84	1508.9	235.4	34.3
D_3	16.01	71.41	10.65	17.29	193.0	65.57	1412.4	215.5	32.9
D_4	15.39	64.63	10.39	16.81	173.8	62.81	1289.9	190.3	31.2
S.Em ±	0.37	0.72	0.28	0.34	1.19	0.68	3.42	1.29	0.49
CD at 5%	1.05	2.06	0.81	0.96	3.42	1.95	9.79	3.69	1.41
Varieties (V)									
V_1	27.04	10.72	6.79	12.09	40.8	32.87	104.5	91.9	25.9
V_2	31.49	17.86	9.98	15.25	41.6	47.73	125.9	99.3	28.3
V_3	8.68	116.21	12.67	23.04	314.8	96.19	2579.1	339.6	39.4
V_4	7.25	106.03	10.96	20.57	260.9	81.48	1991.4	261.4	36.3
V_5	8.08	111.21	14.05	16.43	340.6	75.67	2480.3	328.9	37.9
S.Em ±	0.41	0.80	0.32	0.38	1.34	0.76	3.82	1.44	0.55
CD at 5%	1.17	2.30	0.91	1.08	3.82	2.18	10.95	4.12	1.58

Similar results were reported by Das *et al.* (2015), Singh *et al.* (2015) and Laxmi *et al.* (2015).

Minimum days to first picking (63.7 days) were taken by the variety V_2 (Konkan Bhushan). It was followed by V_1 < V3 < V4 with71.9, 99.2 and 99.8 days, respectively. The variety V_5 (Arka Prasidhi) took maximum days to first picking i.e. 102.5 days. Earliness for the first pod picking in the variety may be due to its greater capacity for accumulation of more photosynthates in less time that favoured induction of early flowering and fruiting and/or due to the genetic make-up of the varieties. Similar variations in days to first picking of Indian bean varieties were reported by Mohan *et al*. (2009), Joshi and Rahevar (2015) and Choudhary *et al*. (2016).

It was also noted that first flowering was dropped in varieties V_3, V_4 and V_5 without fruit setting which was the reason for delayed picking under these varieties as compared to V_1 and V_2. Though, the days to first flowering were not so much differed under all the varieties.

Yield parameters and yield

Findings (Table 3) on the yield parameters and yield indicated significant effect of date of sowing. Highest spike length of 17.75 cm was measured under D_1 (20th July). It was followed by D_2 > D_3 > D_4 with a spike length of 16.88, 16.01 cm and 15.39 cm respectively. Maximum spike length in early sowings may be due to favourable temperatures for spike development coupled with more vegetative growth as compared to late sowings.

Highest number of spikes plant^{-1} (79.03) was noted under D_1 (20th July). It was followed by D_2 > D_3 with 74.54 and 71.41 spikes plant^{-1}, respectively. Minimum number of spikes plant^{-1} i.e. 64.63 was counted under D_4 (5th September). Similar findings were reported by the Uddin *et al.* (2007).

Longest pods (11.56 cm) were produced under D_1 (20th July). It was followed by D_2 > D_3 > D_4 with a pod length of 10.97, 10.65 cm and 10.39 cm, respectively. This was due to longer growth period availed by earlier sown crop which in turn resulted in higher growth and accumulation of food material and ultimately longer pods. In late sown condition due to short period for growth lesser growth and accumulation of food material took place which may have retarded the rate of development of length of pod. These findings agree with the reports of Joshi and Rahevar (2015), Kharbamon *et al*. (2015) and Yadav *et al*. (2015).

Pod width (mm) was noted after each harvesting and mean was calculated. Maximum pod width of 18.17 mm was noted under D_1 (20th July). It was followed by D_2 > D_3 > D_4 with a pod width of 17.64, 17.29 and16.81 mm, respectively. Higher pod width was found in early sowing as compared to late sowing. Similar findings were reported by Uddin *et al*. (2007) and Yadav *et al.* (2015).

Maximum number of pods (224.1) plant^{-1} was counted with D_1 (20th July), which was followed by D_2 (5th August) > D_3 (20th August) > D_4 (5th September) with 208, 193 and 173 pods plant^{-1} in descending order. These findings indicate that delayed sowing caused reduction in number of pod may be due to lesser growth period which in turn led to lesser growth, accumulation of food material and thereby lesser number of pods plant^{-1}. The results are in agreement with the observations recorded by Joshi and Rahevar (2015), Kharbamon *et al.* (2015) and Yadav *et al.* (2015).

Highest weight of 10 pods (70.93 g) was recorded under D_1 (20th July). It was followed by D_2 > D_3 with 67.84 and 65.57 g weight of 10 pods, respectively. Lowest weight of 10 pods i.e. 62.81 g was recorded under D_4 (5th September). The reduction in yield under late sown condition could be attributed to poor development of yield attributes i.e. pod weight. These findings are in line with those reported by Moniruzzaman *et al.* (2007).

Pod yield plant^{-1} (g) was recorded after each harvesting and sum of all the harvesting worked out. Among the dates of sowing, maximum pod yield plant^{-1} (1613g) was noted under D_1 (20th July). It was followed by $D_2 > D_3$ with 1508 and 1412g, respectively. Minimum pod yield plant^{-1} i.e. 1289g was recorded under D_4 (5th September) date of sowing. Keeping the same trend, maximum pod yield of 255 qha^{-1} was noted under D_1 (20th July). It was followed by $D_2 > D_3$ with a pod yield of 235 and 215 qha^{-1}, respectively. Minimum pod yield of 190 q ha^{-1} was recorded under D_4 (5th September). The climate prevailing during early sowings was perhaps favourable for better vegetative growth of plant and lead to the formation of higher photosynthates and translocation to sink 'the pods', which ultimately resulted in higher fresh pod yield plant^{-1}. Green pod yield plant^{-1} decreased with delay in sowing. The reduction in yield under late sown conditions could be attributed to poor development of yield attributes, i.e. number of pods plant^{-1} and pod weight. Yield attributing characters might have been favourably influenced in early sowing and therefore, the yield increased. Late sown crops did not attain required vegetative growth and consequently resulted in poor yield. The results are in agreement with the findings of Kharbamon *et al*. (2015), Yadav *et al.* (2015) and Sharma *et al.* (2016).

Highest harvest index of 35.8% was noted under D_1 (20th July) date of sowing. It was followed by $D_2 > D_3$ with a HI of 34.3 and 32.9%, respectively. Lowest harvest index of 31.2% was found with D_4 (5th September) date of sowing. Similar results have been reported by Moniruzzaman *et al*. (2007).

Varieties showed significant difference in spike length. Longest spike of 31.49 cm was noted with variety V_2 (Konkan Bhushan). It was followed by V_1, V_3, V_5 and V_4 with a spike length of 27.04, 8.68, 8.08 cm and 7.25 cm, respectively. Similar variations in spike length of Indian bean varieties were reported by Savitha *et al*. (2012) and Peer *et al*. (2018).

Highest number of spikes plant^{-1} (116.2) was observed with variety V_3 (Arka Visthar). It was followed by $V_5 > V_4 > V_2$ with 111.2, 106.0 and 17.86 spikes plant^{-1}, respectively. Lowest number of spikes plant^{-1} i.e. 10.72 was found with variety V_1 (Arka Vijay). Similar variations in number of spikes plant^{-1} in Indian bean varieties were reported by Uddin *et al.* (2007), Savitha *et al*. (2012) and Peer *et al*. (2018).

Longest pods of 14.05 cm were observed in the variety V_5 (Arka Prasidhi). It was followed by $V_3 > V_4 > V_2$ with a pod length of 12.67, 10.96 and 9.98 cm, respectively. Minimum pod length of 6.79 cm was noted with variety V_1 (Arka Vijay). This might be due to genetic make-up of the varieties. These findings are in accordance with the results reported by Uddin *et al*. (2007) and Joshi and Rahevar (2015).

The variety V_3 (Arka Visthar) had recorded maximum pod width of 23.04 mm. It was followed by $V_4 > V_5 > V_2$ with a pod width of 20.57, 16.43 and 15.25 mm, respectively. Minimum pod width (12.09 mm) was observed under variety V_1 (Arka Vijay). The variation in pod width of varieties was probably due to their inherited traits and to some extent by environmental factors. Similar variations in pod width of Indian bean varieties were reported by Parmar *et al*. (2013), Das *et al*., (2015) and Choudhary *et al*. (2016).

Highest pods (340.6) per plant were recorded with variety V_5 (Arka Prasidhi). It was followed by $V_3 > V_4 > V_2$ in descending order under the study. Lowest pods (40.80) per plant were noted with variety V_1 (Arka Vijay). This might be due to genetic variability in the varieties. Similar variations in number of pods plant^{-1} were reported by Das *et al*. (2015) and Choudhary *et al*. (2016).

Varieties indicated significant variation for weight of 10 pods. Highest weight of 10 pods (96.2 g) was noted under variety V_3 (Arka Visthar). It was followed by $V_4 > V_5 > V_2$ with 81.5, 75.7 and 47.7 g weight of 10 pods, respectively. Lowest weight of 10 pods (32.9g) was found with variety V_1 (Arka Vijay). Similar results have been reported by Parmar *et al*. (2013) and Choudhary *et al*. (2016).

Varieties indicated significant variation for pod yield plant^{-1} and qha^{-1}. Maximum pod yield per plant (2579.1g) was noted under variety V_3 (Arka Visthar). It was followed by $V_5 > V_4 > V_2$ with a pod yield of 2480.3, 1991.4 and 125.9 g plant^{-1}, respectively. Minimum pod yield per plant (104.5g) was recorded under variety V_1 (Arka Vijay). Similarly maximum pod yield of 339.6 q ha^{-1} was found under V_3 (Arka Visthar). It was followed by $V_5 > V_4 > V_2$ with a pod yield of 328.9, 261.4 and 99.3 q ha^{-1}, respectively. Minimum pod yield of 91.9q ha^{-1} was found with V_1 (Arka Vijay). Varieties having different genetic potential respond differentially to similar management practices that could be the reason for varied performance under the study. Superiority of varieties over the others with respect to yield components and yield may be due to their genetic potential to utilize the growth resources effectively and translocate the photosynthates from source to sink. These findings are in consonance with those reported by Keerthi *et al.* (2014), Das *et al.* (2015) and Choudhary *et al*. (2016).

Amongst varieties, maximum harvest index of 39.4% was determined with variety V_3 (Arka Visthar), which was followed by $V_5 > V_4 > V_2$ with a harvest index of 37.9, 36.3 and 28.3%, respectively. Minimum harvest index of 25.9% was recorded with variety V_1 (Arka Vijay). Similar variations in harvest index of varieties were reported by Moniruzzaman *et al.* (2007) and Joshi and Rahevar (2015).

Quality parameters

The results presented in Table 4 revealed significant effects of dates of sowing and varieties on quality parameters in fresh pods of Indian bean.

Highest protein content (2.57%) was noted under D_1 (20th July) date of sowing. It was followed by $D_2 > D_3$ in descending order with a protein content of 2.47 and 2.34%, respectively. Lowest protein content (2.21%) was under D_4 (5th September). Skjelvag (1981) reported that the nitrogen content of field bean increased with the increase in temperature. As observed from meteorological data, the temperature was high in the months of August to September,

Table 4: Effect of dates of sowing and varieties on quality parameters in Indian bean.

Treatment	Crude protein content (%) in fresh pod	Fibre content (%) in fresh pod	Dry matter content (%)
Date of sowing (D)			
D_1	2.57	1.67	11.27
D_2	2.47	1.61	10.64
D_3	2.34	1.57	10.16
D_4	2.21	1.49	9.73
S.Em ±	0.09	0.04	0.27
CD at 5%	0.26	0.12	0.78
Varieties (V)			
V_1	2.80	1.94	16.20
V_2	2.56	1.81	12.01
V_3	2.23	1.01	7.14
V_4	2.32	1.50	8.01
V_5	2.09	1.67	8.88
S.Em ±	0.10	0.05	0.30
CD at 5%	0.29	0.14	0.87

so in early sown crop (July) the nitrogen content may be higher than late sown crop. Since the protein content is positively correlated with nitrogen content of the plant therefore, more the nitrogen metabolism more was the protein content (Kharbamon *et al.,* 2015).

The findings revealed significant influence of dates of sowing on fibre content. Lowest fibre content (1.49%) was noted under D_4 (5th September) date of sowing. It was followed by $D_3 < D_2 < D_1$ in ascending order with a fibre content of 1.57, 1.61 and 1.67%, respectively. Highest dry matter content (11.27%) was noted under D_1 (20th July). It was followed by $D_2 > D_3 > D_4$ in descending order with a dry matter content of 10.64, 10.16 and 9.73%, respectively. These findings may be attributed to better growth and accumulation of food material which enhanced the dry matter content in pods of early sown crop as compared to late sown crop.

Among the varieties, highest protein content of 2.80% was determined with variety V_1 (Arka Vijay), which was followed by $V_2 > V_4 > V_3$ in descending order with a protein content of 2.56, 2.32, 2.23%, respectively. Lowest protein content i.e. 2.09% was recorded with variety V_5 (Arka Prasidhi). Similar findings were also reported by Joshi and Rahevar (2015) and Choudhary *et al*. (2016).

Lowest fibre content (1.01%) was recorded with the variety V_3 (Arka Visthar). It was followed by $V_4 < V_5 < V_2 < V_1$ in ascending order with a fibre content of 1.50, 1.67, 1.81 and 1.94%, respectively. Similar variations in fibre content of Indian bean varieties were reported by Choudhary *et al*. (2016).

Highest dry matter content (16.20%) was determined with V_1 (Arka Vijay). It was followed by $V_2 > V_5 > V_4$ in descending order with a dry matter content of 12.01, 8.88 and 8.01%, respectively. Minimum dry matter content of 7.14% was found with variety V_3 (Arka Visthar). Similar variations for dry matter content in edible pods were reported by Jhanavi *et al*. (2018).

CONCLUSION

On the basis of present experiment, it may be concluded that among the dates of sowing, D_1 (20th July) date of sowing recorded significantly higher growth and yield parameters and yield. It also recorded highest protein content, dry matter content and fibre content in edible pods. Earliest first flowering, 50% flowering, first picking of pod and lowest fibre content was noted with D_4 (5th September). Among the varieties, variety V_3 (Arka Visthar) showed superiority for growth parameters and yield parameters *viz*., number of spikes plant^{-1}, pod width, weight of 10 pods, pod yield plant^{-1}, pod yield ha^{-1} and harvest index. Earliest first flowering and first picking was observed with V_2 (Konkan Bhushan). Highest spike length was measured with variety V_2 (Konkan Bhushan). Highest pod length and number of pods plant^{-1} were recorded with variety V_5 (Arka Prasidhi). Highest protein, fibre and dry matter content were determined under the variety V_1 (Arka Vijay).

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