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Effect of Planting Time and Phosphorus Dosage on Growth, Yield and Quality Attributes of Indian Bean (*Lablab purpureus* L.)

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ABSTRACT

Indian bean is one of the most important leguminous vegetable crops grown widely in the North Eastern Region of India. The crop is having great demand in the region and it is grown for tender pods as vegetable and seeds as pulse. To ensure the availability of vegetables during off- season with higher yield an experiment was conducted to study the response of semi-dwarf photo-insensitive line of dolichos bean (RCDL-10) to time of planting (May, June, July, August, September and October) and graded dosage of phosphorus (30, 40, 50 and 60 kg/ha P_2O_5) for growth, flowering behaviour, yield and quality traits. Longest vine (331.16 cm) and highest number of primary branches (15.31) were recorded in the July sowing whereas, shortest vine length (158.66 cm) and lowest number of branches per plant was recorded in October sowing (10.08). May sowing took the least number of days to complete the physiological and developmental stages. May planting gave the highest yield (168.70 g/plant) and yield attributes as well as highest crude protein (25.3%) content of the pods. Similarly, phosphorus dose of 60 kg/ha recorded the highest plant growth, number of flowers per panicle (9.41), yield (123.04 g/plant) and maximum crude protein content (25.22 %) of the pods as compared to the lower dosage. Hence, photo-insensitive line RCDL-10 can be cultivated as an off season crop during may having higher yield with the application of 60kg P_2O_5.

1. Introduction

Indian bean (*Lablab purpureus* L.) also known as dolichos bean, is one of the most important indigenous, legume winter vegetable crops. This crop is third most widely grown leguminous vegetable crops after pea and French bean in the North Eastern Region of India. It is grown in almost all the north eastern states of India during August to March. The crop is grown for tender pods as vegetable and mature seeds as pulse and its playing 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).

Further, seeds of Indian bean are reported to be diuretic, anthelmintic, anti-spasmodic, aphrodisiac, digestive, carminative, febrifuge and stomachic (Chopra *et al*., 1986, Kirtikar and Basu 1995). In addition, it is valued as forage and green manure (Maass 2006). Photo-insensitive genotype, which does not require any specific short day conditions for flowering and pod set, can be grown as a highly remunerative off-season crop during summer and rainy season (Pan *et al*., (2004). ICAR Research Complex for North Eastern Hill Region, Umiam, Meghalaya has identified one such semi-dwarf photo-insensitive genotype in dolichos bean, RCDL-10, which can be sown from April to November. The potential productivity of this cultivar in the North Eastern Region of India has been found to be 70-95q/ha. Since, dolichos bean is a remunerative crop having multiple uses and is well suited to rainfed agro-climate.

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Therefore, further investigation is needed to increase the existing levels of productivity by exploring its photo-insensitivity traits for off-season production and the beneficial role of phosphorus fertilisation in conjunction. As P_2O_5 helps in better and efficient nodulation, which results in increased assimilation of nitrogen, well filled pods and higher yield (Saxena *et al.,* 1996). Keeping this in view, the present investigation has been carried out to assess the impact of planting time and dosage of phosphorus on growth, flowering behaviour, yield and quality traits of photo-insensitive line of dolichos bean.

2. Materials and Methods

The present work was carried out during 2009-2010 at the Horticulture Experimental Farm of ICAR Research Complex for NEH Region, Umiam, Meghalaya. The soil type is alfisol with sandy loam texture and acidic in reaction (pH range 4.7- 5.0). The soil is high in organic carbon (> 1%), medium in available N (>270 kg/ ha), low to medium in available P (10-12 kg/ha) and medium in available K content (300kg/ha). The experiment was laid out in split plot design with six treatments as month of sowing allocated in main plots and four different phosphorus levels allocated in sub-plots with three replications. The different months of sowing were May (D_1), June (D_2), July (D_3), August (D_4), September (D_5) and October (D_6) and the different phosphorus (P_2O_5) levels were 30(P_1), 40 (P_2), 50(P_3) and 60 kg/ha (P_4). Seeds were sown at a spacing of 60×30 cm apart. The observations were recorded for plant growth (vine length (cm) and numbers of primary branches/plant), flowering behaviour (anthesis time, days to first flowering, days from first flower opening to last flower opening in a panicle, numbers of flower in a panicle, days from flowering to pod development and days taken to pod maturity) and pod yield and quality related traits pod length (cm), numbers of pods/plant, numbers of seeds/pod, fresh weight and dry weight of pods(g), pod yield per plant (g) and per hectare (q), crude protein by multiplying the nitrogen % of pods with the factor 6.25 (Kjeldahl method). Data were further analyzed statistically using software SPAR-1.

Table 1. Effect of phosphorus and planting time on growth and flowering in dolichos bean

	Days to 1st flowering	Days from flowering to pod formation	Days from pod formation to horticultural maturity	No. of flowers / panicle	Flowering period in a panicle	Vine length (cm)	No. of branches
A. Dosage of Phosphorous (kg/ha)							
P_1 (30 kg/ha)	46.04	7.84	27.42	8.93	9.14	256.02	11.68
P_2 (40 kg/ha)	44.93	7.69	27.12	9.09	9.23	266.34	12.49
P_3 (50 kg/ha)	44.26	7.77	27.01	9.27	9.31	280.42	12.94
P_4 (60 kg/ha)	44.00	7.66	27.23	9.41	9.50	292.07	13.49
SE m±	1.50	0.16	0.40	0.11	0.11	9.28	0.48
CD5%	4.68	0.50	1.30	0.31	0.31	29.23	1.50
B. Month of planting							
D_1 May	36.37	5.48	21.50	9.60	9.59	318.49	13.82
D_2 June	37.28	6.04	23.39	9.56	9.27	314.57	12.63
D_3 July	39.75	5.59	25.33	9.35	9.40	331.16	15.31
D_4 August	40.02	6.16	26.22	9.49	9.39	320.66	13.47
D_5 September	44.03	7.08	28.31	8.61	8.99	198.73	10.59
D_6 October	71.44	16.07	38.43	8.44	8.83	158.66	10.08
SE m±	1.20	0.13	0.33	0.08	0.18	6.44	0.30
CD5%	3.77	0.40	1.03	0.26	0.58	18.47	0.86

Figure 1. Monthly meteorological data during May, 2009 to Feb, 2010

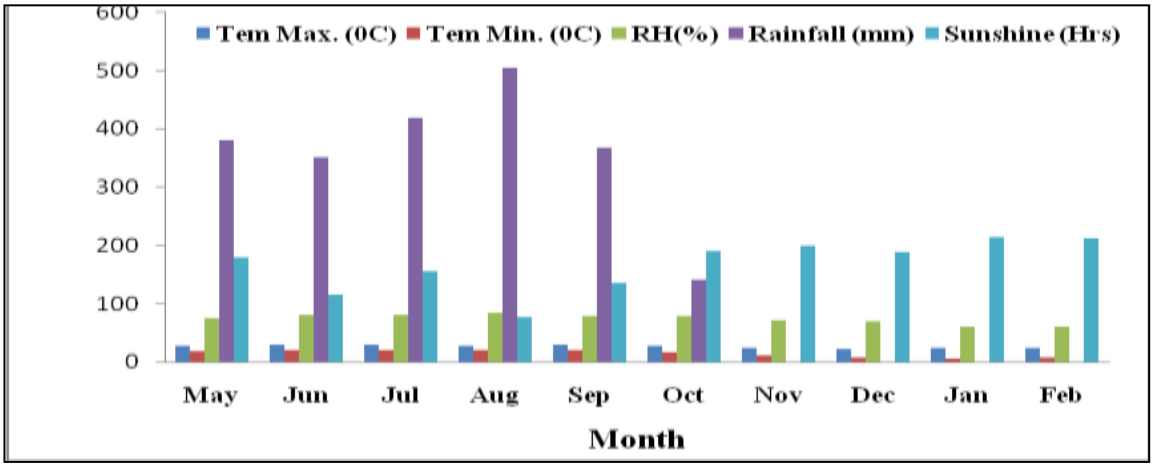


Figure 2. Effect of phosphorous doses on yield and protein content in dolichos bean

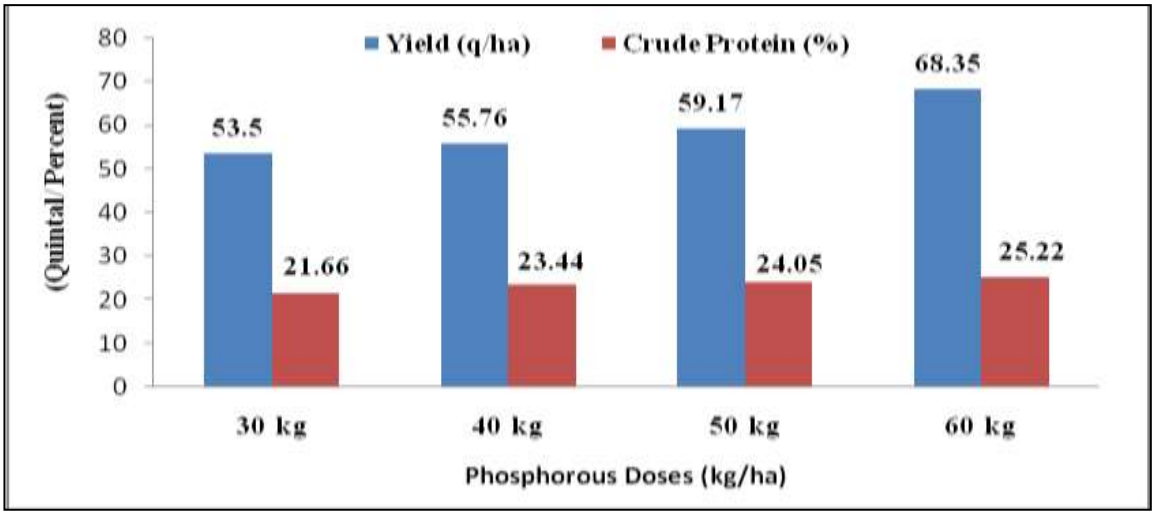
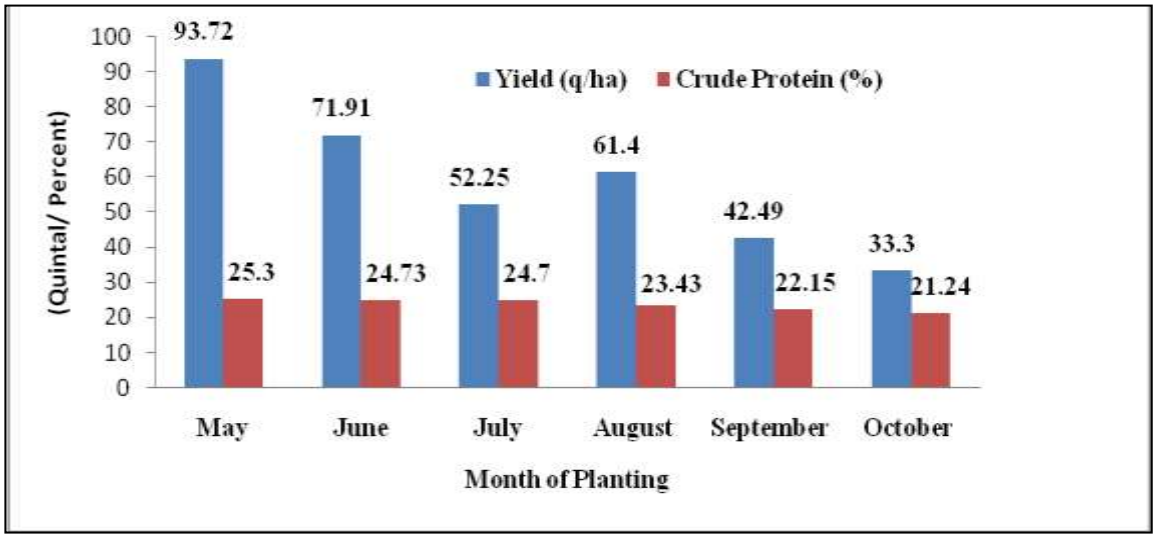


Figure 3. Effect of planting time on yield and protein content in dolichos bean



3. Results and Discussions

The results under present investigation showed significant difference for all the treatments except the dosage of phosphorous for days to first flowering, days from flowering to pod development and days from pod development to horticultural maturity (**Table 1 and 2**). From the meteorological parameters, the highest rainfall was recorded during August followed by July. On the other hand, the lowest sunshine hours was recorded in month of August and shown gradually increasing trend as shown in **Figure 1**. Month of sowing and phosphorus dosage showed significant effect on pod yield and protein content as presented in **Figure 2 and 3**. All the yield attributing factors were found to be positively correlated with early sowing up to August and after that every delay in sowing affected all these factors adversely. The longest vine length (331.16 cm) and highest number of primary branches (15.31) per plant were recorded in the July sowing whereas; shortest vine length (158.66 cm) and lowest number of primary branches (10.08) were recorded in October sowing (Table1).

Similar findings were also recorded by Dhital *et al*., (1997) in cowpea. Less growth and yield in late sowing might be because the plants did not pass the juvenile phase fully or the thermal requirement was not met (Joshi *et al*., 1984). In the present study, it was also observed that the temperature and rainfall decreased from the month of October onwards which might have affected the plant growth. An increasing trend was observed in the plant growth with increase in the phosphorus levels, where, phosphorus dose of 60kg/ha gave the longest vine length (292.07 cm) and the highest number of branches per plant (13.49) while, phosphorus dose of 30kg/ha gave the shortest vine length (256.02 cm) and lowest number of branches per plant (11.68). Similar observations were also made by Tewari and Singh, 2000 in French bean.

The increase in plant growth might be attributed to the role of phosphorus in various metabolic processes such as cell division, cell development and cell enlargement (Singh *et al.,* 2005). The anthesis time was recorded from 9.00 hrs to 17.00 hrs which was similar with the findings of Pokle and Deshmukh (1971). Delay in sowing resulted in late flowering. The May sowing took the least number of days (36.37) to reach first flowering while October sowing took the highest number of days to flower (71.44). Similar observations were recorded by Kathiravan *et al.* (2008) in lablab. As observed from the meteorological data during the period of study, the average temperature decreased from October onwards which might have delayed the flowering in the October month of sowing.

The phosphorus dosage did not have any significant effect on the days to first flowering. The findings were in accordance with the findings of Dwivedi *et al*., (2002).This was corroborated by the findings of Singh *et al*., (2004) and Pan *et al.,* (2004) in dolichos bean. The pod length increased with higher levels of phosphorus dose. The longest pod (8.27cm) was recorded with P_4 while, the shortest pod length (8.05) was recorded at P_1. The increase in the level of phosphorus helped better and efficient nodulation, which resulted in increased assimilation of nitrogen, well filled pods and higher yield (Saxena *et al.,* 1996). Similar observations were recorded by Tewari and Singh (2000) in French bean.

The highest dry weight of pods (0.94g) was recorded in the May and June sowing. May sowing recorded highest fresh weight of pods (4.17 g), number of seeds per pod (4.40), number of pods per plant (42.18), pod yield per plant (168.70 g) and pod yield per hectare (93.72q) while, the lowest fresh weight of pods (3.99g) was recorded in the September sowing, the lowest dry weight (0.73g) of pods, number of pods per plant (14.99), number of seeds per pod (3.99) , pod yield per plant (59.97 g) and per hectare (33.30q) was recorded in the October sowing. Similar observations were also recorded by Singh *et al*., (2004), Pan *et al.,* (2004) and Kathiravan *et al.,* (2008) in dolichos bean and Joshi *et al.,* (1984) in broad bean. The favourable temperature and abundant rainfall during May to September might have resulted in longer pods which were well filled with seeds and the temperature decreased from the month of October which might have affected the plant growth and pod development and this had finally resulted in less number of pods in late sown crops. The yield attributing characters might have been favourably influenced in early sowing and therefore, the yield increased (Kumar *et al.,* 2009). Late sown crops did not attain required vegetative growth and consequently resulted in poor yield.

The highest fresh (4.22g) and dry weight of pods (0.91g), highest number of pods per plant (30.76), number of seeds per pod (4.34), pod yield per plant (123.04g) and per hectare (68.35q) was recorded with phosphorus dose 60kg/ha while, the lowest (4.00g) fresh weight of pods, dry weight of pods (0.79g), number of pods per plant (24.08), number of seeds per pod(4.07), pod yield per plant (96.30 g) and per hectare (53.50q) were recorded at phosphorus dose 30kg/ha. The increase in the level of phosphorus helped better and efficient nodulation, which resulted in increased assimilation of nitrogen, well filled pods and higher yield (Saxena *et al.,* 1996). Low content of phosphorus affected the yield and dry matter production of pulse crops due to indirect effect on nitrogen fixation through the supply of photosynthates to nodules (Cassman *et al.,* 1980). Similar findings were also recorded by Tewari and Singh, 2000 in French bean.

Early sown crop (May to July sowing) produced higher number of flowers per panicle as compared to late sown crop (September to October).The highest number of flowers per panicle (9.60) was recorded in May sowing while, the lowest number of flowers per panicle (8.44) was recorded in the October sowing. The optimum temperatures prevailed during growth phase of early sown crop might have influenced more vegetative growth and physiological activities of plants, which helped in enhancing the better establishment and had a positive influence on the yield attributes (Sreelatha *et al.,* 1999). The maximum number of flowers per panicle (9.41) was recorded in the phosphorus dose 60kg/ha while, the minimum number of flowers per panicle (8.93) was recorded in the phosphorus dose 30kg/ha. Angayarkanni *et al.,* (2001) also reported the same in green gram.

October sowing took the least number of days (8.83) from first flower opening to last flower opening in a panicle while, the May sowing took the highest number of days (9.59). Phosphorus dose of 30kg/ha took minimum days (9.14) from first flower opening to last flower opening in a panicle while, phosphorus dose of 60kg/ha took maximum days (9.50). Early sown crop produced higher number of flowers per panicle; therefore, it took more days for all the flowers in the panicle to open as compared to late sown crop. Similarly, higher dose of phosphorus (P_4) produced higher number of flowers per panicle than lower dosage of phosphorus. Therefore, the plants fertilized with higher levels of phosphorus took more days from first flower opening to last flower opening in a panicle.

The days from flowering to pod development was delayed when sowing was done beyond the month of June. The May sowing took the least number of days from flowering to pod development (5.48 days) and days from pod development to horticultural maturity (21.50) while, the October sown crop has taken highest numbers of days 16.07 and 38.43days for pod development and horticultural maturity, respectively. The temperature decreased from the month of October, which might have delayed the development and maturity of pods in the September and October months of sowing. Days from flowering to pod development was non-significant with different dosage of phosphorus. The findings were in accordance with the findings of Dwivedi *et al*., (2002) in dolichos bean. The longest pod length was recorded with June and July sowing (8.26cm) while; the shortest pod length (8.06cm) was recorded in the September and October months of sowing. The high temperature and abundant rainfall might have favoured good pod development in early sown crop.

The highest crude protein content of the pods on dry weight basis (25.30%) was recorded in the May sowing while the lowest crude protein content of the pods on dry weight basis (21.24%) was recorded in the October sowing. Similar findings were also reported by Milford and Minson (1968) in lablab bean. 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 May to September, so in early sown crop (May to August) the nitrogen content was higher than late sown crop. Since the protein content is positively correlated with nitrogen content of the plant therefore, more the nitrogen metabolism, the more was the protein content. The different dosage of phosphorous has also shown significant effect on protein content of pods. The maximum crude protein content of the pods on dry weight basis (25.22 %) was recorded with 60 kg/ha phosphorus dose while the minimum crude protein content of the pods (21.66%) was recorded with 30 kg/ha phosphorus dose.

Similar observations were also recorded by Meena *et al.* (2006) in chickpea. The increase in crude protein content of the pods with phosphorus application was owing to the fact that the increase in the levels of phosphorus helped better and efficient nodulation increased the rate of symbiotic nitrogen fixation, which resulted in increased assimilation of nitrogen and higher crude protein (Saxena *et al.,* 1996). The results, of present investigation revealed that, the early sowing of photo-insensitive dolichos bean line RCDL-10 in the months of May and June resulted in better yield and quality attributes, even at lower levels of phosphorus fertilization. Moreover, phosphorus dose of 60kg/ha may be recommended to the growers for better yield and quality of produce.

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Table 2. Effect of phosphorus and planting time on yield attributes and protein content in dolichos bean

Dosage/month	Fresh wt. of pods (gm)	Dry wt. of pods (gm)	Pod length at horticultural maturity (cm)	No. of seeds/ pod	No. of pods /plant	Pod yield per plant (gm)	Pod yield (q/ha)	Crude protein (%)
A. Dosage of Phosphorous (kg/ha)								
P_1 (30 kg/ha)	4.00	0.79	8.05	4.07	24.08	96.30	53.50	21.66
P_2 (40 kg/ha)	4.07	0.85	8.16	4.15	25.10	100.38	55.76	23.44
P_3 (50 kg/ha)	4.15	0.89	8.21	4.24	26.63	106.51	59.17	24.05
P_4 (60 kg/ha)	4.22	0.91	8.27	4.34	30.76	123.04	68.35	25.22
SE m±	0.04	0.02	0.04	0.07	2.13	8.54	2.67	0.56
CD5%	0.12	0.07	0.12	0.21	6.73	26.90	8.41	1.77
B. Month of planting								
D_1 May	4.17	0.94	8.18	4.40	42.18	168.70	93.72	25.30
D_2 June	4.13	0.94	8.26	4.27	32.36	129.45	71.91	24.73
D_3 July	4.15	0.89	8.26	4.18	23.51	94.05	52.25	24.70
D_4 August	4.15	0.91	8.22	4.19	27.63	110.52	61.40	23.43
D_5 September	3.99	0.76	8.06	4.17	19.17	76.67	42.49	22.15
D_6 October	4.05	0.73	8.06	3.99	14.99	59.97	33.30	21.24
SE m±	0.03	0.01	0.03	0.07	1.48	5.93	1.85	0.41
CD5%	0.07	0.03	0.09	0.19	4.25	17.01	5.31	1.19

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