EFFECT OF PHOSPHORUS ON GROWTH AND NODULE FORMATION OF INDIGO PLANT UNDER OLD HYMALYAN PIEDMONT FIELD CONDITION

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Accepted for publication: November 03, 2007

ABSTRACT

Siddiqui A.T.S.U.A., Hossain A.K.M. M., Rahman M.M., Rahman S.M. and Sayem S.M. 2007. *Effect of Phosphorus on Growth and Nodule Formation of Indigo Plant under Old Hymalyan Piedmont Field Condition.* **Int. J. Sustain. Crop Prod. 2(6): 21-24**

An experiment was conducted at the soil science field laboratory Hajee Mohammad Danesh Science and Technology University, Dinajpur, during the period from March 28 to 23 October 2005 to evaluate the effect of phosphorus (P) on growth and nodule formation of indigo plant under Old Himalayans Piedmont field condition. The highest shoot length, , shoot dry weight, root dry weight, nodules plant^{-1}, number of effective nodules, dry weight of nodules plant^{-1}, 1000 seed weight, grain yield were obtained from the treatment 50kg P_2O_5. The tallest shoot of 63.60 cm, 140.20 cm and 241.5 cm were recorded from the treatment 50kg P_2O_5 at 45 DAS, 75 DAS and at harvest, respectively. The maximum dry matter of shoot 3.14, 14.74 and 71.33 g plant^{-1}, were recorded in the treatment 50kg P_2O_5 at 45 DAS, 75 DAS and at harvest, respectively. The maximum dry matter yield of root 0.56 g, 1.37 g and 4.31 g plant^{-1} were obtained to the treatment 50kg P_2O_5 at 45 DAS, 75 DAS and at harvest, respectively. The control gave the minimum dry matter yield of shoot and root. The results showed that the highest number of nodule of 12.8 and 24.6 were recorded to the treatment 50kg P_2O_5 at 45 DAS and 75 DAS, respectively.

Key words: Nodulation, indigo plant, dry matter

INTRODUCTION

Indigo is used from ancient time as blue dyes for textiles. Synthetic dye is used everywhere instead of using natural dye. Now a day, indigo is being cultivated in India, some parts of Bangladesh, parts of Southeast Asia and Africa. The pigment (indigo) is present in the leaves and stems of a number of *Indigofera* species (family: Leguminosae) with the Asian *Indigofera tinctoria* L. (Indian indigo) and the African *Indigofera arrecta* (Hochst indigo) having the most important sources of dye for commercial products. Indigo plants have a semi-wood stem and dark green compound leaves that are oval shaped in most species and bear clusters of red or prime flowers that look like butterflies. The plants are propagated from seed and can grow from 1.5 to 2 meter height. *Indigofera* species are perennial herbs and shrubs in habit and the economic lifespan varies from 1 to 3 years according to the species locality, soil and climatic condition. However, there is a paucity of reliable information in the literature on crop yields for various species with regards to their growth, nodulation, biomass production and dye content. Soil moisture and nutrient fertilization also exhibits pronounce effect on dye production. Low level of nutrition has been reported to decrease dye yield and it also adversely affect the N_2 fixation. P deficiency is reported to be major limitation to the growth and nodulation in leguminous species. Before developing nodules, Indigo depends on P, which not only help seedling growth but also aid early nodulation, leading to optimum growth and biomass production. Indigo is only a minor source of dye but has been much planted for cover, green manure and erosion control in coffee, tea and rubber plantations in warm regions of the old world. P plays an important role in the growth of leguminous plant and to the development of a strong root system and seed formation. The beneficial effect of P supply is caused by a strong stimulating effect on nodulation and N_2 fixation capacity of leguminous plant (Gates, 1975). The present investigation was, therefore, designed to study the growth and nodule formation of indigo plant under Old Himalayan Piedmont field condition as affected by P.

MATERIALS AND METHOD

A field experiment was conducted at the soil science field laboratory Hajee Mohammad Danesh Science and Technology University, Dinajpur during the period from March 28 to 23 October 2005 to evaluate the growth and nodule formation of indigo plant under Old Himalayans Piedmont field condition as affected by phosphorus. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The experiment was conducted with nine levels of P_2O_5 viz. 0, 20, 30, 40, 50, 60, 70, 80, 90 kg ha^{-1}. Each of the nine of phosphorus (P) from triple super phosphate was used in the respective plots, Muriate of potash @ 110 kg ha^{-1} and 50% urea@55kgNha^{-1} was used as basal dose. The remaining half of urea was top dressed at 30 DAS. Intercultural operations and irrigation were done as and when necessary. Ten plants were selected from each plot before flowering and at maturity to keep on shoot length, shoot dry weight, root dry weight, no. of nodules Plant^{-1}, 1000- seeds weight, grain yield (Kg ha $^{-1}$). Soil samples were collected before and harvest of crop to analyze total nitrogen and available P, S and Zn contents. Data on yield and yield components were analyzed and means were tested by Duncan's New Multiple Range TEST (DMRT).

RESULTS AND DISCUSSION

Shoot length

The effect of P on growth and nodule formation of indigo plant was highly significant and the results have been presented in Table 1.The longest shoot (63.6 cm) at 45 DAS was obtained in the treatment 50kg P_2O_5 which was statistically identical to the treatments 40kg P_2O_5, 60kg P_2O_5 and 70kg P_2O_5 but significantly higher than those of the rest treatments. At 75 DAS, the longest shoot (140.20 cm) was also found in the treatment 50kg P_2O_5 which was identically followed by the treatment 40kg P_2O_5, 60kg P_2O_5 and 70kg P_2O_5 but differ significantly with those of the rest treatments. At harvest, the longest shoot, 241.5 cm was also observed in the treatment 50kg P_2O_5 which was statistically similar to the previous pattern but significantly higher than the rest treatments. Sattar (1978) reported that the maximum height of lentil was obtained with P_{50} level.

Shoot dry weight

The effect of phosphorus was significant on shoot dry weight at 45 DAS, 75 DAS and at harvest of indigo plant. The shoot dry weight ranged from 3.14 g plant^{-1} to 4.37g plant^{-1} at 45 DAS (Table 1). The maximum shoot dry weight was obtained in the treatment 50kg P_2O_5.The maximum shoot dry weight 14.74 g plant^{-1} was recorded from the treatment 50kg P_2O_5 at 75 DAS, which was statistically similar to the treatments 40kg P_2O_5, 60kg P_2O_5 and 70kg P_2O_5.The maximum dry weight of shoot 71.33 g plant^{-1} was recorded by the treatment 50kg P_2O_5 at harvest which was statistically identical to the treatments 40kg P_2O_5, 60kg P_2O_5 and 70kg P_2O_5. Islam (1964) revealed that phosphates @200 lbs acre^{-1} significantly increased the dry weight of shoot on lentil.

Root dry weight

The maximum root dry weight (0.56 g plant^{-1}) was recorded at 45 DAS in the treatment 50kg P_2O_5 which was statistically identical to the treatments 40kg P_2O_5, 60kg P_2O_5 and 70kg P_2O_5 but differs from the rest treatments. No appreciable difference was found between 30 and 80 kg P_2O_5 ha^{-1}. The dry weight of root at 75 DAS ranged from 0.80 g plant^{-1} in control to 1.37 g plant^{-1} 50kg P_2O_5 ha^{-1} (Table 1).

Number of nodule plant^{-1}

The highest number of nodule plant^{-1} (12.8) was observed at 45 DAS in the treatment 50kg P_2O_5 which was statistically identical to the treatments 40kg P_2O_5, 60kg P_2O_5 and 70kg P_2O_5 and significantly higher than those rest of other treatments (Table 2). The highest number of nodule plant^{-1} (24.6) was recorded at 75 DAS from the treatment 50kg P_2O_5 which was statistically similar to the treatments 40kg P_2O_5, 60kg P_2O_5 and 70kg P_2O_5 and significantly higher than those rest of the treatments. Jones (1976) and Tomar *et al*. (1993) reported that the increasing trend of nodules was observed with the increasing levels of P. Sattar (1978) reported that the maximum nodule was produced from P_{25} to P_{50} level in majority of the cases.

Number of effective nodules plant^{-1}

The treatment 50kg P_2O_5 gave the highest number of effective nodules plant^{-1} (3.70) was obtained at 45 DAS from which was statistically similar to the treatments 40kg P_2O_5, 60kg P_2O_5 and 70kg P_2O_5 It was recorded from the treatment 50kg P_2O_5 (Table 2). Similar findings were also reported by Jones (1976) and Tomar *et al*. (1993) where the increasing trend of nodules was observed with the increasing levels of P. The number of effective nodules increased up to 50kg P_2O_5 and than decreased in treatments from 60kg P_2O_5 to 90kg.

Nodule dry weight

The nodule dry weight of *Indigofera tinctoria* was significantly influenced by different levels of P (Table 2). The highest nodule dry weight 41.10 mg plan^{-1} in treatment 50kg P_2O_5 and the lowest 22.10 mg plant^{-1} in control were obtained at 45 DAS. The dry weight of nodules ranged from 50.10 mg plant $^{-1}$ in control to 68.30 mg plant $^{-1}$ in the treatment 50kg P_2O_5.

1000 seed weight

The highest 1000 seed weight (5.500 g) and the lowest seed weight (5.100 g) were found in the treatment 50kg P_2O_5 and the control, respectively (Table 3). Sattar (1978) revealed that the highest amount of 1000 seed weight was produced in specific dose of P.

Grain yield

The highest grain yield 2484 Kg ha $^{-1}$was obtained from 50kg P_2O_5 ha^{-1} and the lowest 1984 kg ha^{-1} in control (Table 3). Sattar (1978) reported that the highest amount of grain yield was produced in specific dose of phosphorus.

Table 1. Effect of different levels of phosphorus on shoot length, shoot dry weight and root dry weight of indigo plant.

Treatment	Shoot length (cm)			Shoot dry weight (g plant^{-1})			Root dry weight (g plant^{-1})		
	45. DAS	75 DAS	At harvest	45 DAS	75 DAS	At harvest	45 DAS	75 DAS	At harvest
Control	53.00e	117.50 d	225.8	3.14d	7.27e	43.00e	0.39b	0.80d	4.31f
20 kg P_2O_5	57.53 cd	124.40cd	231.9	3.82bc	8.19d	44.00de	0.43b	0.91d	5.29d
30 kg P_2O_5	58.27 bc	129.90bc	234.7	4.07abc	11.99c	45.67de	0.51a	1.01cd	5.45cd
40 kg P_2O_5	61.67 abc	137.40 ab	239.2	4.20ab	13.32b	52.00bc	0.52a	1.15bc	6.04bc
50 kg P_2O_5	63.60 a	140.20 a	241.5	4.37a	14.74a	71.33a	0.56a	1.37a	7.4a
60 kg P_2O_5	62.60 ab	138.0 ab	239.5	4.27a	14.33a	56.00b	0.53a	1.24ab	6.63b
70 kg P_2O_5	61.07 abc	132.30 abc	235.0	4.10abc	12.15c	49.00cd	0.52a	1.01cd	5.53cd
80 kg P_2O_5	58.07 c	125.60 cd	233.2	4.00abc	8.62d	45.33de	0.50a	0.95cd	5.32de
90 kg P_2O_5	53.73 de	117.80 d	230.5	3.77c	8.09d	43.40e	0.42b	0.90d	4.67ef
Level of significance	**	**	NS	**	**	**	**	**	**
LSD	4.07	7.745	15.71	0.3547	0.6241	4.904	0.05474	0.1974	0.6614
CV (%)	4.00	3.46	3.87	5.16	3.29	5.67	6.51	10.92	6.79

** Significant at 1% level. NS = non significance

Table 2. Effect of different levels of phosphorus on total nodule number, effective nodule number and nodule dry weight of indigo plant

Treatment	Number of nodule Plant^{-1}		Effective nodule number		Nodule dry weight (mg)	
	45 DAS	75DAS	45 DAS	75DAS	45DAS	75 DAS
Control	4.83 h	13.0i	2.00g	8.00g	22.10i	50.20h
20	7.1 f	17.3g	2.10g	11.00c	33.20g	55.40g
30	8.5 de	19.4e	2.50c	11.20de	35.50e	58.80e
40	9.8 c	21.0c	3.30c	12.00c	39.20c	63.20c
50	12.8 a	24.6a	3.70a	15.10a	41.10a	68.30a
60	11.5 b	23.3b	3.50b	14.00b	40.30b	66.40b
70	9.2 cd	19.9d	3.00d	11.40d	36.30d	62.60d
80	7.8 ef	18.1f	2.30f	11.10e	34.10f	56.20f
90	6.0 g	15.0h	2.00g	9.00f	30.26h	50.10h
Level of significance	**	**	**	**	**	**
LSD	0.7741	0.59	0.1815	0.2045	0.3947	0.2257
CV (%)	5.19	0.1974	3.89	1.05	0.66	3.4

** Significant at 1% level.

Table 3. Effect of different levels of phosphorus on 1000 seed weight and total grain yield on indigo plant at harvest

Treatment	1000 seed weight (g plant^{-1})	Total grain yield (kg ha^{-1})
Control	5.10	1984i
20 kg P_2O_5	5.24	2083g
30 kg P_2O_5	5.28	2195e
40 kg P_2O_5	5.37	2286c
50 kg P_2O_5	5.50	2484a
60 kg P_2O_5	5.39	2328b
70 kg P_2O_5	5.34	2262d
80 kg P_2O_5	5.25	2174f
90 kg P_2O_5	5.24	2041h
Level of significance	NS	**
LSD	0.6704	5.059
CV (%)	7.30	1.56

** Significant at 1% level. NS = non significance

The findings of the present experiment indicates clearly that 50 kg P_2O_5 ha^{-}1 as TSP showed the better performance out of others investigated treatments on growth, nodulation and all yield characteristics. So the treatment 50 kg P_2O_5 ha^{-1} had the best effect on the growth, nodulation and grain yield of indigo plant.

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