

Short Communication

## Effect of phosphorus levels and bioinoculants on growth and yield of long duration pigeonpea [*Cajanus cajan* (L.) Millsp]

AMITESH KUMAR SINGH and R.S. SINGH

Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221005, India;  
Email: singhrs\_bhu@yahoo.co.in

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### ABSTRACT

A field experiment was conducted during rainy season of 2008-09 and 2009-10 to study the effect of phosphorus levels (0, 25, 50 and 75 kg P<sub>2</sub>O<sub>5</sub> per ha) and bioinoculants (untreated control, PSB, PGPR and PSB + PGPR) on growth and yield of long duration pigeonpea. The results showed that the application of 75 kg P<sub>2</sub>O<sub>5</sub> per ha recorded the maximum plant height, branches/plant, dry matter production/plant, chlorophyll content (SPAD), leaf area, LAI, grain yield, stalk yield, biological yield and harvest index, which were significantly superior over 25 kg P<sub>2</sub>O<sub>5</sub> per ha and control (without phosphorus application) but at par with 50 kg P<sub>2</sub>O<sub>5</sub> per ha during both the years of experiment. Among the bioinoculants, dual inoculation of PSB + PGPR significantly increased higher growth attributes such as plant height, branches plant, dry matter production, chlorophyll content, leaf area, LAI, grain yield, stalk yield, biological yield and harvest index, which were significantly superior over alone application of PSB, PGPR and control (without seed inoculation) during both years of experimentation. Combined application of 75 kg P<sub>2</sub>O<sub>5</sub> per ha + PSB + PGPR was found significantly superior to 25 kg P<sub>2</sub>O<sub>5</sub> per ha + PSB + PGPR and control (without phosphorus application + without seed inoculation), which was at par with 50 kg P<sub>2</sub>O<sub>5</sub> per ha + PSB + PGPR during both years in respect of dry matter production (g), grain yield (kg/ha) and stalk yield (kg/ha).

**Key words:** Bioinoculants, Dry matter production, Grain yield, LAI, Phosphorus levels

Long duration pigeonpea (250-260 days) is generally grown in mono/mixed cropping system in eastern U.P. without any improved agro-technology. This is main reason of low productivity of long duration pigeonpea. Phosphorus (P) is a key plant nutrient, but its fixation is another problem as only 20-25 per cent of the phosphorus applied to the soils is available to the crop in the year of its application and the remaining part is converted into insoluble unavailable forms (Raju *et al.*, 2005). Some heterotrophic microorganisms possess ability to solubilise phosphorus from insoluble sources occurring in soil. Phosphate Solubilising Bacteria (PSB) and Plant Growth Promoting Rhizobacteria (PGPR) as seed dressers in nodulating legumes are highly beneficial in enhancing N and P content due to more N fixation by *Rhizobium* and solubilisation of native P by PSB, thus, making

two essential nutrients available to plants (Bansal, 2009). Considering the significant role of phosphorus and biofertilizers in sustainable production of pulses, an experiment was conducted to study the effect of phosphorus levels and bioinoculants on productivity of pigeonpea.

The field experiment was conducted during two consecutive rainy seasons of 2008-09 and 2009-10 at Agriculture Research Farm of Banaras Hindu University, Varanasi. The experimental soil was sandy clay loam in texture having pH 7.46 and 7.53 in 1<sup>st</sup> and 2<sup>nd</sup> year, respectively. It was moderately fertile being low in organic carbon (0.34 and 0.37%) with available N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and sulphur were 188.7, 18.5, 205.3, 19.3 kg/ha and 194.2, 22.4, 210.6, 21.5 kg/ha during both the years, respectively. The experiment was laid out in split plot design with three replications keeping phosphorus levels (control, 25, 50 and 75 kg/ha) in main plot and bioinoculants (Control, PSB, PGPR and PSB + PGPR) in subplot at the same site during both the years. The recommended dose of nitrogen, potassium, sulphur at 30, 40, 30 kg/ha and phosphorus as per treatment were applied through urea, diammonium phosphate (DAP), muriate of potash and elemental sulphur, respectively. Pigeonpea seed were inoculated with phosphate solubilizing bacteria (*Bacillus polymyxa*), PGPR (*Rhizobium* + *Pseudomonas fluorescens*) and dual seed inoculation of PSB + PGPR before sowing. Sowing of long duration pigeonpea cv. 'Bahar' was done by ridge-furrow method of planting on July 14, 2008 and July 20, 2009 and the crop was harvested on April 06, 2009 and April 12, 2010, respectively. The required plant population (60 cm row to row and 20 cm plant to plant) was maintained after a month of seeding by thinning the plant.

Perusal of data (Table 1 and 2) revealed that the application of 75 kg P<sub>2</sub>O<sub>5</sub>/ha increased the growth attributes viz. plant height (cm), branches/plant, chlorophyll content, leaf area (cm<sup>2</sup>/plant), LAI and dry matter production/plant (g) and this treatment was significantly superior over 25 kg P<sub>2</sub>O<sub>5</sub>/ha and control (no application of phosphorus) but, was statistically at par with 50 kg P<sub>2</sub>O<sub>5</sub>/ha during both the years. Maximum seed yield, stalk yield and biological yield of pigeonpea was found with application of 75 kg P<sub>2</sub>O<sub>5</sub>/ha which was at par with 50 kg P<sub>2</sub>O<sub>5</sub>/ha and significantly superior over 25 kg P<sub>2</sub>O<sub>5</sub>/ha and control during both the years of

**Table 1. Effect of phosphorus levels and bioinoculants on pigeonpea growth attributes**

Treatment	Plant height (cm)		Branches/plant (no.)		Dry matter production/plant (g)		Chlorophyll content (SPAD)		Leaf area (cm <sup>2</sup> /plant)		Leaf area index (LAI)	
	At harvest				At 200 DAS				At 150 DAS			
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
<i>Phosphorus levels (kg/ha)</i>												
Control	180.7	174.7	19.3	18.4	248.4	239.0	34.4	32.5	3645	3390	3.04	2.82
25	196.0	190.3	21.7	20.8	280.3	270.6	39.4	36.7	3991	3736	3.33	3.11
50	212.7	205.2	24.3	23.3	322.2	309.8	44.5	41.0	4347	4092	3.62	3.41
75	215.2	206.8	25.1	23.7	335.1	323.5	45.1	41.8	4370	4114	3.64	3.43
SEm (±)	3.9	3.8	0.4	0.4	5.8	5.6	0.8	0.7	80.3	75.1	0.07	0.06
CD (P=0.05)	13.6	13.2	1.5	1.4	20.0	19.3	2.7	2.5	277.8	260.0	0.23	0.22
<i>Bioinoculants</i>												
Control	184.5	177.7	19.6	18.9	252.6	247.3	36.1	34.0	3785	3529	3.15	2.94
PSB	199.3	193.4	22.7	21.4	291.9	280.1	40.8	37.5	4010	3755	3.34	3.13
PGPR	205.0	198.2	22.9	21.9	300.9	288.5	41.3	38.2	4163	3907	3.47	3.26
PSB + PGPR	215.9	207.7	25.2	23.9	340.5	327.2	45.2	42.3	4396	4140	3.66	3.45
SEm (±)	2.8	2.7	0.3	0.3	4.3	4.2	0.6	0.5	57.5	54.1	0.05	0.05
CD (P=0.05)	8.3	8.0	0.9	0.9	12.6	12.1	1.7	1.6	167.9	157.8	0.14	0.13

**Table 2. Effect of phosphorus levels and bioinoculants on pigeonpea seed, stalk, biological yield and harvest index**

Treatment	Seed yield (kg/ha)		Stalk yield (kg/ha)		Biological yield (kg/ha)		Harvest index (%)	
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
<i>Phosphorus levels (kg/ha)</i>								
Control	1673	1508	6731	6405	8404	7913	19.87	19.02
25	1945	1795	7708	7363	9653	9158	20.11	19.58
50	2218	2068	8600	8398	10818	10465	20.47	19.71
75	2265	2124	8695	8528	10960	10651	20.64	19.89
SEm (±)	39	36	153	147	192	183	0.40	0.39
CD (P=0.05)	134	123	529	510	663	633	NS	NS
<i>Bioinoculants</i>								
Control	1693	1530	6913	6490	8605	8020	19.64	19.08
PSB	1999	1846	7818	7655	9816	9501	20.33	19.38
PGPR	2095	1945	8084	7920	10179	9865	20.55	19.67
PSB + PGPR	2314	2173	8920	8628	11233	10800	20.57	20.08
SEm (±)	29	27	114	110	143	138	0.28	0.27
CD (P=0.05)	86	80	333	321	419	401	NS	NS

investigation. Maximum harvest index was recorded with application of 75 kg P<sub>2</sub>O<sub>5</sub>/ha followed by 50, 25 kg P<sub>2</sub>O<sub>5</sub>/ha and minimum in control during both the years of study. Similar results have been reported by Mahetele and Kushwaha (2011), Deshbhratar *et al.* (2010), Kumar and Kushwaha (2006).

Seed inoculation with bioinoculants proved its superiority over untreated control with respect to growth attributes *viz.* plant height (cm), branches/plant, dry matter production/plant (g), chlorophyll content (SPAD), leaf area (cm<sup>2</sup>/plant) and LAI in pigeonpea (Table 1 and 2). Dual

**Table 3. Interaction effect of phosphorus levels (P) and bioinoculants (M) on pigeonpea dry matter production/plant (g) at harvest**

Treatment	2008-09				2009-10			
	Control	PSB	PGPR	PSB + PGPR	Control	PSB	PGPR	PSB + PGPR
Control	197.0	246.9	255.0	294.6	196.0	234.7	242.7	282.5
25	230.8	278.0	286.0	326.4	230.0	265.8	272.7	314.2
50	286.6	316.3	326.5	359.4	274.0	304.0	314.4	347.1
75	296.1	326.6	336.1	381.6	289.0	316.0	324.0	365.0
		SEm (±)		CD (P=0.05)		SEm (±)		CD (P=0.05)
M at same P		8.6		25.1		8.3		24.2
P at same/diff M		9.4		29.5		9.1		28.4

**Table 4. Interaction effect of phosphorus levels (P) and bioinoculants (M) on pigeonpea seed yield (kg/ha)**

Treatment	2008-09				2009-10			
	Control	PSB	PGPR	PSB + PGPR	Control	PSB	PGPR	PSB + PGPR
Control	1400	1660	1720	1910	1200	1500	1570	1760
25	1620	1880	2000	2280	1470	1730	1850	2130
50	1850	2205	2315	2500	1700	2055	2165	2350
75	1900	2250	2345	2565	1750	2100	2195	2450
		SEm ( $\pm$ )		CD (P=0.05)	SEm ( $\pm$ )		CD (P=0.05)	
M at same P		59		172	55		160	
P at same/diff M		64		199	59		185	

**Table 5. Interaction effect of phosphorus levels (P) and bioinoculants (M) on pigeonpea stalk yield (kg/ha)**

Treatment	2008-09				2009-10			
	Control	PSB	PGPR	PSB + PGPR	Control	PSB	PGPR	PSB + PGPR
Control	5880	6670	6775	7600	5200	6500	6620	7300
25	6670	7500	7860	8800	6000	7350	7700	8400
50	7500	8500	8800	9600	7300	8340	8640	9310
75	7600	8600	8900	9678	7460	8430	8720	9500
		SEm ( $\pm$ )		CD (P=0.05)	SEm ( $\pm$ )		CD (P=0.05)	
M at same P		228		666	220		643	
P at same/diff M		250		780	241		753	

inoculation of PSB + PGPR recorded higher value of all the growth attributes and which was significantly superior over seed inoculation with PSB, PGPR and control. Seed inoculation of PSB was significantly superior over control (without seed inoculation) and at par with seed inoculation with PGPR. Higher seed yield, stalk yield and biological yield was obtained with dual seed inoculation of PSB + PGPR which was significantly superior over seed inoculation of PSB, PGPR and control during both the years of experimentation. Highest harvest index was obtained with dual seed inoculation of PSB + PGPR followed by PGPR, PSB and lowest in control during both the years of investigation. Similar results have been reported by Bansal (2009) in mungbean and Tilak *et al.* (2006) in pigeonpea.

Interaction effects of phosphorus levels and bioinoculants on dry matter production/plant at harvest, seed yield and stalk yield were found significant (Tables 3,4 and 5) during both the years of experimentation. Maximum dry matter production/plant, seed and stalk yield were obtained with combined application of 75 kg P<sub>2</sub>O<sub>5</sub>/ha + PSB + PGPR and this combination was significantly superior over other combinations and which was at par with combined application of 50 kg P<sub>2</sub>O<sub>5</sub>/ha + PSB + PGPR during both the years of experimentation. Similar results were also reported by Singh and Pareek (2003) in mungbean and Dubey (1997) in rainfed soybean.

Thus, it can be inferred that application of 75 kg P<sub>2</sub>O<sub>5</sub>/ha along with seed inoculation with PSB + PGPR would be helpful in getting more growth attributes and higher yield of pigeonpea.

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