

## Original Research Article

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## Studies on Growth, Yield and Quality of Pigeon Pea (*Cajanus cajan* L. millsp.) as Influenced by Different Levels of Phosphorous and Liquid Biofertilizers

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### ABSTRACT

A field was conducted at Experimental Farm, Agronomy Section, College of Agriculture, Latur. The experimental field was levelled and well drained. The soil was medium and black in colour with good drainage. The soil was clayey in nature and slightly alkaline (7.8) in reaction, low in nitrogen (118.86 kg ha<sup>-1</sup>), medium in available phosphorus (17.7 kg ha<sup>-1</sup>) and rich in available potassium (485.89 kg ha<sup>-1</sup>). The environmental conditions were favorably congenial for normal growth and maturity of pigeonpea crop. The experiment was laid out in Factorial Randomized Block Design with two factors and replicated thrice. Whereas first factor comprises levels of phosphorus viz., 0 (control), 40, 50 and 60 kg P ha<sup>-1</sup>, second factor comprises seed inoculations with biofertilizer viz. alone inoculation of *Rhizobium* @ 6 ml kg<sup>-1</sup> seeds, alone inoculation PSB @ 6 ml kg<sup>-1</sup> seeds and dual inoculation *Rhizobium* + PSB each of @ 6 ml kg<sup>-1</sup> seeds. The experimental site having gross and net plot size was 5.4 x 4.5 m<sup>2</sup> and 4.2 x 3.9m<sup>2</sup> respectively. The application of phosphorus @ 60 kg ha<sup>-1</sup> given significantly higher growth and yield attributes, gross monetary return and net monetary return over the rest of the levels of phosphorus. Whereas NMR was remained at par with 50 kg P ha<sup>-1</sup>. Among three biofertilizer treatments, dual seed inoculation with *Rhizobium* + PSB was recorded higher growth and yield attributes, gross monetary return and net monetary return than the individual seed inoculation of *Rhizobium* or PSB.

#### Keywords

Rhizobium,  
Biofertilizer, PSB,  
Phosphorus

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### Introduction

Pigeonpea (*Cajanus cajan* L. Millsp.) is one of the major grain legume (pulse) crop of the tropics and subtropics. It is grown on mountain slopes to reduce soil erosion. Protein content in pigeon pea seeds compares well with that of other important grain legumes. Pigeonpea is commonly known in India as redgram or arhar or tur. It is a tropical crop grown in India, predominantly, during the

kharif season both as sole crop and as intercrop, though found in wide range of agro-ecological situations. Its deep rooting and drought tolerant character make it as successful crop in areas of low and uncertain rainfall. Being a leguminous plant is capable of fixing atmospheric nitrogen and thereby restores nitrogen in the soil. Its deep root system helps in extracting nutrient and moisture from deeper soil layers, thus making it suitable for rainfed condition.

India accounts for 90 percent of pigeonpea areas and production of the world, which is grown in an area of 3.90 million hectare with production 3.17 million tonnes and productivity of 817 kg ha<sup>-1</sup> (Anon., 2015-16). In Maharashtra it was grown on 10.37 lakh hectare with production of 66.1 lakh tonnes and productivity of 637 kg ha<sup>-1</sup> during 2014 (Anon., 2015-16). It is mainly grown in states of Maharashtra, Karnataka, Andhra Pradesh, Uttar Pradesh, Gujarat, Madhya Pradesh and these states constitutes 90 per cent of the area (Anon., 2015-16). In Marathwada region major pigeon pea growing districts are Aurangabad, Jalna, Beed, Parbhani, Osmanabad, Latur, Nanded and Hingoli.

Phosphorus is a key element involved in various function in growth and metabolism of pulses. It is frequently a major limiting nutrient for plant growth in most Indian soils. Phosphorus solubilising bacteria (PSB) can play an important role in increasing phosphorus availability by solubilising the P and supplying it to plants in a more available form (Khan *et al.*, 2007). Inoculants of efficient nitrogen fixing solubilizing bacteria (PSB) which have established their capability in augmenting the productivity of pulses may fulfil the nitrogen and phosphorus needs considerably. The prices of inorganic fertilizers are beyond the reach of marginal farmers. Under these circumstances the present investigation is proposed.

### **Materials and Methods**

A field experiment was conducted on medium black soils at Agronomy Section Farm, College of Agriculture, Latur during *khari* season of 2016-17. The experiment was laid out in Factorial Randomized Block Design with two factors and replicated thrice. Whereas first factor comprises levels of phosphorus *viz.* 0 (control), 40, 50 and 60 kg P ha<sup>-1</sup>, second factor comprises seed

inoculations with biofertilizer *viz.* alone inoculation of *Rhizobium* @ 6 ml kg<sup>-1</sup> seeds, alone inoculation PSB @ 6 ml kg<sup>-1</sup> seeds and dual inoculation *Rhizobium* + PSB each of @ 6 ml kg<sup>-1</sup> seeds. The experimental site having gross and net plot size was 5.4 x 4.5 m<sup>2</sup> and 4.2 x 3.9 m<sup>2</sup> respectively. The recommended dose of fertilizer was applied at time sowing (25:50:00 NPK kg ha<sup>-1</sup> where P applied as per treatments). The sowing was done on 22nd June 2016 by dibbling and harvested on 3<sup>rd</sup> January 2017. All the cultural practices were followed by as per package of practices.

### **Results and Discussion**

#### **Effect of phosphorus on growth and yield**

The maximum plant height (173.8 cm), number of functional leaves plant<sup>-1</sup> (286.6), number of branches plant<sup>-1</sup> (7.9), number of nodules (23.1) and dry matter plant<sup>-1</sup> (188.1 gm) were recorded due to the application of 60 kg P ha<sup>-1</sup> and significantly superior than control but satisfactory at par with 40 and 50 kg P ha<sup>-1</sup>. The higher number of pods plant<sup>-1</sup> (209.3) and seed yield (2613 kg ha<sup>-1</sup>) was obtained by the application of 60 kg P ha<sup>-1</sup>, and remained at par with 50 kg P ha<sup>-1</sup>. Application of 60 kg P ha<sup>-1</sup> recorded significantly higher leaf area recorded (5.56 dm<sup>2</sup>) and test weight (94.4 g) over control, 40 and 50 kg P ha<sup>-1</sup>.

#### **Effect of bio-fertilizers on growth and yield**

Pigeon pea seed treated with liquid rhizobium culture + liquid PSB (phosphorus solubilizing bacteria) recorded significantly higher growth and yield attributes *viz.* number of functional leaves plant<sup>-1</sup>, number of branches plant<sup>-1</sup>, number of nodules, dry matter plant<sup>-1</sup>, number of pods plant<sup>-1</sup>, seed yield and test weight, than alone application of rhizobium and PSB culture while it was found comparable with PSB in respect of plant height (Table 1).

**Table.1** Effect of different levels of phosphorus and various liquid bio-fertilizers on growth and yield of pigeon pea

Treatments	Plant height (cm)	Number of functional leaves plant <sup>-1</sup>	Leaf area plant <sup>-1</sup>	Number of branches plant <sup>-1</sup>	Number of nodules plant <sup>-1</sup>	Total dry matter plant <sup>-1</sup> (g)	Number of pods plant <sup>-1</sup>	Seed yield (kg ha <sup>-1</sup> )	Test weight (g)
<b>A) Phosphorous (kg ha<sup>-1</sup>)</b>									
P <sub>0</sub> : control	157.8	243.8	4.13	6.8	19.8	149.7	172.2	1828	94.4
P <sub>1</sub> : 40	169.9	265.6	4.50	7.4	22.0	177.0	189.4	2231	94.6
P <sub>2</sub> : 50	170.8	265.3	4.49	7.5	22.3	186.7	207.8	2475	94.8
P <sub>3</sub> : 60	173.8	268.6	5.56	7.9	23.1	188.1	209.3	2613	94.9
SE m ±	3.9	6.2	0.11	0.2	0.6	4.3	5.5	63	0.40
CD at 5%	11.6	18.0	0.31	0.6	1.9	12.6	16.2	184	NS
<b>B) Biofertilizer</b>									
B <sub>1</sub> : Rhizobium	162.6	251.5	4.26	6.9	21.2	165.8	187.7	1921	94.0
B <sub>2</sub> : PSB	165.8	253.4	4.31	7.3	20.8	173.7	189.2	2279	94.7
B <sub>3</sub> : Rhizobium + PSB	175.6	277.1	4.17	7.9	23.4	186.6	207.1	2660	94.9
SE m±	3.4	5.3	0.09	0.2	0.5	3.7	4.8	55	0.34
CD at 5 %	10.1	15.6	0.27	0.5	1.6	10.9	14.1	159	NS
<b>Interaction (P x B)</b>									
SE m±	6.9	10.7	0.18	0.4	1.1	7.5	9.3	108	0.7
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS
<b>General mean</b>	168.1	260.8	4.42	7.4	21.8	175.4	194.7	2287	94.6

**Table.2** Protein content, protein yield and economics of pigeonpea as influenced by Different levels of phosphorus and various liquid bio-fertilizers

Treatments	Protein content (%)	Protein yield (kg ha <sup>-1</sup> )	GMR (₹ ha <sup>-1</sup> )	NMR (₹ ha <sup>-1</sup> )	B:C Ratio
<b>A) Phosphorous (kg ha<sup>-1</sup>)</b>					
P <sub>0</sub> : control	18.62	340	93751	59034	2.7
P <sub>1</sub> : 40	18.75	419	114374	76407	3.0
P <sub>2</sub> : 50	18.92	467	126895	88098	3.3
P <sub>3</sub> : 60	19.32	505	133994	94405	3.4
SE m <sub>±</sub>	0.18	12	3177	3177	-
CD at 5%	NS	34	9317	9317	-
<b>B) Biofertilizer</b>					
B <sub>1</sub> : Rhizobium	18.66	357	98550	60796	2.6
B <sub>2</sub> : PSB	18.91	432	116858	79104	3.1
B <sub>3</sub> :Rhizobium + PSB	19.15	510	136353	98560	3.6
SE m <sub>±</sub>	0.15	10	2751	2751	-
CD at 5 %	NS	30	8069	8069	-
<b>Interaction (P x B)</b>					
SE m <sub>±</sub>	0.30	20	5503	6276	-
CD at 5 %	NS	NS	NS	NS	-
<b>General mean</b>	18.90	433	117254	79486	3.1

**Effect of phosphorus on quality and economics of pigeon pea**

Higher protein content (19.32 %) with a protein yield (505 kg ha<sup>-1</sup>) was obtained by the application of 60 kg P ha<sup>-1</sup>. While protein content did not differ significantly but protein yield found significantly higher with the application 60 kg P ha<sup>-1</sup>. The maximum gross momentary return (₹ 1,33,994 ha<sup>-1</sup>) and net momentary return (₹ 94405 ha<sup>-1</sup>) with higher B:C ratio (3.4) recorded with 60 kg P ha<sup>-1</sup> and found significantly at par with 50 kg P ha<sup>-1</sup> (Table 2).

**Effect of bio-fertilizers on quality and economics**

Dual inoculation of liquid biofertilizers (rhizobium + PSB) was obtained higher protein content (19.15%) in pigeon pea seed,

protein yield (510 kg ha<sup>-1</sup>) GMR (₹136353 ha<sup>-1</sup>) and NMR (₹ 98560 ha<sup>-1</sup>) with the higher B: C ratio (3.4) was recorded with dual inoculation of liquid rhizobium and PSB culture.

The pigeon pea crop should be applied with 50 kg phosphorus ha<sup>-1</sup> for better growth and higher yield.

To obtain higher gross and net momentary returns from pigeon pea crop apply 50 kg phosphorus ha<sup>-1</sup> and rhizobium + PSB culture seed treatment.

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