

Original Research Article

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Effect of Bio-Phos (*Chaetomium globosum*) on Castor (*Ricinus communis* L.) Yield at Different Levels of Phosphorus under Irrigated Conditions

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ABSTRACT

The field experiments were conducted at the Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh to assess the response of bio-phos (*Chaetomium globosum*) on castor and compared its efficiency with applied inorganic phosphorus through fertilizer during *kharif* season of year 2011-12 to 2013-14 on medium clay soil under irrigated conditions. The experiment consisted of eight treatment combinations of seed treatment with bio-phos @ 30g inoculants/50 g. castor seed (cv. GCH 7) seed with different doses of phosphorus (20 kg, 40 kg and 60 kg/ha). The seed yield of castor was increased due to seed inoculation with bio-phos to the tune of 309 kg/ha, 33 kg/ha, 188 kg/ha and 156 kg/ha over sole application of 0, 20, 40 and 60 kg P₂O₅ /ha, respectively. The increment in seed yield of castor with bio-phos was higher at 40 kg/ha applied P and decreased with addition of inorganic P. Castor seed yield improvement of 8.35%, net returns of Rs 36989/- and B:C ratio of 2.64 were recorded under application of 40 Kg P₂O₅ /ha along with seed inoculation of bio-phos.

Keywords

Castor, Bio-phos, Phosphorus, Seed inoculation, Yield.

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Introduction

Castor (*Ricinus communis* L.) is an important non-edible industrial oilseed crop grown in *kharif* season under rainfed conditions of India and the country holds a premier and dominant position in its production and supplies. Castor oil is most versatile and economically important natural plant product. According to Solvent Extractors' Association (SEA), India's exports of castor oil and derivatives are estimated about 400,000 tonnes worth around \$800 million during 2014 (Business Standard, 2015). Castor is being grown in many states of India. Castor yield depends on several agronomic factors. Poor fertilizer use efficiency, arid and semi-arid environment and light soil are some of

cause for poor productivity. Phosphorus is most indispensable mineral nutrient for crop as it helps in better root growth and development and thereby making them more efficient in biological nitrogen fixation. It involves in metabolic activities as a constituent of nucleoproteins, nucleotides and also plays a key role in the formation of energy rich phosphate bond like ADP and ATP. Bio-fertilizers (PSB) can play an important role in meeting the phosphorus requirement of crops solubilization of insoluble phosphorus sources. Plant growth promoting bacteria (PGPR) are a group of free living microorganisms that use different methods to increase plant growth (Glick,

1995). Some of these bacteria increase P uptake by the plant belongs to the group of phosphate solubilizing bacteria (PSB) and as biological fertilizers are used to increase plant growth and yield (Chen *et al.*, 2006). Phosphorus is added in the form of phosphatidic fertilizers, part of which is utilized by plants and the remainder converted into soluble fixed forms. To circumvent phosphorus deficiency, phosphate-solubilizing microorganisms (PSM) could play an important role in supplying phosphate to plants in a more environmentally-friendly and sustainable manner. Biophos (*Chaetomium globosum*) is a naturally occurring phosphorus mobilizing organisms when applied through seed treatment, release huge amount of phosphatases, phytase and organic acids which may help in mobilization of native unavailable phosphorus (Tarafdar and Gharu, 2006).

Bio-phos can tolerate moderately high soil temperature prevailing in the arid and semi-arid regions. Biophos was prepared from a phosphatase and phytase releasing fungus *Chaetomium globosum*. Research work on these aspects in castor crop is meager, therefore, the present study was undertaken to assess the role of bio-phos in castor crop under semi-arid conditions.

Materials and Methods

The field experiment was conducted during rainy seasons of 2011-12, 2012-13 and 2013-14 at Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh, and Gujarat, India under irrigated conditions. The soil of the experimental plot was clayey in texture and slightly alkaline in reaction. The soil has an organic carbon content of 0.67 per cent and was low in available nitrogen 211 kg/ha, phosphorus 29.0 kg/ha and high in potash 324 kg/ha. The moisture content of the experimental plot at field capacity and

permanent wilting point were 27.4 and 13.8 per cent, respectively, while the bulk density was 1.34 g cm^{-3} . The experiment was laid out in randomized block design with three replications. The experiment consisted of eight treatment combinations of seed treatment with bio-phos @ 30g. Inoculants/50 g. castor seed (cv. GCH 7) seed with different doses of phosphorus (20 kg, 40 kg and 60 kg/ha). Seed treatment of bio-phos was done by sticking solution (jaggary solution @ 125g/liter water) on seeds. 30g. inoculants were sprinkled on the seeds and it was mixed thoroughly.

Seeds were air dried in shade after treatment and then used for sowing. A recommended dose of nitrogen, potash and seed rate was applied. The crops were sown under rainy season but after cessation of monsoon five irrigations each of 50 mm depth were given to castor crop at an interval of 15 days. Pest and disease control measures were taken as and when required. Castor picked at 90, 120, 150 and 180 days after sowing. The rainfall received during the crop growing season of 2011-12, 2012-13 and 2013-14 was 525 mm, 1520 mm and 1271mm, respectively. All the data obtained were statistically analyzed by using the Panse and Sukhatme (1985) procedure.

Results and Discussion

Growth and yield attributes

Results presented in table 2 revealed that the growth and yield attributes significantly influenced by different treatments. The highest plant height (72.53 cm), number of branches per plant (6.22), number of spikes per plant (9.22), capsules per spikes (77.00) and length of main spike (47.94 cm) were significantly recorded by seed inoculation with bio-phos @ 30g inoculants/50g castor seed + 40 kg P_2O_5 /ha. In pooled results which

was remained at par with application of 40 kg P₂O₅/ha, 60 kg P₂O₅/ha, seed inoculation with bio-phos @ 30g inoculants/50g castor seed + 60 kg P₂O₅/ha. Some of these bacteria increase P uptake by the plant belongs to the group of phosphate solubilizing bacteria and as biological fertilizers are used to increase plant growth and yield (Chen *et al.*, 2006). Microorganisms with phosphate solubilizing potential increase the availability of soluble phosphate and enhance the plant growth (Kucey *et al.*, 1989; Ponnurugan and Gopi, 2006). *Rhizospheric* microorganisms can interact positively in promoting plant growth similar finding was also reported by Tomar *et al.*, (2004). Oil per cent was significantly higher at seed inoculation with bio-phos @ 30g.inoculants/50g castor seed + 20 kg P₂O₅/ha which was at par with application of 20 kg P₂O₅/ha, 40 kg P₂O₅/ha, seed inoculation with bio-phos @ 30g inoculants/50g castor seed + 40 kg P₂O₅/ha. Similar finding was also reported by Tomar *et al.*, (2004) who observed that inoculation and phosphorus application increased oil contents of soybean. Similar experimental results have been reported by Singh *et al.*, (2013) and Yadav and Yadav (2015).

Seed yield

The results showed that seed yield of castor were significantly influenced by different treatments (Table 1). Significantly higher seed yield (1937 kg/ha) was recorded when crop was fertilized with 60 kg P₂O₅/ha. But, it remained at par with 60 kg P₂O₅/ha and seed treatment with bio-phos @ 30g inoculants/50g castor seed (1744 kg/ha) during 2011-12. The results indicated that there was a linear response of added phosphorus to seed yield from 0 level (1750 kg/ha) to 20 kg P₂O₅/ha (2187 kg/ha), 40 kg P₂O₅/ha (2254 kg/ha) and 60 kg P₂O₅/ha (2408 kg/ha). Significantly higher seed yield (2552 kg/ha) was recorded at seed treated

with bio-phos @ 30g.inoculants / 50 g castor seed with 40 kg P₂O₅/ha, but remained at par with seed treatment with bio-phos @ 30g inoculants/50g castor seed + 20 kg P₂O₅/ha, 40 kg P₂O₅/ha, 60 kg P₂O₅/ha and seed treatment with bio-phos @ 30g inoculants/50g castor seed + 60 kg P₂O₅/ha. During 2012-13. While during 2013-14, the application of 60 kg P₂O₅/ha together with bio-phos resulted in distinct improvement in seed yield (3279 kg/ha) over the rest of the treatments except for 40 kg P₂O₅/ha + bio-phos, which indicted the efficacy of bio-phos upto 40 kg P₂O₅/ha. Three years pooled results indicated that there was a linear response of seed yield due to increased phosphorus application from 0 to 60 kg P₂O₅/ha. Significantly higher seed yield was recorded by seed treated with bio-phos @ 30g.inoculants / 50g. Castor seed + 60 kg P₂O₅/ha (2500 kg/ha), but it remained on same bar with seed treatment of bio-phos @ 30g.inoculants / 50g. Castor seed + 40 kg P₂O₅/ha (2437kg/ha) and 40 kg P₂O₅/ha and 60 kg P₂O₅/ha. The effect of bio-phos was further enhanced while P was supplemented with inorganic fertilizer. This was due to release huge amount of phosphatases, phytase and organic acids which may help in mobilization of native unavailable phosphorus by bio-phos (Tarafdar and Gharu, 2006). Some of these bacteria increase P uptake by the plant belongs to the group of phosphate solubilizing bacteria and as biological fertilizers are used to increase plant growth and yield (Chen *et al.*, 2006). The PSB solubilize the fixed soil P and applied phosphates resulting in higher crop yields (Gull *et al.*, 2004). The higher value of castor seed yield was result of higher value of different growth and yield contributing characters. These findings are in the conformity with the result of Singh *et al.*, (2013) and Yadav and Yadav (2015).The lower seed yield recorded in treatment where control was due to no application of phosphorus and bio-phos.

Table.1 Effect different treatments on seed yield and economics of castor

Tret. No.	Treatments	Seed yield (kg/ha)				Economics			
		2011	2012	2013	Pooled	Gross return (Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	B:C ratio
T ₁	Control (No P ₂ O ₅)	1099	1750	1956	1601	64058	34500	29558	1.86
T ₂	Seed treatment with bio-phos @ 30g.inoculants / 50g. castor seed	1273	2052	2406	1910	76416	34800	41616	2.20
T ₃	20 kg P ₂ O ₅ /ha	1505	2187	2452	2048	81916	35738	46178	2.29
T ₄	T ₂ + 20 kg P ₂ O ₅ /ha	1384	2248	2610	2081	83226	36038	47188	2.31
T ₅	40 kg P ₂ O ₅ /ha	1921	2254	2572	2249	89963	36689	53275	2.45
T ₆	T ₂ + 40 kg P ₂ O ₅ /ha	1644	2552	3116	2437	97492	36989	60504	2.64
T ₇	60 kg P ₂ O ₅ /ha	1937	2408	2688	2344	93761	37588	56173	2.49
T ₈	T ₂ + 60 kg P ₂ O ₅ /ha	1744	2478	3279	2500	100004	37888	62116	2.64
	S.Em±	91	117	112	101	-	-	-	-
	C.D. (P=0.05)	277	354	343	305	-	-	-	-
	C.V.%	10.1	9.0	7.7	8.8	-	-	-	-

Market price: Castor: Rs. 40/kg, Cost of inputs (Rs. /kg): Urea -6.50, DAP- 25.18, Bio-phos: 100.00

Table.2 Effect of different treatments on growth and yield attributes of castor (Pooled data of three years)

Tret. No.	Treatments	Plant Stand /ha	Plant height (cm)	No. of Branches/ Plant	No. of Spikes / Plant	No. of Internodes/ plant	Capsules/ spike	Length of main spike (cm)	100 seed wt (g)	Oil %
T ₁	Control	13462	51.09	4.22	6.89	18.00	52.78	37.78	31.90	47.6
T ₂	Seed treatment with bio-phos @ 30g.inoculants / 50g. castor seed	13423	60.80	5.00	8.00	18.44	68.89	44.73	32.57	49.4
T ₃	20 kg P ₂ O ₅ /ha	13557	60.87	5.22	8.78	19.44	70.89	43.67	33.38	49.9
T ₄	T ₂ +20 kg P ₂ O ₅ /ha	13457	62.70	5.33	8.22	19.44	71.67	44.11	33.14	50.7
T ₅	40 kg P ₂ O ₅ /ha	13470	61.23	6.11	9.00	18.78	72.89	45.00	32.92	50.0
T ₆	T ₂ +40 kg P ₂ O ₅ /ha	13529	72.53	6.22	9.22	18.67	77.00	47.94	33.43	50.1
T ₇	60 kg P ₂ O ₅ /ha	13639	63.13	5.67	8.78	19.22	72.56	46.00	33.37	48.9
T ₈	T ₂ +60 kg P ₂ O ₅ /ha	13510	64.98	5.89	8.67	19.33	74.56	47.00	33.21	49.5
	S.Em±	164	2.46	0.26	0.27	0.52	1.89	1.55	0.42	0.4
	C.D. (P=0.05)	NS	7.02	0.73	0.77	NS	5.41	4.71	NS	1.0
	C.V.%	3.64	11.87	14.09	9.58	8.24	8.10	7.14	3.81	2.2

Economics

Economics of different treatments are presented in table 1. Gross realization, cost of cultivation, net realization and B:C ratio of different treatments was worked out on the basis of current market prices of castor and inputs used.

The results indicated that inoculation of bio-phos + 40 kg P₂O₅/ha recorded higher gross return (Rs. 97492/ha), net return (Rs. 60504/ha) and B:C ratio (2.64) in pooled results.

From the three years data it is concluded that seed treatment of bio-phos @ 30g inoculants/50g. Castor seed + application of 40 kg P₂O₅/ha was more productive and remunerative for castor under irrigated conditions.

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