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Research Article

Performance of *Rabi* niger [*Guizotia abyssinica* (L.) Cass] influenced by phosphorus management

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ABSTRACT : Field experiments were conducted at the College Farm, N.M. College of Agriculture, Navsari Agricultural University, Navsari during *Rabi* season of 2010-11 and 2011-12. The increase in *Rabi* niger yields with these treatments were the results of increased growth and yield attributes *viz*., plant height, dry matter accumulation, capitula per plant and number of seeds per capitula, protein yield, oil content, the highest seed and straw yields of niger were recorded with 20 kg P_2O_5 ha^{-1} from SSP with PSM (T_6) and was at par with 10 kg P_2O_5 ha^{-1} from SSP + PSM (T_4), 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM (T_8). These treatments were 43.87, 38.64 and 36.91 per cent higher than control (T_2) in respect of grain yield. Soil inoculation with PSM significantly increased the growth and yield attributes *viz*., plant height, dry matter accumulation, capitula per plant and number of seeds per capitula, thereby increasing the seed and straw yields of niger. Increased the net realization and benefit to cost ratio from niger crop was recorded with 20 kg P_2O_5 ha^{-1} from SSP with PSM (T_6).

KEY WORDS : Levels of phosphorus and different sources of phosphorus, Protein yield, Oil content, Seed and straw yield, Economics

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INTRODUCTION

India occupies a premier position in global oilseed scenario accounting for 19 per cent oilseeds area and 9 per cent oilseeds production (Hegde, 2000). Oilseeds are rich source of energy and nutrition. Edible oils and oil meals have an important role to play in relieving malnutrition of human and animal population. Niger (*Guizotia abyssinica* L. Cass) belongs to Compositae family is grown in tropical and subtropical countries like India, Ethiopia, East Africa, West Indies and Zimbabwe. Where, India and Ethiopia are two major niger growing countries in the world. In India, niger is grown in an area of 4.2 lakh ha with a production of 1.12 lakh tonnes and productivity of 252 kg/ha (Anonymous, 2005). India earns Rs 30 crores through export of niger seed. Niger contributes about 3% of Indian oilseed production (Damodaran and Hegde, 2003). The niger seeds which are small, spindal like and shiny black contain 30 to 40 per cent good quality edible oil. It is mainly grown in tribal pockets with the use of minimum agro inputs, particularly fertilizers leading to very low productivity (Sharma, 1993). Inspite of such a significance the productivity of this crop is very low which may enhanced by adequate supply of nutrient specially phosphorus, because being oilseed crop niger respond well to phosphorus. Hence, yield potential of this crop can be improved through adequate supply of phosphorus to Indian soils which are generally low to medium in available phosphorus and the phosphorus supply through fertilizers is still below the optimum level due to very high prices of phosphatic fertilizers. Moreover, the efficiency of

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applied phosphorus seldom exceeds 20 to 25 per cent to the current crop and the remaining parts get converted into relatively unavailable forms. In this context several strains of phosphorus solublising bacteria (PSB), phosphorus soliblising microbes (PSM) and fungi have been isolated, which have capacity to solublize the applied as well as native phosphorus. The phosphorus management involving the conjunctive use of fertilizers and organic sources assumed great importance recently due to paucity of phosphatic fertilizers and need to sustain productivity (Nambaiar and Abrol, 1989).

EXPERIMENTAL METHODS

Field experiments were conducted at the College Farm, N.M. College of Agriculture, Navsari Agricultural University, Navsari in Block- D, plot No.15 and Block- E plot No. 24 during *Rabi* season of 2010-11 and 2011-12. The soil of the experimental plots was clay (66.52 and 65.27%) in texture, low in organic carbon (0.47 and 0.50%), available nitrogen (210.00 and 218.00 kg ha^{-1}) and phosphorus (28.24 and 30.64 kg ha^{-1}), high in available potassium (336.56 and 348.38 kg ha^{-1}), medium in available sulphur (20.16 and 22.44 kg ha^{-1}) and slightly alkaline in reaction (pH 7.7 and 7.57), respectively during 2010-11 and 2011-12 crop seasons. There were 9 treatments consisted of T_1: *Rabi* Fallow (No niger crop, absolute control), T_2: Without phosphorus and PSM (Control), T_3: 10 kg P_2O_5 ha^{-1} from SSP, T_4: 10 kg P_2O_5 ha^{-1} from SSP + PSM, T_5: 20 kg P_2O_5 ha^{-1} from SSP, T_6: 20 kg P_2O_5 ha^{-1} from SSP + PSM, T_7: 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1}, T_8: 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM and T_9: 200 kg RP ha^{-1} + PSM. Experiment was laid out in Randomized Block Design with three replications. The variety RCR-317 was used as test crop, in both the years for niger. The experiment was sown at 30 cm spacing in row proportion as per treatments in the fourth and third week of November. The seed rate was 6 kg ha^{-1} for niger. The package of practices recommended for crops were adopted for cultivation of oilseeds. The crop were harvested for grain yield. The economics was worked out considering the current market prices.

EXPERIMENTAL RESULTS AND ANALYSIS

The results obtained from the present study have been discussed in detail under following heads :

Crop growth parameters :

The plant height recorded and dry matter production at harvest was influenced significantly due to different phosphorus management treatments.

The treatment (T_6) 20 kg P_2O_5 ha^{-1} from SSP with PSM recorded 62.02, 65.32 cm and 64.35, 66.32 cm plant height and remained at par with treatments 20 kg P_2O_5 ha^{-1} from SSP alone (T_5), 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM (T_8) and 10 kg P_2O_5 ha^{-1} from SSP + PSM (T_4) at 60 DAS and harvest during both the years. The increase in plant height may be due to the fact that phosphorus is a constituent of the cell nucleus (DNA and RNA) and it is essential for cell division and for development of meristematic tissues (Russell, 1973).

The treatment 20 kg P_2O_5 ha^{-1} from SSP with PSM (T_6) recorded maximum dry matter production (22.09 and 23.12) and remained at par with treatments 20 kg P_2O_5 ha^{-1} from SSP alone (T_5), 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM (T_8) and 10 kg P_2O_5 ha^{-1} from SSP + PSM (T_4) at 60 DAS during both the years. Phosphorus plays great role in metabolic processes and enzyme reactions responsible for growth and development of oilseed crops and photosynthetic capacity of the plant, thereby increasing the biomass production of niger reported by Karwasra and Dahiya (1997).

Yield parameters :

Significantly the highest numbers of capitulas per plant

Table 1 : Plant height, dry matter accumulation, number of capitulas plant^{-1} and Nos. of seeds capitula^{-1} of *Rabi* Niger as influenced by phosphorus management

Treatments	Plant height		Dry matter accumulation (g plant^{-1})		Number of capitulas plant^{-1}		Nos. of seeds capitula^{-1}	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
T_1	-	-	-	-	-	-	-	-
T_2	52.69	53.36	18.90	19.14	14.16	14.82	27.74	28.41
T_3	54.60	55.26	19.10	19.77	15.70	15.91	30.12	31.46
T_4	57.10	57.76	20.83	21.50	16.79	16.99	35.85	37.51
T_5	59.76	61.76	21.60	22.27	17.97	18.07	38.01	39.60
T_6	62.02	64.35	22.09	23.12	18.92	19.12	39.49	41.49
T_7	53.66	54.33	19.63	19.59	15.90	16.10	29.14	30.98
T_8	57.30	58.63	21.05	21.81	16.44	16.48	33.72	34.39
T_9	55.30	55.63	20.14	20.81	16.97	16.97	32.06	33.13
S.E.±	1.78	1.94	0.56	0.45	0.24	0.33	1.03	0.74
C.D. (P=0.05)	5.20	5.68	1.65	1.32	0.71	0.96	3.01	2.16
C.V. %	7.30	5.84	4.78	3.71	2.54	3.39	5.36	3.70

(18.92, 19.12 and 19.02) were recorded in treatment 20 kg P_2O_5 ha^{-1} from SSP with PSM (T_6) during 2010-11 and 2011-12 crop seasons as well as in pooled.

The treatment T_6 20 kg P_2O_5 ha^{-1} from SSP with PSM recorded higher number of seeds per capitula (39.49, 41.49 and 40.50), during 2010-11, 2011-12 crops seasons and in pooled analysis, gave % increase, respectively and remained at par with treatments 20 kg P_2O_5 ha^{-1} from SSP alone (T_5) during 2010-11, 2011-12 and pooled data, respectively. These results are in agreement with the findings of Sharma and Kewat (1994), Agrawal *et al.* (1996) and Deshmukh *et al.* (2002).

The protein yield was influenced significantly due to different phosphorus management treatments and phosphorus fertilized crop gave higher protein yield than the control during both the years as well as in pooled analysis.

Though the highest protein yield of 109.71, 136.81 and 123.26 kg ha^{-1} by niger seed were recorded under the treatment T_6 *i.e.* 20 kg P_2O_5 ha^{-1} from SSP with PSM during both the crop seasons. It remained at par with treatments 20 kg P_2O_5 ha^{-1} from SSP alone (T_5) during both the years and 10 kg P_2O_5 ha^{-1} from SSP + PSM (T_4), 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM (T_8) during 2011-12 crop season only.

The phosphorus fertilized crop gave significantly higher oil content in seed than the control during both the years as well as in pooled analysis. The highest oil content of 38.23, 38.93 and 38.58 per cent in niger seed were recorded under the treatment 20 kg P_2O_5 ha^{-1} from SSP with PSM (T_6) during the 2010-11 and 2011-12, respectively. However, treatment T_6 was found at par with treatments 20 kg P_2O_5 ha^{-1} from SSP alone (T_5) during 2011-12. The increased in oil content with phosphorus application could be due to the fact that phosphorus helps in synthesis of fatty acids and their esterifacation by acceleration biochemical reaction in glyoxylate cycle (Dwivedi and Bapat 1988 and Dhange *et al.*, 2008) in respect of oil content.

Table 2 : Protein yield (kg ha^{-1}), oil content and yield (kg ha^{-1}), seed yield (kg ha^{-1}) and straw yield (kg ha^{-1}) of *Rabi* Niger as influenced by phosphorus management

Treatments	Protein yield (kg ha^{-1})		Oil content (%)		Oil yield (kg ha^{-1})		Seed yield (kg ha^{-1})		Straw yield (kg ha^{-1})	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
T_1	-	-	-	-	-	-	-	-	-	-
T_2	54.98	68.38	34.17	34.83	120.59	149.82	353.00	429.34	1114.67	1274.67
T_3	83.08	96.45	35.35	36.01	184.71	214.07	522.44	594.44	1473.43	1555.43
T_4	97.22	114.12	36.79	37.45	218.03	256.30	592.81	682.15	1541.14	1651.14
T_5	101.07	116.94	37.13	37.94	225.82	267.10	608.30	704.07	1550.96	1674.30
T_6	109.72	136.81	38.23	38.93	240.28	298.63	627.52	766.19	1572.80	1706.14
T_7	80.65	89.32	34.48	35.15	178.20	197.22	516.60	561.11	1479.93	1530.60
T_8	94.55	107.75	36.35	37.02	211.41	244.22	581.85	658.15	1537.52	1627.19
T_9	90.88	101.06	36.16	36.60	203.87	227.70	563.74	622.07	1505.41	1604.07
S.E.±	3.62	10.34	0.65	0.56	9.53	24.89	20.76	37.79	26.93	42.13
C.D. (P=0.05)	10.59	30.26	1.90	1.43	27.87	52.83	50.48	110.55	65.51	101.48
C.V. %	7.04	17.25	3.12	2.66	8.34	16.59	5.28	10.44	2.54	3.71

Table 3 : Seed (kg ha^{-1}), gross realization, total cost of cultivation, net realization (Rs.ha^{-1}) and benefit to cost ratio from Niger as influenced by phosphorus management

Treatments	Seed yield (kg ha^{-1})		Gross realization (Rs.ha^{-1})		Total cost of cultivation (Rs. ha^{-1})		Net realization (Rs. ha^{-1})		Benefit : Cost ratio	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
T_1	-	-	-	-	-	-	-	-	-	-
T_2	353.00	429.34	7060	8587	6840	6752	220	1835	1.03	1.27
T_3	522.44	594.44	10449	11889	7046	6958	3403	4931	1.48	1.71
T_4	592.81	682.15	11856	13643	7190	7102	4666	6541	1.65	1.92
T_5	608.30	704.07	12166	14081	7253	7165	4913	6916	1.68	1.97
T_6	627.52	766.19	12550	15324	7397	7309	5153	8015	1.70	2.10
T_7	516.60	561.11	10332	11222	7446	7358	2886	3864	1.39	1.53
T_8	581.85	658.15	11637	13163	7590	7502	4047	5661	1.53	1.75
T_9	563.74	622.07	11275	12441	7784	7696	3491	4745	1.45	1.62
S.E.±	20.76	37.79	415.14	755.79	-	-	415.14	755.79	0.06	0.03
C.D. (P=0.05)	50.48	110.55	1214.50	2211.08	-	-	1214.50	2211.08	0.16	0.13
C.V. %	5.28	10.44	6.59	10.44	-	-	19.99	24.64	6.49	9.45

Yields:

The seed and straw yields was influenced significantly due to different phosphorus management treatments and phosphorus fertilized crop gave significantly higher seed yield than the control during both the years as well as in pooled analysis.

Though the highest seed yield of 628, 766 and 697 kg ha^{-1} was obtained with treatment 20 kg P_2O_5 ha^{-1} from SSP with PSM (T_6), statistically it remained at par with treatments 10 kg P_2O_5 ha^{-1} from SSP + PSM (T_4), 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM (T_8) during 2010-11 and 2011-12 crop seasons and 20 kg P_2O_5 ha^{-1} from SSP alone (T_5) during 2010-11, 2011-12 and pooled, respectively. Phosphorus application increased the photosynthetic and microbial activities and translocation of photosynthates which resulted in higher seed yield. The present results are in consonance with those of Tiwari and Bisen (1965), Singh and Verma (1975), Agrawal *et al.* (1996), Deshmukh *et al*. (2002) and Jadhav and Deshmukh (2008).

The highest straw yield 1573, 1706 and 1639 kg ha^{-1} was obtained with treatment 20 kg P_2O_5 ha^{-1} from SSP with PSM (T_6) and statistically did not differ with treatments receiving 20 kg P_2O_5 ha^{-1} from SSP alone (T_5), 10 kg P_2O_5 ha^{-1} from SSP + PSM (T_4), 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM (T_8) during 2010-11 and 2011-12 crop seasons and pooled, respectively. Phosphorus improved growth and fresh and dry weight which might have resulted into increased straw yield. These results are in agreement with the findings of Agrawal *et al.* (1996) and Deshmukh *et al*. (2002).

Economics:

Phosphorus fertilization increased the net realization and highest benefit to cost ratio over control during both the years and in pooled data. However, application of 10 and 20 kg P_2O_5 ha^{-1} from SSP with and without PSM (T_6, T_5 and T_4) remained at par with each others and significantly increased the net realization and benefit to cost ratio from niger crop over rest of the levels and sources of phosphorus during both the years as well as in pooled data. The highest net realization and benefit to cost ratio was recorded under 20 kg P_2O_5 ha^{-1} from SSP with PSM inoculation (T_6) during both the years as well as in pooled analysis. These results are in agreement with the findings of Thakuria and Gogoi (1992)

Conclusion:

On the basis of two years investigation, the following broad conclusion can be drawn. The application of 20 kg P_2O_5 ha^{-1} from SSP with PSM to niger was found to be beneficial for getting higher seed and straw yields as well as to obtain higher net realization and benefit to cost ratio from *Rabi* niger under South Gujarat conditions as well as gave optimum net realization and benefit to cost ratio from niger.

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