academicJournals

Vol. 8(49), pp. 6401-6408, 19 December, 2013
DOI: 10.5897/AJAR2013.7438
ISSN 1991-637X ©2013 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Quality studies in niger (*Guizotia abyssinica* L. Cass) in relation to phosphorus levels

Vaishali H. Surve[1]*, C. L. Patel[2], R. R. Pisal[3], A. S. Chavan[4] and P. R. Patil[5]

[1,2,3,5]Navsari Agricultural University, Navsari-396 450 (Gujarat), India.
[4]At.Post. Pakhrud Tal.Bhoom,Dist.Osmanabad-413534, State-Maharashtra,India.

Accepted 4 December, 2013

Field experiments were conducted at the College Farm, N.M. College of Agriculture, Navsari Agricultural University, Navsari during *rabi* season of 2010 to 2011 and 2011 to 2012. The increase in *rabi* niger yields with these treatments were the results of increased quality and yield viz., improved the quality of niger in terms of N, P, K and S content and uptake by seed and straw, the highest seed and straw yields of niger and N, P, K and S content in soil were recorded with 20 kg P_2O_5 ha^{-1} from single superphosphate (SSP) with phosphorus soliblising microbes (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% higher than control (T_2) in respect of grain yield. Soil inoculation with PSM significantly increased the quality parameters, soil content viz., N, P, K and S uptake by seed and straw, the seed and straw yields of niger and N, P, K and S content in soil.

Key words: Nutrient content and uptake, soil study, seed and straw yield.

INTRODUCTION

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) belonging to Astaracea 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). Though 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 and shiny black contain 30 to 40% 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). Niger being a highly cross pollinated crop, it gives low yield in monsoon season due to lack of honey bees under South Gujarat condition. The primarily screening during *rabi* season gave encouraging results, with more than double yield, being a short duration crop and require less inputs (water and fertilizers). This crop well filled in multiple cropping systems. Niger is a short duration and low moisture and nutrients required crop. Hence it can be grown in *rabi*; further this will fulfill the demand of ever increasing edible oil. Inspite of such a significance the productivity of this crop is very low which may be enhanced by adequate supply of nutrient especially phosphorus, because being oilseed crop niger respond well to phosphorus. Hence yield potential of this crop can be improved through adequate supply of phosphorus

*Corresponding author. E-mail: vaishusdream@gmail.com

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 applied phosphorus seldom exceeds 20 to 25% 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).

MATERIALS AND 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 to 2011 and 2011 to 2012. 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}) (Table 3) and slightly alkaline in reaction (pH 7.7 and 7.57), respectively during 2010 to 2011 and 2011 to 2012 crop seasons. There were 9 treatments consisting 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 single superphosphate (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. The experiment was laid out in RBD with three replications. The varieties RCR-317 were used as test crop respectively for niger. The experiment was sown at 30 cm spacing in row proportion as per treatments in the fourth and yhird week of November. The seed rate 6 kg ha^{-1} for niger and yield is 500 to 600 kg ha^{-1}. The package of practices recommended for crops were adopted for cultivation of oilseeds.

RESULTS AND DISCUSSION

Quality parameters

Nitrogen and phosphorus content in seed due to different treatments of phosphorus management was found to be non significant during both years.

The nitrogen and phosphorus content in straw was influenced significantly due to different phosphorus management treatments and phosphorus fertilized crop gave significantly higher nitrogen content in straw than the control during both the years. Though the highest nitrogen content in straw (0.96) and seed (1.01%) was found with treatment 20 kg P_2O_5 ha^{-1} from SSP with PSM (T_6), however statistically it 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 + PSM (T_4), 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM (T_8) and 200 kg RP ha^{-1} + PSM (T_9) during 2010 to 2011 and 2011 to 2012 crop seasons, respectively. Paikaray et al. (1997) also reported gradual increase in N and P content in niger with increasing levels of N and P.

Potassium and sulphur content in seed and straw due to different treatments of phosphorus management was found to be non-significant during both years (Table 1).

The highest nitrogen, phosphorus, potassium and sulphur uptake by *rabi* niger seed and straw were recorded under the treatment 20 kg P_2O_5 ha^{-1} from SSP with PSM (T_6) during both the seasons of experimentation and found at par with treatments 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM (T_8), 200 kg RP ha^{-1} + PSM (T_9), 20 kg P_2O_5 ha^{-1} from SSP alone (T_5), and 10 kg P_2O_5 ha^{-1} from SSP + PSM (T_4) during both the years. The greater uptake of nutrients with the higher dose of phosphorus might be due to higher content of this nutrient and comparatively higher seed yield than the lower phosphorus levels and control. Paikaray et al. (1997) also found highest N and P uptake by niger with increase in levels of N and P_2O_5 application. Comparatively higher N, P, K and S content and there uptake was recorded with single super phosphate than rock phosphate (Table 2) (Figures 1 to 4). The water soluble source of P in single super phosphate provided an easy access to plants to adequate quantity as against the sparingly soluble source of P in rock phosphate.

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 2010-2011 and 2011-2012 crop seasons and 20 kg P_2O_5 ha^{-1} from SSP alone (T_5) during 2010 to 2011 and 2011 to 2012 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), Agarwal et al. (1996), Deshmukh et al. (2002) and Jadhav and Deshmukh (2008) (Tables 1 to 2).

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 to

Table 1. Nitrogen, phosphorus, potassium and sulphur content of seed and straw of *rabi* Niger as influenced by phosphorus management.

Treatment	Nitrogen content				Phosphorus content				Potassium content				Sulphur content			
	Seed		Straw		Seed		Straw		Seed		Straw		Seed		Straw	
	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012
T_1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_2	4.04	4.32	0.78	0.81	0.61	0.62	0.21	0.20	0.73	0.74	1.37	1.37	0.82	0.83	0.63	0.64
T_3	4.25	4.35	0.82	0.85	0.63	0.64	0.24	0.23	0.74	0.76	1.39	1.40	0.86	0.86	0.64	0.66
T_4	4.61	4.63	0.94	0.98	0.67	0.66	0.28	0.31	0.75	0.76	1.41	1.42	0.93	0.94	0.73	0.74
T_5	4.63	4.65	0.94	0.98	0.69	0.67	0.28	0.30	0.76	0.77	1.41	1.42	0.90	0.91	0.70	0.73
T_6	4.66	4.68	0.96	1.01	0.72	0.73	0.32	0.34	0.77	0.79	1.42	1.43	0.95	0.97	0.75	0.76
T_7	4.57	4.59	0.81	0.84	0.62	0.63	0.22	0.22	0.73	0.75	1.38	1.39	0.85	0.84	0.64	0.65
T_8	4.62	4.64	0.92	0.98	0.61	0.65	0.26	0.29	0.75	0.77	1.40	1.41	0.89	0.89	0.72	0.72
T_9	4.60	4.62	0.94	0.96	0.60	0.64	0.25	0.27	0.74	0.76	1.39	1.41	0.92	0.91	0.70	0.70
S.Em.±	0.22	0.21	0.03	0.02	0.05	0.03	0.01	0.01	0.01	0.01	0.04	0.04	0.02	0.02	0.036	0.04
C.D. at 5%	NS	NS	0.08	0.06	NS	NS	0.04	0.03	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	8.61	7.84	5.00	3.94	12.17	8.07	9.04	7.33	2.67	4.27	5.17	4.99	4.79	5.73	8.98	10.84

Table 2. Nitrogen, phosphorus, potassium and sulphur uptake (kg ha^{-1}) of seed, straw and total of *rabi* Niger as influenced by phosphorus management .

Treatment	Nitrogen uptake (kg ha^{-1})						Phosphorus uptake (kg ha^{-1})					
	Seed		Straw		Total		Seed		Straw		Total	
	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012
T_1	-	-	-	-	-	-	-	-	-	-	-	-
T_2	14.26	18.41	8.66	10.36	22.92	28.77	2.17	2.49	2.34	2.59	4.51	5.25
T_3	22.23	25.83	12.04	13.22	34.27	39.05	3.31	3.83	3.53	3.58	6.84	7.41
T_4	27.32	31.57	14.51	16.20	41.83	47.77	3.96	4.53	4.32	5.06	8.28	9.59
T_5	28.16	32.70	14.62	16.43	42.78	49.13	4.18	4.71	4.34	5.03	8.52	9.74
T_6	29.25	35.94	15.05	17.25	44.30	53.19	4.51	5.65	4.97	5.75	9.48	11.40
T_7	23.60	25.77	11.99	12.93	35.59	38.70	3.20	3.55	3.24	3.35	6.44	6.90
T_8	26.90	30.48	14.10	15.97	41.00	46.47	3.58	4.30	3.92	4.69	7.50	8.99
T_9	25.97	28.75	14.17	15.43	40.14	44.15	3.37	3.96	3.77	4.29	7.14	8.25
S.Em.±	1.61	2.92	0.47	0.64	-	-	0.33	0.50	0.19	0.23	-	-
C.D. at 5%	4.71	8.53	1.37	1.88	-	-	0.97	1.46	0.55	0.68	-	-
C.V. %	11.28	17.61	6.15	7.54	-	-	16.33	20.89	8.63	9.36	-	-

Treatment	Potassium uptake (kg ha^{-1})	Sulphur uptake (kg ha^{-1})

Table 2. contd.

Treatment	Seed		Straw		Total		Seed		Straw		Total	
	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012
T_1	-	-	-	-	-	-	-	-	-	-	-	-
T_2	14.26	18.41	8.66	10.36	22.92	28.77	2.17	2.49	2.34	2.59	4.51	5.25
T_3	22.23	25.83	12.04	13.22	34.27	39.05	3.31	3.83	3.53	3.58	6.84	7.41
T_4	27.32	31.57	14.51	16.20	41.83	47.77	3.96	4.53	4.32	5.06	8.28	9.59
T_5	28.16	32.70	14.62	16.43	42.78	49.13	4.18	4.71	4.34	5.03	8.52	9.74
T_6	29.25	35.94	15.05	17.25	44.30	53.19	4.51	5.65	4.97	5.75	9.48	11.40
T_7	23.60	25.77	11.99	12.93	35.59	38.70	3.20	3.55	3.24	3.35	6.44	6.90
T_8	26.90	30.48	14.10	15.97	41.00	46.47	3.58	4.30	3.92	4.69	7.50	8.99
T_9	25.97	28.75	14.17	15.43	40.14	44.15	3.37	3.96	3.77	4.29	7.14	8.25
S.Em.±	1.61	2.92	0.47	0.64	-	-	0.33	0.50	0.19	0.23	-	-
C.D. at 5%	4.71	8.53	1.37	1.88	-	-	0.97	1.46	0.55	0.68	-	-
C.V. %	11.28	17.61	6.15	7.54	-	-	16.33	20.89	8.63	9.36	-	-

Treatment	Potassium uptake (kg ha^{-1})						Sulphur uptake (kg ha^{-1})					
	Seed		Straw		Total		Seed		Straw		Total	
	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012
T_1	-	-	-	-	-	-	-	-	-	-	-	-
T_2	2.58	3.19	15.23	17.41	17.81	20.60	2.89	3.58	7.03	8.21	9.92	11.79
T_3	3.89	4.50	20.43	21.75	24.32	26.25	4.50	5.12	9.49	10.36	13.99	15.48
T_4	4.44	5.18	21.74	23.40	26.18	28.58	5.50	6.40	11.31	12.28	16.81	18.68
T_5	4.61	5.45	21.87	23.81	26.48	29.26	5.46	6.39	10.92	12.29	16.38	18.68
T_6	4.83	6.01	22.39	24.27	27.22	30.28	5.94	7.41	11.82	13.04	17.76	20.45
T_7	3.79	4.21	20.38	21.23	24.17	25.44	4.41	4.70	9.53	10.00	13.94	14.70
T_8	4.34	5.05	21.53	22.94	25.87	27.99	5.17	5.86	11.16	11.80	16.33	17.66
T_9	4.18	4.71	20.98	22.57	25.16	27.28	5.17	5.66	10.60	11.30	15.77	16.96
S.Em.±	0.17	0.44	0.83	0.94	-	-	0.23	0.37	0.64	0.84	-	-
C.D. at 5%	0.48	1.28	2.42	2.76	-	-	0.67	1.02	1.86	2.46	-	-
C.V. %	7.01	15.78	6.97	7.36	-	-	8.16	12.48	10.78	13.05	-	-

Treatment	Seed yield		Straw yield	
	2010-2011	2011-2012	2010-2011	2011-2012
	-	-	-	-
T_1	353.00	429.34	1114.67	1274.67
T_2	522.44	594.44	1473.43	1555.43

Table 2. Contd.

T_3	592.81	682.15	1541.14	1651.14
T_4	608.30	704.07	1550.96	1674.30
T_5	627.52	766.19	1572.80	1706.14
T_6	516.60	561.11	1479.93	1530.60
T_7	581.85	658.15	1537.52	1627.19
T_8	563.74	622.07	1505.41	1604.07
T_9	20.76	37.79	26.93	42.13
S.Em.±	50.48	110.55	65.51	101.48
C.D. at 5%	5.28	10.44	2.54	3.71

Table 3. Organic carbon (%), available N, P, K and S content (kg ha^{-1}) in soil after harvest of *rabi* Niger as influenced by Phosphorus management.

Treatment	Organic carbon (%)		Available N (kg ha^{-1})		Available P_2O_5 (kg ha^{-1})		Available K_2O (kg ha^{-1})		Available S (kg ha^{-1})	
	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012
T_1	0.44	0.48	207.72	215.06	29.19	28.52	310.33	314.45	12.34	12.11
T_2	0.45	0.50	208.56	221.66	27.94	26.94	315.47	319.51	12.72	13.39
T_3	0.49	0.51	210.15	223.12	38.41	37.27	317.66	320.02	13.54	14.21
T_4	0.50	0.52	211.89	224.69	44.87	43.53	319.10	322.79	14.43	15.10
T_5	0.50	0.52	214.81	227.38	43.63	42.96	325.66	329.85	19.41	20.60
T_6	0.52	0.53	220.15	231.08	46.72	45.39	331.79	334.83	20.75	22.80
T_7	0.47	0.51	216.09	226.62	43.77	42.87	318.18	321.79	18.86	19.53
T_8	0.51	0.55	219.42	228.79	48.96	47.96	323.12	326.48	17.72	18.39
T_9	0.54	0.57	223.01	233.67	50.11	49.44	321.51	324.45	15.56	16.23
S.Em.±	0.01	0.01	1.38	1.62	1.13	1.48	2.64	1.99	0.71	0.75
C.D. at 5%	0.03	0.03	4.15	4.85	3.39	4.46	7.91	5.96	2.14	2.24
C.V. %	3.48	2.98	1.12	1.25	4.84	6.35	1.43	1.06	7.66	7.61
Initial	0.47	0.50	210.00	218.00	28.24	30.64	336.56	348.38	20.16	22.44

2011 and 2011 to 2012 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 Agarwal et al. (1996) and Deshmukh et al. (2002).

Soil study

The organic carbon, nitrogen and phosphorus increased significantly with increase in the levels of phosphorus irrespective of phosphorus sources. Application of 200 kg RP ha^{-1} + PSM (T_9) during both the years, however, it was remained at par with 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM (T_8) and 20 kg P_2O_5 ha^{-1} from SSP with PSM (T_6) during both crop season. The rock phosphate was found to be superior over single super phosphate in increasing soil available

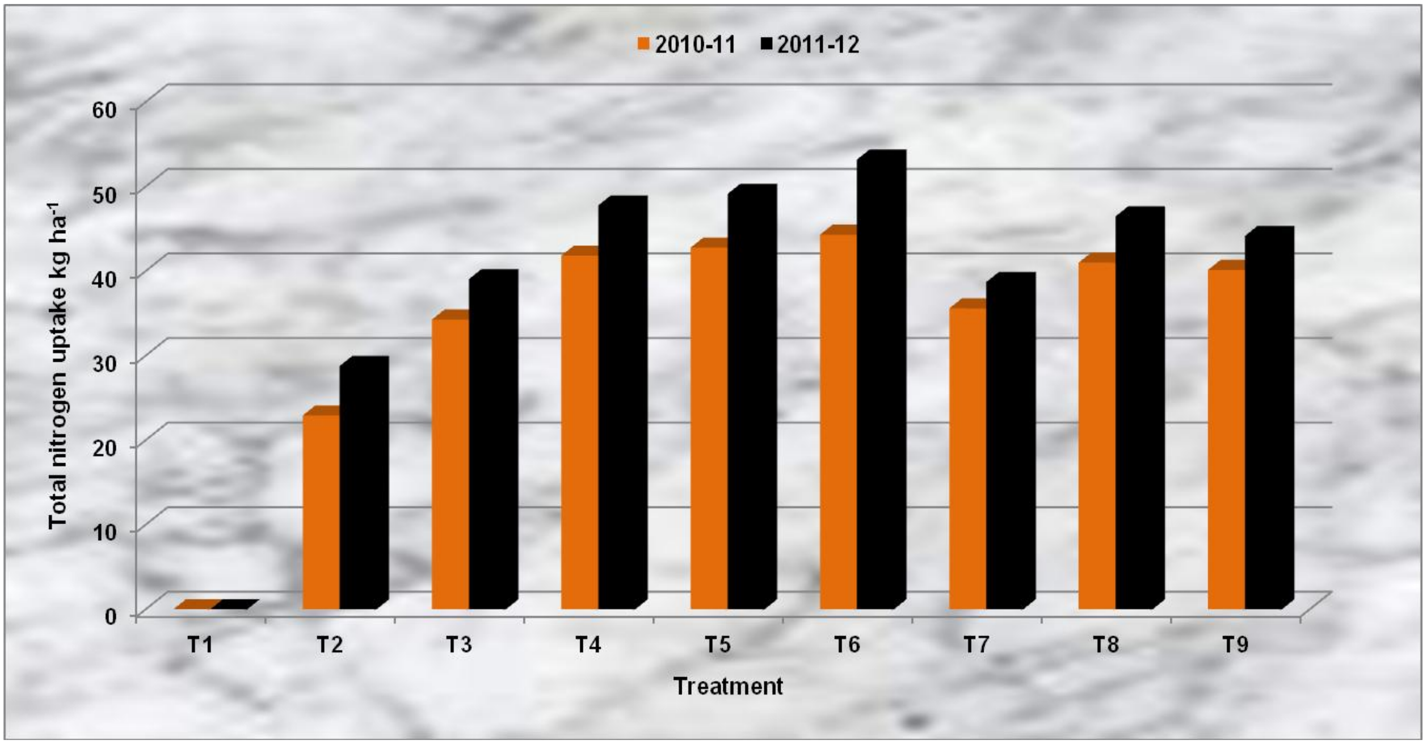

Figure 1. Total nitrogen uptake (seed and straw kg ha^{-1}) of *rabi niger* as influenced by phosphorus management during 2010 to 2011 and 2011 to 2012.

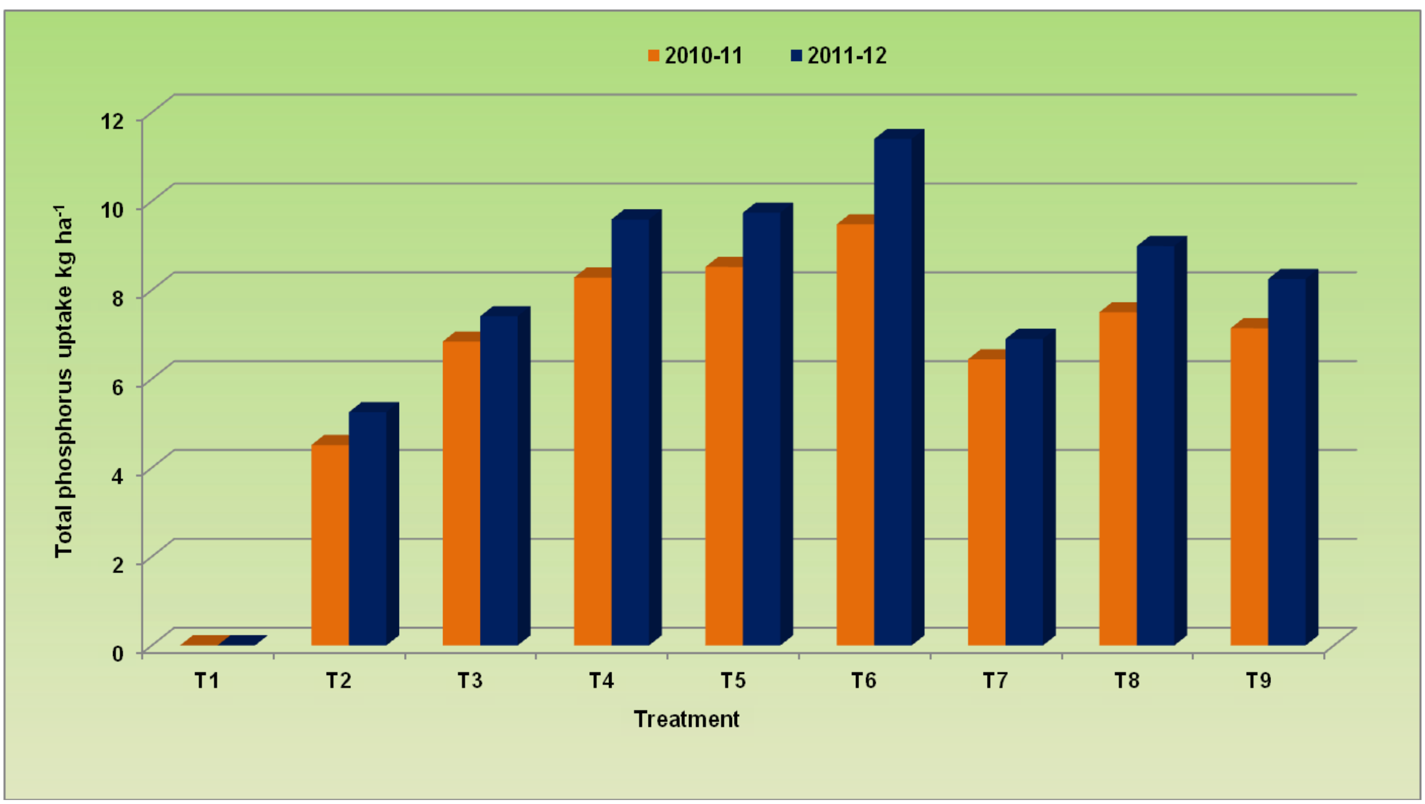

Figure 2. Total phosphorus uptake (seed and straw kg ha^{-1}) of *rabi* niger as influenced by phosphorus management during 2010 to 2011 and 2011 to 2012.

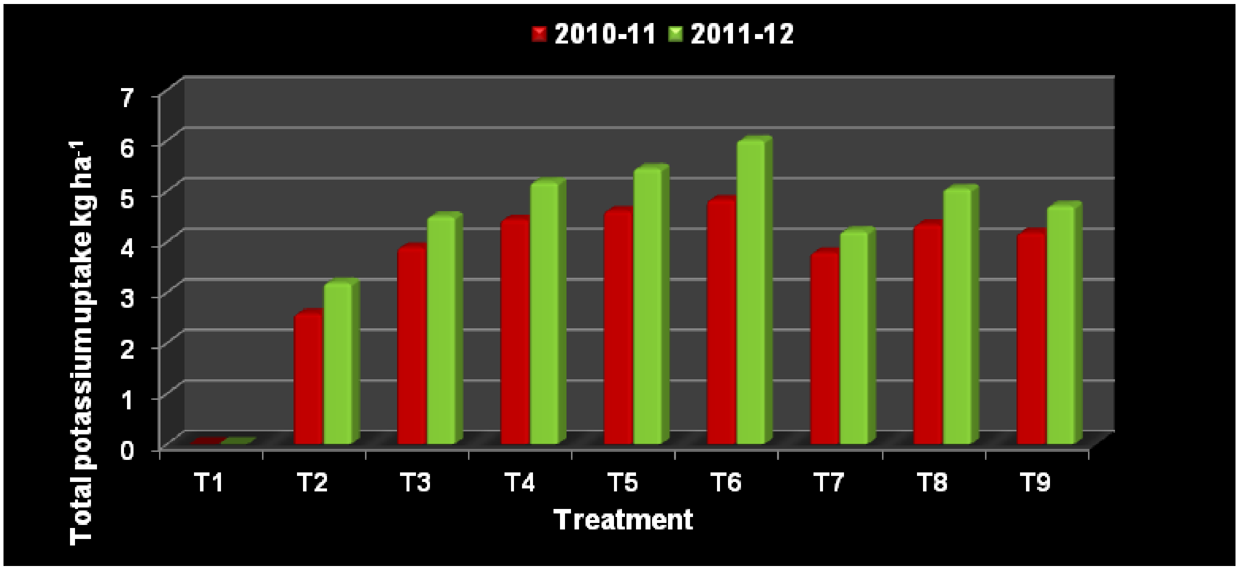

Figure 3. Total potassium uptake (seed and straw kg ha^{-1}) of *rabi* niger as influenced by phosphorus management during 2010 to 2011 and 2011 to 2012.

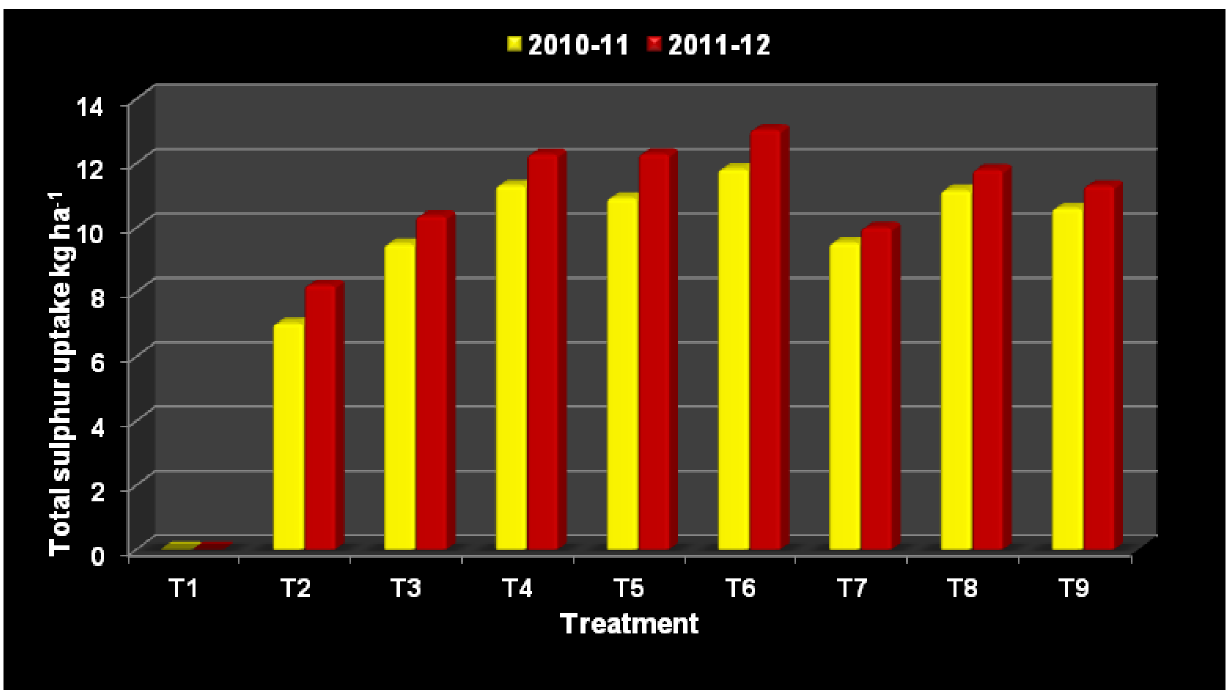

Figure 4. Total sulphur uptake (seed and straw) kg ha^{-1} of *rabi* niger as influenced by phosphorus management during 2010 to 2011 and 2011 to 2012.

organic carbon, nitrogen and P_2O_5 during both both the years. This may be due to PSM which solubilised the fixed phosphate by secretion of organic acid and phosphate enzymes leading to higher growth and yield of niger. This might have contributed towards increased organic carbon and available N, P, K and S status of soil. These results are in line with the findings of Meshram et al. (2000), Deshmukh et al. (2002) and Thakur et al. (2005) in respect of available N and P content of soil. The available K_2O and sulphur content of soil after harvest of niger slightly increased with increasing levels of phosphorus irrespective of P sources. The higher soil available K was recorded with 20 kg P_2O_5 ha^{-1} from SSP with PSM during both the years. The performance of single super phosphate was slightly higher than rock phosphate in increasing soil available K after harvest of niger during both the years. These results are in line with the findings of Meshram et al. (2000) and Deshmukh et al. (2002).

REFERENCES

Agarwal KK, Jain KK, Sharma RS, Kashyap ML (1996). Response of winter niger (*Guizotia abyssinica* Cass.) to sowing time and fertility levels. J. oilseed Res. 13(1):122-123.

Anonymous (2005). *TECL Research Publication.* Ministry of Agriculture, Govt. of India.

Damodaran T, Hegde DM (2003). Seed and oil quality characteristics of some niger genotypes. *J. D. Oil Technologists Association in India*, 25(2):42-44.

Deshmukh MR, Jain HC, Duhoon SS, Goswami U (2002). Performance of niger influenced by inorganic fertilizers, FYM and biofertilizers in different soil types. J. Oilseeds Res. 19(1):79-81.

Jadhav AS, Deshmukh LS (2008). Response of niger to sowing time and fertility levels. J. Oilseeds Res. 25(2):212-213.

Nambaiar KKM, Abrol IP (1989). Long term fertilizer experimrnts in India- An over view. *Fertilizer News,* 34 (4):11-20-26.

Meshram AT, Jadhav AC, Konde BK, Wani PV (2000). Effect of VAM fungi and P sources on nodulation, dry matter and yield of chickpea. J. Maharatstra. Agric. Univ. 25(1):99-101.

Paikaray RK, Mishra KN, Khanda, CM, Garnayak LM (1997). Effect of nitrogen, phosphors and plant density on yield and nutrient uptake in late sown niger (*Guizotia abyssinica* Cass.). Indian J. Agron. 42(3):520-523.

Sharma SM (1993). Status and strategies of sesame and niger research in India. *National* Seminar on Oilseeds Research and Development in India, held at Hyderabad, Aug 2 to 5, pp. 60-69.

Singh PP, Verma SNP (1975). Yield potential of niger (*Guizotia abyssinica* Cass.) Mysore J. Agric. Sci. 9(4):644-648.

Thakur NS, Deshmukh MR Sharma RS (2005). Studies on N and P fertilization of niger in satpura plateu zone of Madhya Pradesh. J. Oilseeds Res. 22(1):213-214.

Tiwari BP, Bisen CR (1965). Fertilizer response of niger (*Guizotia abyssinica* L.) in Madhya Pradesh. Indian J. Agron. 10(1):55-66.