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Research Article

Effect of Phosphorus on Productivity and Economics in *Rabi* Niger (*Guizotia Abyssinica* L. Cass) - Fodder Sorghum (*Sorghum Bicolor* L. Moench) Cropping Sequence

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Abstract

A field experiment consisting of nine treatments was conducted for two consecutive years from 2010 - 2011 and 2011-2012 in randomized block design with three replications at Navsari, Gujarat to study the effect of phosphorus on productivity in rabi Niger (*Guizotia abyssinica* L. Cass) - fodder Sorghum (*Sorghum bicolor* L. Moench) cropping sequence. Application of 20 kg P_2O_5 ha^{-1} through SSP with Phosphorus solubilizing Microbes (PSM) recorded significantly higher plant height, dry matter accumulation, capitula per plant and number of seeds per capitula and grain yield (628, 766 and 697 kg ha^{-1}) by niger during both the years and remained at par with application of 10 kg P_2O_5 ha^{-1} from SSP + PSM. Similarly, application of 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha-1 + PSM preceding fodder sorghum recorded significantly higher green fodder yield of sorghum (368, 415 and 391q ha^{-1}) and net realization from niger - fodder sorghum cropping system (5915 and 39,109₹ ha^{-1}) over other treatments during both the years. Thus, it is evident that with respect to the economy in fertilizer use, a saving of 25 per cent RDF (20 kg N + 10 kg P_2O_5 ha^{-1}) in fodder sorghum can be achieved under adequately fertilized niger - fodder sorghum cropping system.

Keywords: Economics; Fodder sorghum; Niger; Phosphorus; Productivity

Introduction

Niger (*Guizotia abyssinica* L. Cass) belongs to compositae family mostly grown in tropical and subtropical regions. 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 [1]. 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); can grow in multiple cropping systems. It 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. The low productivity of Indian livestock is mainly due to chronic shortage of feed and fodder coupled with poor quality. Availability of green fodder to the animals is the key for success of dairy enterprises and it is difficult to maintain the health and milk production of the livestock without supply of the green fodder. Green fodder helps in easy digestion and also supplies abundant quantity of Vit-A and important minerals like Ca and Fe in addition to energy for animals. The present study was therefore, taken up to study the response of niger and fodder sorghum to P and test the profitability of phosphorus (P) in niger - fodder sorghum cropping system.

Materials and Methods

A field experiment was conducted at Navsari, Gujarat; consisting of nine treatments was conducted for two consecutive years from 2010 - 2011 and 2011 - 2012 in randomized block design with three replications. The soil of the experimental field contained 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 P (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. The experiment on preceding on niger crop was laid out in randomized block design with nine treatments, consisting two levels of P were two levels and two sources of P (10 and 20 kg P2O5 ha^{-1} from SSP and 100 and 200 kg rock phosphate ha^{-1}) along with and without PSM (P Soliblising Microbes) @ 1.2 lit ha^{-1} as soil inoculants and two control i.e., control (No P and PSM to niger) and absolute control (rabi Fallow) replicated three times. The experiment on fodder sorghum was superimposed on the same site without changing the randomization of treatments during both the years to assess the residual effect of P management in preceding Rabi niger on succeeding fodder sorghum raised under two fertility levels (75 and 100% of the recommended dose of 80 kg N + 40 kg P_2O_5 ha^{-1}) in split plot design with three replications because when one of the treatment factors needs more replication or experimental units (material) than another or when it is hard to change the level of one of the factors, these design become important. In fodder sorghum, there were 18 treatment combinations consisting of nine residual treatments of Rabi niger as main plots and two levels of P applied to fodder sorghum. The experiment started during Rabi season of 2010-11 and 2011-12 with sowing of niger 'RCR-317'. Niger sowing during 24.11.2010 and sowing of fodder sorghum 'GFS-505' during 05.03.2011. All the necessary cultural practices were taken as and when required.

Results and Discussion

Growth and yield attributes of Niger

All the parameters have significant influence on the growth parameters of the niger crop over absolute control (Table 1). Ap-

plication 20 kg P_2O_5 ha^{-1} from SSP with PSM to niger crop recorded significantly higher plant height, dry matter accumulation, capitula per plant and number of seeds per capitula and grain yield and was at par with 10 kg P_2O_5 ha^{-1} from SSP + PSM (T4), 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM.

These results are in agreement with the findings of Somani and Dadhich [2], Agrawal., *et al.* [3], Paikaray., *et al.* [4], Deshmukh., *et al.* [5].

Treatment	Plant height (cm)		Dry matter accumulation (g)		Capitula per plant		Number of seeds per capitula		Grain yield (kg/ha)		
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	Pooled
T_1	-	-	-	-	-	-	-	-	-	-	-
T_2	53.02	54.36	19.77	20.47	14.16	14.82	27.74	28.41	353.00	429.34	391.17
T_3	55.26	56.26	20.60	21.24	15.70	15.91	30.12	31.46	522.44	594.44	558.44
T_4	58.10	58.62	21.97	22.68	16.79	16.99	35.85	37.51	592.81	682.15	637.48
T_5	61.88	62.54	22.71	23.38	17.97	18.07	38.01	39.60	608.30	704.07	656.19
T_6	65.32	66.32	23.75	24.79	18.92	19.12	39.49	41.49	627.52	766.19	696.85
T_7	54.33	55.15	20.96	20.69	15.90	16.10	29.14	30.98	516.60	561.11	538.85
T_8	60.07	61.73	22.22	23.09	16.44	16.48	33.72	34.39	581.85	658.15	620.00
T_9	56.30	57.30	21.21	22.21	16.97	16.97	32.06	33.13	563.74	622.07	592.91
S.Em . ±	1.74	1.38	0.82	0.97	0.24	0.33	1.03	0.74	20.76	37.79	17.28
C.D. at 5%	5.10	4.05	NS	NS	0.71	0.96	3.01	2.16	50.48	110.55	50.07
C.V. %	5.20	4.06	6.54	7.52	2.54	3.39	5.36	3.70	5.28	10.44	7.22

Table 1: Growth and yield attributes and grain yield of niger as influenced by phosphorus management.

Niger and fodder sorghum yield

On pooled basis and during 2010 - 11 and 2011 - 12, application 20 kg P_2O_5 ha^{-1} from SSP with PSM to niger crop recorded significantly higher yield attributes and grain yield table 2. During summer season application of 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM to sorghum also behaves statistically similar treatments. On pooled basis, the 47.31 and 34.86 per cent increase in fodder sorghum yield. Thus, this is a better source of P for niger-sorghum cropping system. Agrawal., *et al.* (2005) who reported beneficial and significant effect of residual effect of P applied in preceding crop on succeeding cereal crops. Chotiya and Singh [6] who found higher green and dry fodder yield of fodder sorghum (Table 2).

Treatment	Green fodder yield (q ha^{-1})		Dry fodder yield (q ha^{-1})		Total P uptake (kg/ha)		Available P_2O_5 (kg/ha)	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Residual effect of P managements in rabi niger crop								
T_1	201.78	210.62	70.94	77.94	5.28	5.62	22.54	22.93
T_2	228.64	239.98	75.17	82.17	8.67	8.46	24.04	24.44
T_3	269.31	290.78	78.95	87.78	11.60	11.63	25.13	25.56
T_4	295.62	306.45	90.12	99.35	14.79	14.86	34.37	34.71
T_5	315.35	325.52	84.28	93.64	13.40	13.91	30.54	30.97
T_6	318.02	348.02	95.14	105.18	15.89	16.22	35.37	36.11
T_7	340.12	374.28	103.37	112.70	16.82	17.13	38.85	39.48
T_8	368.23	414.62	108.60	119.94	20.91	21.18	42.24	42.83
T_9	356.18	399.12	98.10	106.38	18.98	18.94	43.37	44.19
S.Em . ±	6.54	6.49	3.04	2.17	0.15	0.21	0.76	0.59
C.D. at 5%	19.61	19.47	9.12	6.50	0.46	0.64	2.27	1.77
C.V. %	5.36	4.92	8.33	5.40	2.67	3.66	5.62	4.32
Fertilizer levels applied to succeeding fodder sorghum crop								
F_1	289.90	313.71	85.57	94.42	13.89	14.06	31.77	32.33
F_2	308.56	332.81	93.25	102.27	14.18	14.37	34.11	34.60
S.Em . ±	3.15	1.93	1.233	0.713	0.08	0.10	0.35	0.29
C.D. at 5%	9.36	5.73	3.66	2.12	0.23	0.29	1.03	0.85
C.V. %	5.47	3.10	7.17	3.77	2.87	3.59	5.45	4.42

Table 2: Green fodder and dry fodder yield (q ha^{-1}) total P uptake and available P in soil (kg/ha) after harvest of Rabi niger as influenced by phosphorus management.

Economics

The net realization from niger-sorghum cropping system increased significantly with application of 20 kg P_2O_5 ha^{-1} from SSP + with PSM to preceding niger crop over other treatments during both the years and application of 75 per cent RDF to succeeding fodder sorghum under niger - fodder sorghum cropping system comparable with 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM table 3. It might be due to higher yield of crops under these treatments. Deshmukh., *et al.* [5] and Thakur., *et al.* [7] who reported higher net returns and benefit to cost ratio.

Treatment	Total cost of cultivation (Rs. ha^{-1})		Gross realization (Rs. ha^{-1})		Net realization (Rs. ha^{-1})		Benefit to cost ratio	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Residual effect of P managements in *rabi* niger crop								
T_1	7742	7969	24214	25274	16472	17305	3.13	3.17
T_2	7742	7969	27437	28798	19695	20828	3.54	3.61
T_3	7742	7969	32317	34894	24575	26925	4.17	4.38
T_4	7742	7969	35474	36774	27732	28805	4.58	4.61
T_5	7742	7969	37842	39062	30100	31093	4.89	4.90
T_6	7742	7969	38162	41762	30420	33793	4.93	5.24
T_7	7742	7969	40814	44914	33072	36945	5.27	5.64
T_8	7742	7969	44188	49754	36446	41785	5.70	6.24
T_9	7742	7969	42742	47894	35000	39925	5.52	6.01
S.Em . ±	-	-	785.05	779.21	785.05	779.21	0.10	0.10
C.D. at 5 %	-	-	2353.57	2336.08	2353.57	2336.08	0.30	0.30
C.V. %	-	-	5.36	4.92	7.05	6.37	5.36	4.95
Fertilizer levels applied to succeeding fodder sorghum crop								
F_1	7530	7755	34788	37646	27258	29891	4.62	4.85
F_2	7954	8183	37027	39938	29073	31755	4.66	4.88
S.Em . ±	-	-	377.98	231.28	377.97	231.29	0.05	0.03
C.D. at 5 %	-	-	1123.03	687.16	1123.03	687.16	NS	NS
C.V. %	-	-	5.47	3.10	7.20	4.01	5.48	3.15

Table 3: Net realization (Rs/ha) and B:C ratio of Rabi niger-summer sorghum cropping system as influenced by phosphorus management.

Conclusion

Thus, on the basis of net realization and benefit: cost ratio, it could be concluded that in niger - sorghum cropping system, the niger crop should be fertilized with 20 kg P_2O_5 ha^{-1} from SSP + with PSM only and sorghum crop should be fertilized with 10 kg P_2O_5 ha^{-1} from SSP + 100 kg RP ha^{-1} + PSM to sorghum crop only.

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