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NUTRIENT BALANCE UNDER INMS IN SORGHUM-CHICKPEA CROPPING SEQUENCE

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ABSTRACT

A field experiment was conducted during 2001-02 and 2002-03 to study the effect of integrated nutrient management system in sorghum {*Sorghum bicolor* (L) Moench} - chickpea {*Cicer arietinurm* (L)} cropping sequence under irrigated conditions. Application of 75 per cent RDF + FYM + biofertilizers produced significantiy higher grain and fodder yield of sorghum which was at par with that of application of 100 per cent RDF through inorganics alone. The residual effect of application of 5 t FYM ha^{-1} to preceding crop sorghum and 100 per cent RDF to chickpea resulted in significantly higher grain and *bhusa* yields of chickpea which was at par with that of 50 per cent RDF to chickpea. Maximum net balance of nitrogen was recorded due to treatment 75 per cent RDF + FYM + biofertilizers while phosphorus and potassium balance was maximum due to treatment 50 per cent RDF + biofertilizers. The fertilizer level of 100 per cent RDF applied to chickpea recorded maximum available nitrogen and potassium while phosphorus balance was maximum due to control treatment.

INTRODUCTION

Sorghum-chickpea is one of the important and stable crop sequences under assured water supply in Maharashtra (Umrani *et al.*, 1993). The existing system of fertilizer recommendation is based on fertilizer requirement of individual crop ignoring the carry over effects of the manures or fertilizers applied to the preceding crop. Organic sources of nutrients applied to the preceding crop benefit the succeeding crop to a great extent (Hegde, 1998). Hence, the present study was undertaken to evaluate the effective combination of chemical fertilizers, organic manures (FYM) and biofertilizers under cropping sequence and also to study the nutrient balance under the sequence.

MATERIAL AND METHODS

A field experiment was conducted during the rainy (*kharif*) and winter (*rabi*) seasons of 2001-02 and 2002-03 on clayey soil, having pH 8.0 and electrical conductivity (EC) 0.29 dSm^{-1}. It was medium in organic carbon (0.52 %), low in available nitrogen (175.62 kg ha^{-1}), medium in available phosphorus (15.05 kg ha^{-1}) and very high in available potassium (553.62 kg ha^{-1}). The experiment was laid out in randomized block design during *kharif* season with eight main plot treatments of integrated nutrient management to *kharif* cropping of sorghum replicated thrice (Table 1). In *rabi* season, each main plot treatment was subdivided into three sub-plot treatments with three levels of RDF to *rabi* cropping of chickpea, resulting in 24 treatment combinations in *rabi* season replicated thrice in split plot design. Recommended doses of inorganic fertilizers consisting of 120 kg N and 60 kg each of P_2O_5 and K_2O ha^{-1} and 25 kg N and 50 kg P_2O_5 ha^{-1} were applied to sorghum and chickpea, respectively. For sorghum, N was applied in two splits, half at sowing and remaining half at 30 days after sowing while that for chickpea the entire dose of NPK was applied at sowing. Nitrogen, phosphorus and potassium were applied through urea, single super phosphate and muriate of potash, respectively. FYM was added @ 5 t ha^{-1}. The biofertilizers used in the form of seed inoculation were *Azospirillum* and Phosphate solubilizing bacteria (PSB) according to the treatments. Sorghum (cv. CSH-17) and chickpea (cv. Vijay) were sown using seed rates of 7.5 kg ha^{-1} and 60 kg ha^{-1} with a spacing of

Table 1. Effect of integrated nutrient management system on yield of sorghum and chickpea under sorghum-chickpea cropping sequence (Pooled data of 2 years)

Treatment	Sorghum		Chickpea	
	Grain yield ($q\ ha^{-1}$)	Fodder yield ($q\ ha^{-1}$)	Grain yield ($q\ ha^{-1}$)	*Bhusa* yield ($q\ ha^{-1}$)
INMS to sorghum (*kharif*)				
T_1 : Control	20.97	81.1	20.03	24.7
T_2 : 100% RDF	62.02	131.2	21.20	22.5
T_3 : 75% RDF + FYM	59.79	134.6	19.95	23.4
T_4 : 75 % RDF + biofertilizer	53.86	117.6	19.81	23.7
T_5 : 75% RDF + FYM + bioferlilizer	64.66	133.7	21.44	24.5
T_6 : 50%RDF-!-FYM	55.96	125.0	21.52	26.3
T_7 : 50 % RDF + biofertilizer	53.40	110.8	20.84	24.5
T_8 : 50% RDF + FYM +biofertilizer	59.04	128.0	19.50	23.1
CD (P = 0.05)	12.36	20.5	N.S.	N.S.
Fertilizer levels to chickpea (*rabi*)				
F_1 : Control			18.00	20.6
F_2 : 50% RDF	-	-	21.04	24.8
F_3 : 100% RDF	-	-	22.57	26.8
CD (P = 0.05)	-	-	5.62	9.49

FYM = Farm yard manure;
RDF = Recommended dose of fertilizer;
N.S. = Not significant.

45 cm x 15 cm and 30 cm x 10 cm for sorghum and chickpea respectively. Sorghum was sown in last week of July and harvested during 1st week of November. To study the residual effect of INMS treatments chickpea was sown on same site without changing the randomization in 2nd week of November and harvested in 1st week of March during both the years of experimentation. The crop sequence received total rainfall of 557.7 mm in 2001-02 and 418.4 mm in 2002-03 during the crop growth periods. Both the crops were irrigated as per the critical growth stages and also considering the distribution of rainfall. The data on grain and fodder yields of sorghum and grain and *bhusa* yields of chickpea at harvest were recorded. Representative soil samples were drawn before start of the experiment and also at each harvest of the sequence. Representative plant and grain samples were also drawn from each harvest of the sequence. The soil and plant samples were analysed for N, P and K using standard analytical procedures. The data obtained was used for uptake and nutrient balance studies. The net soil nutrient balance was calculated using simple mathematical calculation considering the available soil nutrients before commencement of the experiment, addition of these nutrients through fertilizers, uptake by the crop and left over nutrients in the soil. The data on yield was analyzed statistically as per Panse and Sukhatme (1967). The data on nutrient balance studies was not analyzed statistically and the inferences were drawn on average values.

RESULTS AND DISCUSSION

Yield studies: Application of 75 per cent RDF + FYM + biofertilizers recorded significantly higher grain yield than those recorded in rest of the treatments during both the years and as well as on pooled mean basis. The grain yield pooled mean analysis showed almost all the INMS treatments at par with each other except control. The fodder yield pooled analysis showed significantly higher value due to 75 per cent RDF + FYM followed by 75 per cent RDF + FYM + biofertilizers, which

Table 2. Balance sheet of mean available soil nitrogen, phosphorus and potassium (kg ha^{-1}) as influenced by different treatments after completion of two cycles of sorghum-chickpea cropping sequence under INMS

Treatment	Nutrients applied during 4 seasons (kg ha^{-1})			Nutrient uptake by crop during 4 seasons (kg ha^{-1})			Soil available nutrients after 4 seasons (kg ha^{-1})			Net soil nutrient balance (kg ha^{-1})		
	N	P	K	N	P	K	N	P	K	N	P	K
INMS to sorghum (*kharif*)												
T_1 : Control	25.0	22.0	0.0	372.37	65.51	176.03	133.80	8.24	305.76	305.55	36.70	-71.83
T_2 : 100% RDF	265.0	74.8	99.6	679.71	124.88	292.99	192.34	11.28	357.51	431.43	46.31	-2.72
T_3 : 75% RDF + FYM	268.5	117.1	149.7	674.53	115.49	284.24	175.62	11.09	385.73	406.03	-5.57	-33.35
T_4 : 75 % RDF + biofertilizer	205.0	61.6	74.7	568.82	103.51	246.24	175.62	12.26	390.43	363.82	39.12	8.36
T_5 : 75 % RDF + FYM + biofertilizer	268.5	117.1	149.7	734.38	128.54	310.06	183.98	12.66	428.06	474.24	9.05	34.80
T_6 : 50% RDF+FYM	208.5	103.9	124.8	629.87	105.94	262.00	200.70	11.67	423.36	446.45	-1.34	6.94
T_7 : 50 % RDF + biofertilizer	145.0	48.4	49.8	530.41	96.96	232.53	175.62	12.56	413.95	385.41	46.07	43.06
T_8 : 50% RDF + FYM + biofertilizer	208.5	103.9	124.8	640.20	114.70	270.92	167.26	13.05	418.66	423.34	8.80	11.16
Fertilizer levels to chickpea (*rabi*)												
F_1 : Control	0.0	0.0	0.0	544.85	99.19	24.5.70	144.26	9.64	388.08	513.49	93.78	80.16
F_2 : 50% RDF	25.0	22.0	0.0	625.83	107.65	261. 23	181.89	11.70	389.84	607.10	82.30	97.45
F_3 : 100 % RDF	50.0	44.0	0.0	660.64	113.98	279.98	200.70	13.43	393.37	635.72	68.36	119.73

Initial status of nutrients (kg ha^{-1}) : N = 175.62, P = 15.05, K = 553.62

RDF = Recommended dose of fertilizer;
FYM = Farm yard manure.

were at par with all the treatments except control and 50 per cent RDF + biofertilizer. Dubey *et al.* (1997) also reported that organic manure application in conjunction with lower doses of N, P and K resulted in higher grain yield in important cropping systems. Singh *et al.* (1981) opined that the organic manures like FYM increased the adsorptive power of soil for cations and anions particularly phosphates and nitrates and these were released slowly for the benefit of crops during entire crop growth period leading to higher yields.

Chickpea grown after harvest of sorghum responded favorably to the residual effect of INMS treatments applied to the preceding crop sorghum. The grain yield and *bhusa* yield of chickpea was maximum due to 50 per cent RDF + FYM applied to sorghum. The fertilizer levels applied to chickpea increased the grain and *bhusa* yield of chickpea with maximum value recorded due to 100 per cent RDF which was at par with that of 50 per cent RDF and the lowest value due to control. This indicated that the residual nutrients were inadequate to obtain the high yield of subsequent crop, hence supplemental application of chemical fertilizers upto 50 per cent RDF was essential (Singh *et al.*, 1999).

Nutrient balance: The nutrient balance pertaining to nitrogen, phosphorus and potassium at the end of second sequence of sorghum-chickpea showed beneficial effect due to INMS to sorghum (Table 2). Maximum net balance of nitrogen (474.24 kg N ha^{-1}) was recorded due to treatment 75 per cent RDF + FYM + biofertilizer. Maximum net balance of phosphorus (46.07 kg ha^{-1}) was recorded with 100 per cent RDF which is comparable with that recorded with 50 per cent RDF + biofertilizers. Maximum net balance of potassium (43.06 kg ha^{-1}) was recorded due to 50 per cent RDF + biofertilizers applied to sorghum. Similar results were also reported by Shelke *et al.* (1997) in sorghum-wheat cropping system. The treatment effect was also noticed due to the fertilizer levels applied to chickpea (*rabi*). The maximum residual status of available nitrogen and potassium was observed due to application of 100 per cent RDF followed 50 per cent RDF and lowest nutrient balance of nitrogen and potassium was due to control treatment. In respect of phosphorus balance, control treatment was superior to all the treatments followed by 50 per cent RDF and least by the 100 per cent RDF. A number of researchers have reported synergistic effect of supplying nitrogen and phosphorus together on root growth. The greater root mass is believed to be responsible for increased crop uptake of phosphorus. (Tisdale *et al.*, 1990) In control treatment, no application of nitrogen resulted in less root and shoot mass leading to less yield and less crop uptake of phosphorus and ultimately maximum net soil phosphorus balance.

Data in consideration with net soil nutrient balance, it is revealed that, the use of farm yard manure and biofertilizers in combination with 75 per cent recommended dose for sorghum crop in sorghum- chickpea cropping sequence is the most appropriate source for optimum nutrient balance in said sequence. Similarly the higher levels of nutrients (100 per cent RDF) were suitable for the chickpea crop for optimum nutrient balance in the sequence. Thus, it can be concluded that, integration of inorganic fertilizers (75 per cent RDF) and organic manures (FYM) and biofertilizers to sorghum crop followed by chickpea with application of 50 per cent recommended dose through inorganic fertilizers is the best proposition not only to achieve the high productivity of sorghum and chickpea but also to sustain the nutrient status of the soil.

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