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Soil Productivity as Influenced by Long Term Fertilization and Cropping System

Prajakta M. Metkari[1], Suresh S. Kharat[2] and Papita H. Gourkhede[3]

Abstract: *A permanent field experiment is continued since 1988 at Research Farm, LTFE, Dr.PDKV., Akola, Maharashtra with a view to find out the effect of long term fertilization on soil productivity of sorghum (Sorghum bicolor(L.) Moench) - wheat (Triticumaestivum) crop sequence. The long term impact of manure and fertilizer application on soil productivity was studied after 24th and 25th cycle (2011-12 and 2012-13). The treatment comprised different levels of recommended dose of fertilizers (RDF), viz. 50, 75, 100, 150% RDF in combination with farm yard manure. The results indicated that, application or 100% RDF +FYM @ 10 t ha^{-1} recorded highest sorghum (49.37, 116.39 q ha^{-1}) and wheat (34.68, 55.81q ha^{-1}) grain yield.*

Key wards*: soil productivity, cropping system, long term manure and fertilizer application, grain, fodder and straw yield.*

INTRODUCTION

Through India is food surplus nation at presentwith about 259 million tonnes food grain production, it will require about 4-5 tonnes additional food grains each year if the trend in rising population persists (Anonymous 2012). It is anticipated that in India in the year 2025, total food grain demand will reach 291 million tonnes comprising 109 million tonnes of rice, 91 million tonnes of wheat, 73 million tonnes of coarse grains and 15 million tonnes of pulses against the limitation of expansion of the cultivable land area (Kumar an Shivay,2010). One of the alternatives to achieve this goal is to raise crop productivity through improved varieties and the matching production technology to sustain soil fertility and crop productivity in the future. Intensive cultivation and growing exhaustive crops have made the soil deficient I macro as well as micronutrients. The success of any cropping system depends upon the appropriate management of resources including balanced use of manures and fertilizers. Conjoint use of organic manures and chemical fertilizers may prove a viable option for sustaining the productivity of cereal based cropping sequence in view of the mere availability of macro as well as micro nutrients due to intensive cultivation and heavy feeding habits of this crop sequence. The present investigation mainly focused on impact of long term manuring andfertilization on crop productivity of sorghum (*Sorghum bicolor*(L.) *Moench*) - wheat (*Triticumaestivum*) crop sequence.

MATERIALS AND METHODS

The present investigation was undertaken during the year 2011-12 and 2012-13 on the old long- term fertilizer experiment started since 1988, to study the effects of long-term fertilization of Vertisol on soil productivity of sorghum-wheat cropping sequence at Research Farm, Department of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola. The soil at the start of experiment was Vertisol with slightly alkaline in reaction (8.1), low in organic carbon (4.6 g kg^{-1}), available N (120 kg ha^{-1}) and available phosphorus (8.4kg ha^{-1}) and high in available potassium (358 kg ha^{-1}). There were twelve treatments replicated four times in a randomized block design comprised of varying NPK levels with and without FYM, S and Zn. The details of various treatments in the permanent plot experiment are given in Table 1. FYM containing on an average 0.52, 0.17, 0.56 % N, P_2O_5 and K_2O, respectively on dry weight basis was applied in *kharif* season only. The recommended dose of fertilizer was applied @ 100:50:40 and 120:60:60

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra

1. Ph.D Scholar,Dept. of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola, *E-mail: dr.prajaktametkari@gmail.com*
2. Senior Research Assistant, Dr. PDKV, Akola.
3. Assistant Professor, VNMKV, Parbhani.

N,P_2O_5 and K_2O kg ha^{-1} to sorghum and wheat respectively. Half dose of N and full dose of P and K was applied at the time of sowing to sorghum and wheat crops. Remaining half dose of N was applied at 21 days after sowing. The sulphur (though gypsum) was applied to each plot as per the treatments. Zinc (through zinc sulphate) was applied once in two years for wheat crop only. Plot-wise surface (0-15 cm) soil samples were collected after the harvest of sorghum and wheat. The crop was harvested at maturity. The grain and straw yield of each crop were recorded separately for each crop and the yield was calculated.

RESULT AND DISCUSSSION

Sorghum Yield

Effect of various long term treatments showed significant influence on yield of sorghum after 24th and 25th cycle of experimentation. The data presented in Table 2 showed the grain yield of sorghum was recorded significantly highest i.e. 52.68 q ha^{-1} (2011-12), 46.05 q ha^{-1} (2012-13) in treatment receiving 100% NPK + FYM @ 10 t ha^{-1} closely followed by 48.67 q ha^{-1} (2011-12) and 42.25 q ha^{-1} (2012-13) treated with 150% NPK and this treatment was found at par with each other, whereas, lowest value were recorded 3.25 q ha^{-1} (2011-12), 3.81 q ha^{-1} (2012-13) in absolute control. The pooled data revealed that, significantly highest sorghum grain yield (49.37 q ha^{-1}) was recorded in 100% NPK + FYM @10 t ha^{-1} treatment and the lowest value was observed in absolute control (3.53 q ha^{-1}).The fodder yield of sorghum was recorded significantly maximum in treatment 122.33 q ha^{-1} (2011-12), 110.48 q ha^{-1} (2012-13) receiving 100% NPK + FYM @ 10 t ha^{-1} closely followed by 115.03 q ha^{-1} (2011-12), 101.48 q ha^{-1} (2012-13) treated with 150% NPK and this treatment was found at par with each other, Whereas, lowest value were recorded 5.89 q ha^{-1} (2011-12), 7.26 q ha^{-1} (2012-13) in absolute control. The pooled data revealed that, significantly highest sorghum fodder yield (116.41q ha^{-1}) was recorded in 100% NPK + FYM @10 t ha^{-1} treatment and the lowest value was observed in absolute control (6.58 q ha^{-1}).The higher yield by NPK with FYM application might have increased availability of nutrients in steady manner. The soil microbes are valuable not only because they supply nutrients but also they enhance the synchrony of plant nutrient demand with soil (Jadhao, 2014). A field experiment for monitoring long-term changes in soil fertility and crop yields under sorghum-wheat cropping sequence at Akola since 1988 (*kharif*). The results revealed that highest yield of sorghum and wheat was obtained with application of full recommended dose of NPK + 10 t FYM ha^{-1}. Application of inorganic in combination with organics increased the uptake of nutrients by both the crops as well as their availability in the soil, highest being under NPK+ FYM (Ravankar*et al.* 2005). It may be concluded that long term application of FYM @ 10 t ha^{-1} in combination with recommended dose to sorghum (100:50:40 NPK kg ha^{-1}) and wheat (120:60:60 NPK kg ha^{-1}) significantly improved and sustained the crop productivity in Vertisol under semi arid (Nandapure 2011).

Wheat Yield

Effect of various long term treatments showed significant influence on yield of wheat after 24th and 25th cycle of experimentation. The data presented in Table 3 showed the grain yield of wheat was recorded significantly highest i.e.33.88 q ha^{-1} (2011-12), 35.47 q ha^{-1} (2012-13) in treatment receiving 100% NPK + FYM @ 10 t ha^{-1} closely followed by 32.13 q ha^{-1} (2011-12) and 31.46 q ha^{-1} (2012-13) treated with 150% NPK and this treatment was found at par with each other, whereas, lowest value were recorded 0.53 q ha^{-1} (2011-12), 0.69 q ha^{-1} (2012-13) in absolute control. The pooled data revealed that, significantly highest wheat grain yield (34.68 q ha^{-1}) was recorded in 100% NPK + FYM @10 t ha^{-1} treatment and the lowest value was observed in absolute control (0.61 q ha^{-1}). The straw yield of wheat was recorded significantly highest i.e.57.88 q ha^{-1} (2011-12), 53.73 q ha^{-1} (2012-13) in treatment receiving 100% NPK + FYM @ 10 t ha^{-1} closely followed by 53.75 q ha^{-1} (2011-12) and 47.96 q ha^{-1} (2012-13) treated with 150% NPK and this treatment was found at par with each other, whereas, lowest value were recorded 1.18 q ha^{-1} (2011-12), 1.38 q ha^{-1} (2012-13) in absolute control. The pooled data revealed that, significantly highest wheat straw yield (55.81 q ha^{-1}) was recorded in 100% NPK + FYM @ 10 t ha^{-1} treatment and the lowest value was observed in absolute control (1.28 q ha^{-1}). In the present investigation reduction in biological yields in the treatments receiving only N or NP was also seen and was might to be a result of imbalance in the supply of essential nutrients to both the crops. The higher grain yield due to inorganic one and in combination with inorganic sources along with FYM might be increased due to sustained nutrient supply and also as a result of better utilization of applied nutrients through improved microbial activity that involved in nutrient transformation and fixation (Jadhao, 2014). A permanent field experiment is continued since 1984-

Table 1
Treatment Details

Tr.	*Treatment details*	*N, P_2O_5 & K_2O rate(kg ha^{-1})*		*Fertilizer source*
		Sorghum	*Wheat*	
T_1	50% NPK	50:25:20	60:30:30	Urea, SSP, MOP
T_2	75% NPK	75:37.5:30	90:45:45	Urea, SSP, MOP
T_3	100% NPK	100:50:40	120:60:60	Urea, SSP, MOP
T_4	100% NPK-S Free	100:50:40	120:60:60	Urea, DAP,MOP
T_5	150% NPK	150:75:60	180:90:90	Urea, SSP, MOP
T_6	100% NP	100:50:00	120:60:00	Urea, SSP
T_7	100% N	100:00:00	120:00:00	Urea
T_8	100% NPK + Zn @ 2.5 kg ha^{-1}	100:50:40	120:60:60	Urea, SSP, MOP, $ZnSO_4$
T_9	100% NPK +S @ 37.5 kg ha^{-1}	100:50:40	120:60:60	Urea, DAP MOP, Gypsum
T_{10}	100% NPK + FYM @ 10 t ha^{-1}	100:50:40	120:60:60	Urea, SSP,MOP
T_{11}	FYM @ 10 t ha^{-1}	10 t ha^{-1}	No manure, no fertilizer application	Well decomposed FYM
T_{12}	Control	-	-	-

Table 2
Yield of sorghum crop as influenced by long term manures and fertilizers application under sorghum-wheat cropping sequence

Tr.	*Treatment Details*	*Sorghum Yield (q ha^{-1})*					
		Grain			*Fodder*		
		2011-12	*2012-13*	*Pooled*	*2011-12*	*2012-13*	*Pooled*
T_1	50% NPK	26.76	23.90	25.33	63.86	56.28	60.07
T_2	75% NPK	33.58	36.10	34.84	78.08	84.79	81.44
T_3	100% NPK	36.97	31.43	34.20	85.24	75.28	80.26
T_4	100% NPK-S	34.27	27.78	31.02	75.78	66.36	71.07
T_5	150% NPK	48.67	42.25	45.46	115.03	101.48	108.26
T_6	100% N P	30.02	25.40	27.71	66.22	58.52	62.37
T_7	100% N	18.77	17.65	18.21	41.95	41.83	41.89
T_8	100% NPK + Zn @ 2.5 kg ha^{-1}	41.70	36.20	38.95	98.55	86.22	92.39
T_9	100% NPK + S @ 37.5 kg ha^{-1}	43.20	37.05	40.13	105.18	90.65	97.92
T_{10}	100% NPK + FYM @ 10 t ha^{-1}	52.68	46.05	49.37	122.33	110.48	116.41
T_{11}	FYM @ 10 t ha^{-1}	25.02	24.13	24.58	55.45	58.28	56.87
T_{12}	Control	3.25	3.81	3.53	5.89	7.26	6.58
SE (m) $\pm$		2.83	1.35	2.09	6.06	2.90	4.48
CD at 5 %		5.76	3.89	4.83	12.34	8.35	10.35

Table 3
Yield of Wheat crop as influenced by long term manures and fertilizers application under sorghum-wheat cropping sequence

Tr.	*Treatment Details*	*Wheat Yield (q ha^{-1})*					
		Grain			*Straw*		
		2011-12	*2012-13*	*Pooled*	*2011-12*	*2012-13*	*Pooled*
T_1	50% NPK	18.75	18.04	18.40	30.88	29.68	30.28
T_2	75% NPK	19.75	22.05	20.90	32.63	35.29	33.96
T_3	100% NPK	27.88	27.95	27.92	42.38	42.11	42.25
T_4	100% NPK-S	24.38	24.55	24.47	39.75	37.92	38.84
T_5	150% NPK	32.13	31.46	31.80	53.75	47.96	50.86
T_6	100% N P	14.25	13.21	13.73	27.38	21.34	24.36
T_7	100% N	8.88	7.47	8.18	16.38	12.86	14.62
T_8	100% NPK + Zn @ 2.5 kg ha^{-1}	29.25	30.69	29.97	44.25	45.89	45.07
T_9	100% NPK + S @ 37.5 kg ha^{-1}	30.25	30.95	30.60	44.63	46.71	45.67
T_{10}	100% NPK + FYM @ 10 t ha^{-1}	33.88	35.47	34.68	57.88	53.73	55.81
T_{11}	FYM @ 10 t ha^{-1}	11.75	12.89	12.32	19.38	21.65	20.52
T_{12}	Control	0.53	0.69	0.61	1.18	1.38	1.28
SE (m) $\pm$		0.71	1.21	0.96	0.75	1.60	1.18
CD at 5 %		2.04	3.47	2.76	2.15	4.61	3.38

85 at Research Farm, AICRP on cropping systems research unit, Akola, Maharashtra with a view to find out effect of integrated nutrient management on soil quality and productivity of sorghum (*Sorghumbicolour* (L.) *Moench*) – wheat (*TriticumaestivumL.*) crop sequence. The result indicated that the application of 50% RDF + 50%N through FYM recorded highest sorghum (24.58 q. ha^{-1}) and wheat (26.23 q. ha^{-1}) grain yield (Mali, 2015). Effect of long-term application of inorganic fertilizers and organic manure on yield, potassium uptake and profile distribution of potassium fractions in Vertisol under sorghum-wheat cropping system. They conducted under All India Coordinated Research Project on long-term fertilizer experiment was aimed on the effect of inorganic fertilizers with or without organic manure on yield of soybean-wheat cropping sequence during 2009-10 in a vertisol. The investigations revealed that the maximum yield of soybean (1.84 t ha^{-1}) and wheat (5.26 t ha^{-1}) and K uptake was obtained with the treatment 100% NPK + FYM. Grain yield obtained in 100% NPK + FYM treatment (1.84 and 5.26 t ha^{-1} in soybean and wheat, respectively) was significantly higher than 150% NPK treatment. (Sawarkar*et al.* 2013) It was concluded that substitution of 100% NPK in combination with FYM @ 10 t ha^{-1} resulted higher grain productivity in sorghum-wheat cropping sequence.

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