DOI: 10.15740/HAS/AU/12.TECHSEAR(7)2017/1974-1977 *Agriculture Update*
Volume **12** | TECHSEAR-7 | 2017 | 1974-1977
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RESEARCH ARTICLE :

Soil properties and yield of sorghum-wheat sequence as affected by long term integrated nutrient management

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ARTICLE CHRONICLE :
Received :
19.07.2017;
Accepted :
03.08.2017

SUMMARY : A permanent field experiment is continued since 1984-85 at AICRP on Integrated Farming System Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra with a view to find out the soil properties of sorghum [*Sorghum bicolor* (L.) Moench] -wheat (*Triticum aestivum* L.) crop sequence as affected by long term integrated nutrient management. The long term impact of integrated nutrient management on soil properties were studied after 32nd cycle (2015-16). The treatment comprised different levels of recommended dose of fertilizers (RDF) *viz.*, 50, 75, 100% RDF in combination with and without farm yardmanure, wheat straw and green manure. The results indicated that, among the chemical properties soil pH and the electrical conductivity was recorded non-significant. The highest organic carbon percentage was observedin treatment receiving chemical fertilizers along with FYM. It was significantly improved (0.71, 0.69%) with the application of 50% NPK + 50% N through FYM (T_6) and lowest value (0.44, 0.41%) was observed in absolute control.The influence on soil properties ultimately reflected in higher yield of sorghum and wheat in the same treatment. It is also observed that the soil propertieswere significantly correlated with yield. Hence, it can be concluded that the use of 50% NPK + 50% N through FYM is imperative for sustainable productivity and maintenance of soil fertility.

KEY WORDS :
Integrated nutrient management, FYM, pH, EC, Organic carbon, Vertisols

How to cite this article : Rathod, B.G., Patil, S.R., Patil, V.S., Andhlae, R.P., Dhage, A.B., Sable, P.P. and Dhonde, M.B. (2017). Soil properties and yield of sorghum-wheat sequence as affected by long term integrated nutrient management. *Agric. Update*, **12**(TECHSEAR-7) : 1974-1977; **DOI: 10.15740/HAS/AU/12.TECHSEAR(7)2017/1974-1977.**

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BACKGROUND AND OBJECTIVES

The long term Experiments provide valuable information on the effect of rotational cropping, use of organic manures, application of single nutrients and multi nutrients on crop yields and there by changes in some soil properties.Soil-health degradation has emerged as a major factor responsible for the stagnation in agricultural production.The maintenance of good soil health needs balanced fertilization, which includes application of all the required plant nutrients in proper amount and form.Chemical fertilizers and organic manures alone cannot sustain the

Table A : Different treatment combinations in the long-term experiment

Treatments	*Kharif* Sorghum	*Rabi* Wheat
T_1	No fertilizer, no organic matter (control)	No fertilizer, no organic matter (control)
T_2	50% recommended NPK through fertilizers	50% recommended NPK through fertilizers
T_3	50 % recommended NPK through fertilizers	100% recommended NPK through fertilizers
T_4	75% recommended NPK through fertilizers	75 % recommended NPK through fertilizers
T_5	100% recommended NPK through fertilizers	100% recommended NPK through fertilizers
T_6	50% recommended NPK through fertilizers + 50% N through FYM	100% recommended NPK through fertilizers
T_7	75% recommended NPK through fertilizers + 25% N through FYM	75% recommended NPK through fertilizers
T_8	50% recommended NPK through fertilizers + 50% N through wheat straw	100% recommended NPK through fertilizers
T_9	75% recommended NPK through fertilizers + 25 % N through wheat straw	75% recommended NPK through fertilizers
T_{10}	50% recommended NPK through fertilizers + 50% N through GM	100% recommended NPK through fertilizers
T_{11}	75 % recommended NPK through fertilizers + 25 % N through GM	75% recommended NPK through fertilizers
T_{12}	Farmer's conventional practice	Farmer's conventional practice

FYM-Farm Yard Manure and GM- Green Manuring

desired levels of crop production under continuous farming. Integrated nutrient management may be an option to restore the soil productivity. Degradation of soil health in many intensively cultivated areas is manifested in terms of loss of soil organic matter, depletion of native soil fertility due to imbalanced and unscientific use of fertilizer, which is now one of the major constraints in improving crop productivity.

Sorghum-wheat cropping sequence has been popular among the farmers of peninsular India covering Maharashtra, Tamil Nadu, Karnataka and Andhra Pradesh. Soil type greatly influences the choice of crop and cropping system.

It is being increasingly realized that when crops are grown in system, the fertilizer requirements of the cropping system as a whole is important than that of the individual crop (Sharma and Singh, 2003). The integrated plant nutrient supply system, by which we can apply the nutrients in balanced form, is emerging as the most logical concept for managing and sustaining long term soil fertility and productivity. Prasad *et al*. (1995) reported that the integrated use of green manure (GM) and organic manure with chemical fertilizer resulted in a build-up of available nutrients in soil much more effectively than that of chemical fertilizer alone. Long-term experiments on different soil types have shown that incorporation of crop residues increased organic carbon, total N and available P and K contents in soil.

In view of the above the results of integrated nutrient management experiment, conducted for 32 years at MPKV, Rahuri developed suitable integrated nutrient supply and management systems and studied the long-term effect of conjunctive use of fertilizers and organic manures on the productivity of cereal based crop sequences and on soil health.

RESOURCES AND METHODS

The long-term field experiments on sorghum–wheat cropping system was conducted continuously on fixed site from 1984-85 to 2015-16 (32 years) under the network of All India Co-ordinated Research Project (AICRP) on Cropping systems now Farming systems at MPKV, Rahuri. The soil of the experimental field has a clay loam texture (sand 22.3%, silt 26.4%, and clay 51.3%), Typic Chromustert with pH 8.15, organic carbon 0.64%, electrical conductivity 0.35 dS m^{-1}, Bulk density 1.32 Mg m^{-3},Infiltration rate 0.76 cm h^{-1} and CEC 10.7 cmol kg^{-1} of soil. The available N, P and K were 153, 14.2,705 kg ha^{-1}, respectively. Sorghum cultivar CSH-9 and wheat HD-2189 were grown in sequence during *Kharif* and *Rabi* season, respectively at the same site. The experiment consisted of twelve treatments, each replicated four times in Randomized Block Design (RBD) having individual plot size of 12.6m x 8.10m. The treatment details for *Kharif* and *Rabi* are given in Table A.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads and Table 1 to 2:

Physico-chemical properties:

Physico-chemical properties of soil as influenced by fertilization under sorghum wheat sequence indicated that no significant changes were observed in pH and electrical conductivity of soil due to various treatment combinations. Organic matter content varied significantly with various treatments, the highest being recorded under treatment 50% NPK +50% N through FYM. Organic matter content was lowest in control plot. FYM application and increased biomass are the main contribution factors to increased organic matter content. Significant increases in available NPK were observed as compared to control. Highest value of available NPK was observed with application 50% NPK +50% N through FYM.

Chemical properties*:*

Total N, P and K content was affected significantly due to various treatment combinations. Application of 50% NPK + +50% N through FYM showed highest

Table 1 : Physico- chemical properties of soil as influenced by various treatment (2015-16)

Treatments	pH (1:2.5)	E.C. (dSm^{-1})	Organic carbon (%)	Available nutrients			Nutrient uptake		
				N	P	K	N	P	K
				kg ha^{-1}			kg ha^{-1}		
T_1	8.21	0.21	0.44	122	7	526	2	0.36	2
T_2	8.18	0.20	0.63	167	15	636	49	8	52
T_3	8.19	0.21	0.63	173	17	638	56	10	61
T_4	8.17	0.21	0.65	182	17	642	65	12	69
T_5	8.19	0.23	0.67	191	19	664	74	15	81
T_6	8.12	0.23	0.71	195	22	669	87	16	91
T_7	8.13	0.22	0.68	182	19	660	80	14	86
T_8	8.14	0.21	0.66	183	19	643	71	12	76
T_9	8.13	0.22	0.66	181	17	639	71	12	68
T_{10}	8.12	0.21	0.70	194	20	665	79	14	80
T_{11}	8.12	0.23	0.68	189	18	642	80	12	76
T_{12}	8.16	0.22	0.56	149	13	597	23	4	26
S.E. ±	0.09	0.01	0.01	4.99	0.12	9.79	4.27	0.73	4.32
C.D. (P=0.05)	NS	NS	0.03	14.36	0.35	28.17	12.28	2.10	12.44
Initial	8.15	0.35	0.64	153	14	705	--	--	--

NS=Non-significant

Table 2 : Yield of sorghum and wheat affected by various treatments (2015-16)

Treatments	Sorghum (kg ha^{-1})		Wheat (kg ha^{-1})	
	Grain	Fodder	Grain	Straw
T_1	121	192	345	510
T_2	2283	3607	2744	3872
T_3	2681	4236	3173	4333
T_4	2981	4709	2796	3902
T_5	3348	5290	3721	4872
T_6	3827	6047	4203	5391
T_7	3564	5631	3471	4641
T_8	2860	4871	3172	4213
T_9	3163	4998	3405	4600
T_{10}	3298	5211	3766	4881
T_{11}	3543	5597	3561	4711
T_{12}	1128	1783	1971	2813
S. E.±	193.7	287.8	224.8	306.1
C.D. (P=0.05)	557.4	828.2	646.9	880.7
CV %	14.18	13.24	14.85	15.07

values of total N, P and K content in soil. Ravankar *et al.* (1998) also reported similar increase in total N with combined application of inorganics and organics in sorghum wheat sequence on vertisols. Similarly, Goswami (1988) reported that organic residues addition (green manure, FYM) hasbeneficial role, particularly in nutrient supply and improvementof soil aggregation.

Grain and fodder yield:

Application of NPK, either through inorganic fertilizers or in combination with organic manures/crop residue/green manure, significantly increased the yields of sorghum, wheat and sorghum grain equivalent yield over control. Grain and fodder/straw yield of sorghum and wheat increased significantly with the increase in NPK levels from 50 to 100%. The maximum grain yield of sorghum and wheat that of the system in terms of sorghum grain equivalent yield was recorded under T_6 (50% NPK along with 50% N through FYM during *Kharif* followed by 100% NPK during *Rabi*).

The sorghum grain equivalent yield in respect of the system in T_6 was significantly superior over the rest of the treatments. Amongst different sources of organics, substitution of 50% N through FYM attained significantly higher system productivity (9892 kg ha^{-1}) in term of sorghum grain equivalent yield by12 and 29% over green manure and wheat cut straw at same level. Substitution of 50% N through any of the organic sources, recorded significantly higher sorghum grain equivalent yield as compared to 25% N substitution rate. The omission of chemical fertilizers and organic manures continuously for the last 32 years resulted in low yield of both the crops due to continuous mining of nutrients. The integrated use of chemical fertilizers with organics *viz.*, FYM, green manure and wheat cut straw might have added huge quantity of organic matter in soil that resulted in higher grain yields. This could be ascribed to the contribution from annual use of organics that improved physico-chemical properties of soil and increased availability of plant nutrients (Chaudhary and Thakur, 2007). Further the organic matter also supplies macro and micro nutrients and complexing agents that enrich the soil. These results are in conformity with the findings of Gupta *et al*. (2006) and Urkurkar *et al*. (2010).

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