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EFFECT OF CONTINUOUS USE OF INORGANIC FERTILIZERS AND ORGANIC MANURE ON CROP PRODUCTIVITY, SOIL FERTILITY AND SUSTAINABILITY OF SOYBEAN -WHEAT CROPPING SYSTEM IN A VERTISOL

N.K. Khamparia[1], Risikesh Thakur[2] and S.D. Sawarkar[3]

ABSTRACT

The present study was conducted during 2010-11 under the ongoing All India Coordinated Project on Long Term Fertilizer Experiment with soybean-wheat cropping system in a Vertisol, which was commenced from 1972 at J.N.K.V.V., Jabalpur (MP). The findings of the present study showed that the application of recommended dose of N, P and K (20:80:20 kg ha^{-1} to soybean and 120:80:40 kg ha^{-1} to wheat) with 15 t FYM ha^{-1} gave the maximum pooled grain yields of 1.91 and 4.91 t ha^{-1}, respectively and minimum was recorded in control plot (0.79 t ha^{-1} for soybean and 1.25 t ha^{-1} for wheat, respectively). Conjoint use of FYM with 100% NPK substantially improved the organic carbon status by 4.15 g kg^{-1}, as well as available N, P, S and Zn by 147, 35.3, 28.8 kg ha^{-1} and 0.56 mg kg^{-1} in soil over its initial values, thereby indicating significant contribution towards sustaining the soil health. On the other hand, omission of S in 100% NPK–S treatment caused a continuous depletion (3.31%) in soil S status over initial value. A declining trend from its initial value (370 kg ha^{-1}) of available K status was also observed as a result of continuous cropping; this indicates considerable mining of available K from the soil. However, the decline of K was of lower magnitude with 100% NPK+FYM (13.5%) and 150% NPK (26.3%) treatments indicating the need to raise the level of K fertilizer application to meet the demand of crops. However, the fertility of the soil appears to be adversely affected due to the imbalanced use of nutrients viz., NP or N alone. Thus, the balanced use of fertilizers continuously either alone or in combination with organic manure is necessary for sustaining soil fertility and productivity of crops.

(Key words: Inorganic and organic fertilizers, sustainable yield index)

INTRODUCTION

Soybean – wheat is one of the most prevalent cropping sequence followed in a substantial area of Madhya Pradesh, and to some extent in other part of the country. Long-term fertilizer experiments give the valuable information on effect of continuous application of different levels of fertilizer nutrients alone and in combination with and without organic manure under intensive cropping on soil fertility and crop productivity. These experiments can be used for precise monitoring of changes in soil fertility and productivity and could be of paramount help in solving the complex problems related to the soil fertility management. There is an apprehension that the use of chemical fertilizers over the years might may impair the soil fertility. In continuous cropping, use of imbalanced nutrients (N or NP alone) through inorganic fertilizers without organic manure cannot sustain the desired level of crop production (Thakur *et al.,* 2011). Integration of inorganic fertilizers with organic manures will not only sustain the crop production but also will be effective in improving soil health and enhancing the nutrient use efficiency. In view of declining productivity levels, increasingly greater emphasis is now being given on the integrated nutrient supply system which may play a significant role in sustaining soil quality (Selvi *et al.,* 2005). As information is lacking on the effect of continuous cropping and fertilization on soil properties and crop productivity in a Vertisol, thus, the present study was undertaken to find out the influence of continuous use of inorganic fertilizers and organic manure on crop productivity, soil fertility and sustainability of soybean-wheat cropping system in a Vertisol.

MATERIALS AND METHODS

The present investigation is a part of an ongoing AICRP on Long Term Fertilizer Experiment with soybean-wheat cropping sequence which was initiated during 1972

1. Assoc. Professor, Deptt. of Soil Science & Agril. Chemistry, College of Agriculture, Rewa, J.N.K.V.V., Jabalpur (M.P.)
2. Asstt. Professor, Deptt. of Soil Science & Agril. Chemistry, College of Agriculture, Waraseoni (Balaghat), J.N.K.V.V., Jabalpur (M.P.)
3. Professor (Soil Science), KVK, Chhindwara, J.N.K.V.V., Jabalpur (M.P.)

at the Research Farm of the Department of Soil Science & Agril. Chemistry, JNKVV, Jabalpur, Madhya Pradesh (23°103 N latitude and 79° 573 E longitude). The soil of the experimental field is medium black (56.8% clay) belonging to Kheri series of fine montmorillonitic hyperthermic family of *Typic Haplustert.* The experiment included 10 treatments and replicated four times in a randomized block design. The details of treatment and amounts of nutrients applied in different treatments are given in table 1. The recommended N, P and K dose, based on initial soil test, was 20 kg N, 80 kg P_2O_5 and 20 kg K_2O ha^{-1} for soybean and 120 kg N, 80 kg P_2O_5 and 40 kg K_2O ha^{-1} for wheat.

The sources of N, P and K used were urea, single super phosphate and muriate of potash. During rainy season, all the nutrients, viz., N, P and K were applied as basal before last harrowing, whereas in wheat half of the nitrogen was applied at the time of sowing and the remaining half was applied in two splits first half at 21–25 days (after the first irrigation) and the rest at 51-55 days after sowing. In 100% NPK + HW treatment weeding is done manually, whereas in other treatments chemical weed control (herbicide) was followed. Soybean (var. JS 97 52) was sown in the last week of June to first week of July as rainfed during *kharif* and wheat (var. GW 366) in the first week to second week of November as irrigated during *rabi*. Wheat was irrigated at critical phases of crop growth as and when needed. Insects and diseases were kept under check following suitable control measures. Soybean and wheat crops were harvested at maturity and yield data were recorded after threshing. The soil samples were collected after harvest of wheat crop from 0-15 cm depths in the 38^{th} cropping year (2010-11) and were analysed for different parameters by standard laboratory procedures for soil pH (1:2.5 soil: water suspension), EC by conductivity meter (Jackson, 1973), organic carbon by rapid titration method (Walkley and Black, 1934). Available N was estimated by alkaline permanganate method (Subbiah and Asija, 1956), available P by Olsen's method (Olsen *et al.,* 1954), available K by ammonium acetate extraction method (Muhr *et al.,* 1965) and available S was estimated by turbidimetric method (Chesnin and Yien, 1951). The Available Zn was extracted with DTPA and determined by atomic absorption spectrophotometer as described by (Lindsay and Norvell, 1978). The data generated on soil analysis and crop yields were statistically analyzed to draw inferences as per method described by Panse and Sukhatme (1970). The pooled grain yields of soybean and wheat (average of 10 years) have also been reported. The sustainability yield index (SYI) of soybean and wheat crops was also calculated using following equation as suggested by Singh *et. al.* (1990) :

$$SYI = (y - ä_{n-1})\, Y_m^{-1}$$

Where : y is mean yield of respective treatment, $ä_{n-1}$ is the standard deviation and Y_m is the maximum yield obtained under a set of management practices in any of the treatment and any of the year in a given experiment.

RESULTS AND DISCUSSION

Crop productivity

The data pertaining to the mean grain yields of soybean and wheat have been presented in table 2 and indicated that highest pooled average grain yields of soybean (1.91 t ha^{-1}) and wheat (4.91 t ha^{-1}) were obtained in treatment receiving optimal dose of NPK with FYM and the lowest yields of soybean (0.79 t ha^{-1}) and wheat (1.25 t ha^{-1}) were recorded in control plot. The results of long-term fertilizer experiment indicated that the application of 100% N alone had increased the yield by 24.9 and 31.9% for soybean and wheat, respectively over control. Continuous application of N alone caused an increase in the yields over control but the response exhibited declining trend with time due to imbalanced use of nutrients (Singh *et al.,* 2012). Further, the supplementation of P with N (100% NP) enhanced the yields by 58.6 and 148.8% in soybean and wheat, respectively. Application of K along with NP *i.e.* 100% NPK further increased the yields by 10.2% and 7.8%, respectively. Further, the deficiency of S manifested itself through yield reduction of 6.9% (1.61 t ha^{-1}) against 100% NPK (1.73 t ha^{-1}) in soybean. Similarly, yield reductions were 6.5% (4.16 t ha^{-1}) against 100% NPK (4.45 t ha^{-1}) in plots where S-free NPK fertilizers have been applied continuously. Thus, addition of S became essential after a few cycles of intensive cropping. These findings clearly indicate that the highest crop response in terms of yield was found with balanced application of fertilizers. Further, the use of 50% NPK caused 88.9 and 170.5% increase in yield over control in soybean and wheat, respectively followed by 119.9 and 254.8% increase due to application of 100% NPK. The balanced application of 100% NPK produced higher soybean and wheat yields. Sharma *et al.,* (2013) also reported from their experiment that the substitution of 25% NPK through farmyard manure in recommended dose of NPK along with biofertilizers noted significantly higher grain yield over the 100% NPK treatment.

In continuous cropping, the application of organic manure @ 15 t FYM ha^{-1} along with optimal dose of fertilizer *i.e.* 100% NPK + FYM was beneficial for enhanced crop productivity and soil fertility. It produced highest yields of soybean (1.91 t ha^{-1}) and wheat (4.91 t ha^{-1}), followed by yields of 1.79 and 4.77 t ha^{-1} of soybean and wheat, respectively obtained under super-optimal dose of fertilizer (150% NPK). These findings indicate that integrated use of optimal dose of fertilizer and organic manure treatment is superior to super-optimal dose. Thus, the balanced use of fertilizer either alone or in combination with organic manure is necessary for sustaining soil fertility and productivity of crops. The advantage of organic manures is quite obvious, as these provide a steady supply of nutrients leading better growth of plants. Moreover, the increased availability of P and K in addition to other plant nutrients released by the organic manures might have contributed in enhancing the yield-attributes. The positive impact of availability of individual plant nutrients and humic substances from manure and balanced supplement of nitrogen through inorganic fertilizers might have induced cell division, expansion of cell wall, meristematic activity, photosynthetic efficiency and regulation of water intake into the cells, resulting in the enhancement of yield parameters. Improvement in yield due to combined application of inorganic fertilizer and organic manure might be attributed to control release of nutrients in the soil through mineralization of organic manure which might have facilitated better crop growth (Katkar *et al.,* 2011).

Soil fertility

Soil pH, EC and soil organic carbon

The data (Table 3) on soil analysis with continuous fertilizer addition for 38 years and soil test values indicated that slight changes in soil pH and EC values were noted due to imposition of different treatments and found well within the limit which was a result of the high buffering capacity of the experimental soil. The organic carbon content ranged between 4.21 to 9.85 g kg^{-1}. Organic carbon content of soil with an initial value of 5.7 g kg^{-1} (1972) had increased significantly and attained a maximum value of 9.85 g kg^{-1} in the treatment that has received 100% NPK along with FYM. Increasing levels of fertilizer application has helped in increasing the organic carbon content, which is due to increased contribution from the biomass, as it is also observed that with increasing levels of fertilizer application, the crop yields had increased. Further, applying organic manure along with NPK fertilizer was beneficial because it supplemented NPK and added some secondary and micronutrients and also improved the physical and biological characteristics of the soil (Gathala *et al.,* 2007).

Available nitrogen

The available nitrogen content ranged from 189 to 340 kg ha^{-1} (Table 3) and that the highest value of available N was found associated with treatments where recommended fertilizer with FYM @ 15 t ha^{-1} had been applied. These results are in line with findings of Singh *et al.* (2012), who observed that available nitrogen content in soil increased significantly with the use of recommended dose of fertilizer in combination with manure. Further, by increasing the application rate of nutrients, the amount of available nutrients also increased significantly (T_8 and T_3). However, application of phosphorus along with nitrogen (100% NP) improved the available nitrogen status of the soil in comparison to the application of nitrogen alone (100% N), and further the application of potassium with 100% NP (100% NPK) had also improved N content (280 kg ha^{-1}) in soil. Sharma *et al.* (2015) also reported an increase in available nitrogen contents due to graded application of NPK. Control plot showed reduction in the available nitrogen status due to removal of nutrients with continuous cropping without fertilization (Raghuwanshi *et al.,* 2016).

Available phosphorus

The results from this long-term experiment indicate (Table 3) that imbalanced use of fertilizers reduced the available P content in the soil. A significant reduction in available P content observed under nitrogen alone (100% N) and unfertilized treatments occurred due to removal of P by the crops in the absence of P supplementation through external source. Use of 100% NP over 100% N significantly increased the available P status of soil. Similarly, Dubey *et al.* (2016) also reported that the increasing levels of fertilizer enhancing the available P content in a Vertisol. Further, the application of 100% NPK over 100% NP had no significant effect on available P status. A marked build up of available P status of soil was observed under 100% NPK + FYM and 150% NPK treatments. The use of recommended dose of fertilizer with organic manure resulted in an increase in the available P status of soil (42.9 kg ha^{-1}) which was comparable with that present in 150% NPK treatment (40.9 kg ha^{-1}).

Available potassium

The perusal of data indicated a declining trend (178 to 326 kg ha^{-1}) from its initial level (370 kg ha^{-1}) of available K status which indicates considerable mining of available soil K after 38 years of intensive cropping (Table 3). The maximum decline was observed in case of control followed by 100% N alone; the magnitude of decline decreased with increasing levels of NPK application. Among the inorganic fertilizers, continuous application of N or NP had depressive effect on available K content of the soil which may be due to nutrient imbalance in the soil. Continuous omission of K in crop nutrition caused mining of its native pools that caused reduction in the crop yields (Sawarkar *et al.,* 2013). However, the highest available K status of soil found associated with 100% NPK+FYM followed by 150% NPK treatments. The application of organic manure may have caused reduction in K fixation and consequentially increased K content due to interaction of organic matter with clay besides the direct addition to the available K pools of soil (Prasad and Mathur, 1997). From the results, it can be concluded that the present K recommendations are not sufficient and need revision; otherwise an abrupt decline in production could be encountered in the near future.

Available sulphur

Continuous growing of soybean–wheat without application of S containing fertilizers caused decline in available S in the soil (Table 3) from its initial amount of 15.6 to 12.6 kg ha^{-1} in control, followed by 12.9 kg ha^{-1} in 100% N alone and 15.1 kg ha^{-1} in sulphur free treatment (100% NPK–S). It may be attributed to continuous use of DAP as P source which resulted in S deficiency in 100% NPK-S plots causing reduction in crop yields (Thakur and Sawarkar, 2009). But an appreciable increase in available S content was found in the treatment receiving continuously full dose of P through single superphosphate which contains 12% S in addition to 16% P_2O_5. Further, the application of recommended dose of fertilizer with organic manure in significantly raised available S status of soil (44.4 kg ha^{-1}). Similar, findings have also been reported by Birla *el al.* (2015), who reported that the successive addition of sulphur fertilizer increased the available S status in a Vertisol under soybean-wheat cropping system.

DTPA-extractable zinc

Addition of zinc along with 100% NPK (T_5) significantly raised the level of available Zn content (1.32 mg kg^{-1}) in the soil (Table 3). A significant build up of available Zn due to zinc sulphate application has been reported by Sahare *et al.* (2014). Further, the inclusion of FYM also contributed significantly to the build up of Zn content (0.89 mg kg^{-1}) in soil over the 100% NPK treatment (0.55 mg kg^{-1}). This could be attributed to the direct contribution of FYM to nutrient pool and its beneficial effects either through complexation or mobilization of native Zn (Singh, 2007). Similar, findings have also been reported by Sawarkar *et al.* (2010) , who reported that the application of balance fertilizer with 25 kg ha^{-1} gave the maximum Zn content in soil followed by 100% NPK+15 t FYM ha^{-1}.

Nutrient balance in Soybean – Wheat cropping sequence

It is always desirable to calculate the apparent nutrient balance to attain the desired level of production without depleting the native reserves and ensuring the maintenance and improvement in soil fertility. Nutrients' drain has been calculated on the basis of the removal by grain and straw of the plants which were harvested. Perusal of data on inputs (nutrient applied) and output (nutrient uptake) indicated a positive balance of P and negative balance of N and K under the best management practices for soybean–wheat cropping sequence. Soybean is a leguminous crop having biological nitrogen fixation ability through which the N management is possible but such facilities are not available for K. Therefore, much attention is required for potassic fertilizers in soils to maintain K status of soil and to prevent K mining (Mahapatra *et al.,* 2007).

Apparent nutrient changes in soil after harvest of wheat as compared to the initial values were computed and presented in table 4. It was observed that the annual addition of 15 t FYM ha^{-1} helped in maintenance of the available N and K under continuous cropping. The maximum available N status 4.08 kg ha^{-1}yr^{-1} was observed in 100% NPK+FYM. Appreciable increase in available P status in soil was recorded in all the treatments except control and 100% N alone treatment. Apparent P balance increased with increase in the quantity of P applied from 50% to 150%. The negative P balance is obviously due to absence of P in fertilization schedule whereas positive P balance is because of addition of P in excess of its uptake by crops (Thakur *et al.,* 2011). The maximum negative balance of K in soil was recorded in 100% NP treatment. The critical evaluation of data indicated that on an average, there was net mining of 150-200 kg K ha^{-1} at normal to good productivity levels.

Sustainability Yield Index (SYI) :

The sustainable yield index values for soybean–wheat system are presented in table 6. The highest SYI value for soybean 0.35 and wheat 0.59 was recorded with 100% NPK+FYM, while, the lowest SYI of 0.12 and 0.13 were observed with soybean and wheat, respectively. The next in order was the treatment of 100% NPK which showed SYI of 0.31 and 0.54 for soybean and wheat. This was attributed to the additional benefit of FYM other than nutrients supply. The findings are in conformity with Bhattacharya *et al.* (2008).

From the results obtained under long-term experiment with continuous addition of fertilizers for the last 38 years in black soil improved the organic carbon and available nutrients (N, P and S) over its initial values. Integration of FYM with optimal fertilizer application sustained productivity of soybean and wheat. Further, the balanced and integrated use of nutrient (100% NPK and 100% NPK+FYM) can take care of micronutrient (Zn) requirement of crops for quite long time by mobilizing from the native source during decomposition of residual bio-mass of soybean and wheat added each year. Hence, it is recommended that balance application of fertilizers integrating with FYM is necessary to maintain soil fertility, crop productivity and sustainability over a period of time.

Table 1. Details of treatments and nutrient rates (kg ha^{-1}) in soybean and wheat

Treatments	Soybean			Wheat		
	N	P	K	N	P	K
T_1- 50 % NPK	10	17.6	8.3	60	17.6	16.6
T_2-100 % NPK	20	35.2	16.6	120	35.2	33.2
T_3-150% NPK	30	52.8	24.9	180	52.8	49.8
T_4-100 % NPK+HW	20	35.2	16.6	120	35.2	33.2
T_5-100 % NPK+Zn*	20	35.2	16.6	120	35.2	33.2
T_6-100 %NP	20	35.2	NA	120	35.2	NA
T_7-100 % N	20	NA	NA	120	NA	NA
T_8-100 % NPK+FYM**	110	54	16.6	120	35.2	33.2
T_9-100 % NPK (-S)#	20	35.2	16.6	120	35.2	33.2
T_{10}-Control	NA	NA	NA	NA	NA	NA

*Zinc application @ of 20 kg $ZnSO_4$ ha^{-1} in alternate years to wheat crop was followed till 1987.
**FYM was applied 15 t ha^{-1} to soybean every year 15–20 days before sowing;
#Diammonium phosphate (DAP) was used instead of SSP as source of P; NA = Not Applied.

Table 2. Effect of different treatments on pooled average (1972-2011) of soyabean and wheat crop yields

Treatments	Pooled average of grain yields (t ha^{-1})		Per cent response over control	
	Soybean	Wheat	Soybean	Wheat
T_1-50% NPK	1.49	3.39	88.9	170.5
T_2-100% NPK	1.73	4.45	119.9	254.8
T_3-150% NPK	1.79	4.77	127.3	280.3
T_4-100% NPK + HW	1.69	4.25	114.0	238.9
T_5-100% NPK + Zn	1.71	4.39	117.2	249.7
T_6-100% NP	1.57	4.13	99.1	229.5
T_7-100% N	0.99	1.66	24.9	31.9
T_8-100% NPK + FYM	1.91	4.91	142.4	291.0
T_9-100% NPK (-s)	1.61	4.16	103.8	231.7
T_{10}-Control	0.79	1.25	-	-
SEm ±	0.003	0.005		
CD (P=0.05) For T	0.009	0.015		
SEm ±	0.019	0.032		
CD (P=0.05) For T x Y	0.053	0.089		

Table 3. Effect of continuous cropping on soil test values after harvest of wheat (2010 - 2011)

Treatments	pH	EC (dSm^{-1})	OC (g kg^{-1})	Available Nutrients (kg ha^{-1})				DTPA- Zn (mg kg^{-1})
				N	P	K	S	
T_1- 50% NPK	7.51	0.14	5.40	217	22.0	241	21.5	0.48
T_2- 100% NPK	7.56	0.16	7.58	280	32.8	265	34.8	0.51
T_3-150% NPK	7.57	0.18	8.68	310	40.9	293	41.3	0.55
T_4-100% NPK + HW	7.54	0.16	7.55	259	31.4	241	32.6	0.61
T_5-100% NPK + Zn	7.55	0.15	7.38	278	31.7	235	32.1	1.32
T_6-100% NP	7.53	0.17	6.70	257	28.6	229	30.5	0.51
T_7-100% N	7.48	0.16	5.26	206	11.8	193	12.9	0.46
T_8-100% NPK + FYM	7.57	0.17	9.85	340	42.9	326	44.4	0.89
T_9-100% NPKS	7.60	0.16	7.26	279	30.2	205	15.1	0.49
T_{10}-Control	7.56	0.12	4.21	189	9.9	178	14.6	0.30
SEm ±	-	-	0.20	7.0	0.7	6.3	0.8	0.02
CD (P=0.05)	-	-	0.58	20.4	2.2	18.4	2.3	0.05
Initial value (1972)	7.6	0.18	5.7	193	7.6	370	15.6	0.33

Table 4 . Nutrient balance under soybean –wheat cropping sequence after harvest of wheat (2010-2011)

Treatments	Available nutrient contents after harvest of wheat (kg ha^{-1})			Apparent nutrient changes as compared to their initial values (kg ha^{-1})			Increase/decrease in nutrient content of soil year^{-1} (kg ha^{-1} yr^{-1})		
	N	P	K	N	P	K	N	P	K
T_1-50% NPK	217	22.0	241	24	14.4	-129	0.63	0.38	-3.39
T_2-100% NPK	280	32.8	265	87	25.2	-105	2.29	0.66	-2.76
T_3-150% NPK	310	40.9	293	117	33.3	-77	3.08	0.88	-2.03
T_4-100% NPK + HW	259	31.4	241	66	23.8	-129	1.74	0.63	-3.39
T_5-100% NPK + Zn	278	31.7	235	85	24.1	-135	2.24	0.63	-3.55
T_6-100% NP	257	28.6	229	64	21	-141	1.68	0.55	-3.71
T_7-100% N	206	11.8	193	13	4.2	-177	0.34	0.11	-4.66
T_8-100% NPK + FYM	340	42.9	326	147	35.3	-44	3.87	0.93	-1.16
T_9-100% NPKS	279	30.2	205	86	22.6	-165	2.26	0.59	-4.34
T_{10}-Control	189	9.9	178	-4	2.3	-192	-0.11	0.06	-5.05
Initial value (1972)	193	7.6	370	-	-	-	-	-	-

Table 5. Effect of different treatments on nutrient balance in soil under soybean - wheat cropping sequence (1972-2011)

Treatments	Nutrient additions through manure and fertilizers (kg ha^{-1} yr^{-1})			Nutrient removal by soybean-wheat system (kg ha^{-1} yr^{-1})			Nutrient balance after harvest of wheat (kg ha^{-1} yr^{-1})		
	N	P	K	N	P	K	N	P	K
T_1-50% NPK	70.0	35.2	24.9	230.2	22.3	163.0	-160.2	12.9	-138.1
T_2-100% NPK	140.0	70.4	49.8	315.0	33.4	223.3	-175.0	37.0	-173.5
T_3-150% NPK	210.0	105.6	74.7	356.5	39.1	265.4	-146.5	66.5	-190.7
T_4-100% NPK + HW	140.0	70.4	49.8	289.2	30.9	212.0	-149.2	39.5	-162.2
T_5-100% NPK + Zn	140.0	70.4	49.8	307.7	32.4	222.0	-167.7	38.0	-172.2
T_6-100% NP	140.0	70.4	0.0	274.2	29.3	196.5	-134.2	41.1	-196.5
T_7-100% N	140.0	0.0	0.0	155.5	10.5	92.0	-15.5	-10.5	-92.0
T_8-100% NPK + FYM	219.5	90.2	128.3	377.1	42.5	293.8	-157.6	47.7	-165.5
T_9-100% NPKS	140.0	70.4	49.8	283.6	29.0	204.5	-143.6	41.4	-154.7
T_{10}-Control	0.0	0.0	0.0	94.0	7.7	64.3	-94.0	-7.7	-64.3

Table 6. Effect of different treatments on Sustainability Yield Index (SYI) of soybean and wheat (1972-2011)

Treatments	Sustainability Yield Index	
	Soybean	Wheat
T_1-50% NPK	0.25	0.40
T_2-100% NPK	0.31	0.54
T_3-150% NPK	0.32	0.56
T_4-100% NPK + HW	0.30	0.51
T_5-100% NPK + Zn	0.29	0.53
T_6-100% NP	0.26	0.50
T_7-100% N	0.14	0.15
T_8-100% NPK + FYM	0.35	0.59
T_9-100% NPKS	0.28	0.50
T_{10}-Control	0.12	0.13

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