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Research Article

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Effect of Conjunctive use of Organic and Inorganic Sources of Nutrients on Soybean-Wheat Productivity, Economics and Soil Health of Typic Ustochrepts of Central India

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ABSTRACT

The field experiment was conducted in soybean and Wheat cropping system at the research farm of the Krishi Vigyan Kendra (R.V.S.K.V.V.) Kothibagh, Rajgarh (Biaora) during 2015-16 and 2016-17. The recommended dose of fertilizer 20:60:20 NPK kg ha^{-1} for soybean and 120:60:60 NPK kg ha^{-1} for wheat was applied in randomized block design with replicated three times of nine treatments viz control T_1, 100% RDF T_2, 50% RDF + 50% FYM T_3, 50% RDF + 50% VC T_4, 100% FYM T_5, 100% VC T_6, 100% RDF + 25 kg $ZnSO_4$ (first year) T_7, 100% RDF (DAP as source of P) T_8 and 100% RDF + 0.5 kg Ammonium molybdate T_9 in both the crops. System Productivity recorded highest (8628 kg ha^{-1}) in T_4 followed by T_3 (8598 kg ha^{-1}), T_7 (8530 kg ha^{-1}), T_2 (8393 kg ha^{-1}) and T_9 (8336 kg ha^{-1}). The higher value of soil reaction pH -1:2.5 (7.58), electrical conductivity (0.39 dSm^{-1}) and organic carbon (0.68%) were found. Maximum available-N (198 kg ha^{-1}), available-P (12.8 kg ha^{-1}), in soybean and available-N (192 kg ha^{-1}), available-P (13.8 kg ha^{-1}), in wheat were found significantly higher in the 100% N through Vermi Compost (T_6) followed by 50% RDF + 50% Vermi Compost (T_4) and available-K (325 kg ha^{-1}), soybean and available-K (319 kg ha^{-1}),in wheat was non significant. The highest Gross Income Rs 99910, Cost of Cultivation Rs 27000, Net Return Rs 75115 and benefit cost ratio 4.32 (B:C) in 2016-17 of soybean and Gross Income Rs 79935, Cost of Cultivation Rs 27000, Net Return Rs 46905 and benefit cost ratio 2.42 (B:C) was found in 2015-16 of wheat. The maximum (1608 Kg ha^{-1}) seed yield of Soybean and (4610 Kg ha^{-1}) grain yield of wheat was recorded in the treatment of 50%RDF+ 50% VC, followed by 50%RDF+ 50% FYM, 100% RDF + ZnSO4, 100% N through VC,100% N through FYM which were higher over control. Thus practice improved soil health and productivity of soybean and wheat.

Key words: *Nutrient Management, Productivity, Soil Health, Soybean and Wheat.*

INTRODUCTION

To sustain the pressure of increasing demand of food from ever growing population, we are forced to produce more and more from decreasing natural resources like land, water and availability of nutrient sources.

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To enhance and sustain the productivity over a long period of time improvement in soil health by adoption of cultural practices is essential. Soybean (*Glycin max* L.)-Wheat (*Triticum aestivum* L.) is predominant cropping system of central India. During *kharif* season soybean crop occupying nearly 5 million hectare area in M.P. and the area under wheat after soybean is increasing day by day with increasing irrigation facility like harvesting rain water, construction of open well and small irrigation projects and adoption of micro irrigation systems. The average productivity of soybean is around 1.2 t ha^{-1} and that of wheat it is 2.5 t ha^{-1}. (Recently it has increased to 3.0). In recent past the productivity of soybean declined to less than one ton in the recent past. Deterioration of soil health is considered as one of the main causes for the decline in yield of Soybean The long term imbalance application of nutrients through fertilizer supply of nutrients under intensive cropping may deplete the reserve pool of nutrients which if not replenished may leads to decline in soil productivity. If we want to achieve the target of 300 million tones food grain production by 2030 AD and to sustain the system, should give more emphasis on application of organic and inorganic sources of nutrient in integration manner. Integrated nutrient management refers to the maintenance of soil fertility and of plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all possible sources of organic, inorganic and biological components in an integrated manner so as to sustain the growth of living being. Soybean has capability of fixing atmosphere nitrogen for its use and part of that nitrogen goes to soil through residual bio-mass. Studies indicate that soybean withdraws very high amount of N but most of its N derived from atmosphere and a good amount (30-57 kg N) is returned back to the soil by Singh *et al.*[14]. Various soil fertility parameters including chemical and biological properties showed conspicuous improvement over the initial status under the treatments of FYM and poultry manure. Sustainability yield index was maximum under 1.0NPK, followed by 1.0NPK + poultry manure or FYM. It was concluded that application of available organic sources, particularly FYM and poultry manure along with full recommended dose of NPK fertilizers to wheat was essential for improving productivity, grain quality, profitability, soil health and sustainability of wheat–soybean system of Behera *et al.*[1]. This biologically fixed nitrogen is utilized by subsequent crop and nitrogen application can be reduced accordingly. In India, to assess the impact of nutrient management on crop productivity, sustainability and soil health, a series of long-term fertility experiments was started, using both organic and inorganic sources of nutrients, during the late 1960s and early 1970s when fertilizer-responsive high-yielding cultivars of different crops were introduced. Some studies were made on productivity analysis, nutrient balance, and soil quality Singh *et al.*[13]. The soybean and wheat cropping sequence has the highest nutrient requirement; however, it is most attractive system in terms of economics returns and energy efficiency by the Vyas *et al.*[20]. The use of chemical fertilizer in balanced form not only sustains the productivity at higher level but also improves the soil quality. However integrated use of chemical fertilizers and farm yard manure or poultry manure or vermin-compost further elevated the yield level and also causes in improvement in soil quality. Like other crops, soybean also withdraws other nutrients like P, K, S, etc from soil in comparable quantity to wheat by the Vidyavathi *et al.*[19]. 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 by Thakur *et al.*[17]. The present study was conducted with an objective to assess of impact of nutrient management on crops yield and soil health under soybean-wheat cropping sequence on Typic Ustochrepts soil of central India.

MATERIALS AND METHODS

The field experiment was conducted during two years of 2015-16 and 2016-17 at the research farm of the Krishi Vigyan Kendra (R.V.S.K.V.V.) Kothibagh, Rajgarh (Biora), situated in Malwa Plateau at the latitude of 24^0 00'46"N and longitude 76^0 44'13"E with an altitude of 340 meters from mean sea level (MSL). The research was conducted on well maintained plots, having fairly uniform topography with gentle slope and adequate drainage. The climate of experimental site is semi-arid and sub-tropical experiencing dry summer and cold winter. Maximum temperature goes up to 45 ^{0}C during summer and steeps down to as low as 4 – 5^0C during winter. Annual average rainfall of the farm is 1100 mm and most of the rain occurs during second week of June to mid of September. Winter rains are occasional and uncertain. Soil of experimental site belongs to the series *Surajpura* Typic Ustochrepts established by National Bureau of Soil Survey & Land Use Planning, Nagpur (NBSSLUP). The soil is dominated with montmorrilonite clay mineral. The soil of the experimental site is alluvial, sandy clay loam in texture and classified as Typic Ustochrepts at sub group level. The soil is low in organic carbon (0.48%), low in available N (158 Kg ha^{-1}), low in P(9.1 Kg ha^{-1}) and high in K (298 Kg ha^{-1}), medium in S (22.2 Kg ha^{-1}), medium in Zn (0.51 mg Kg^{-1}), pH 7.50 and EC 0.34 dSm^{-1}. Since Kharif 2012 the site was under soybean- wheat sequence for breeder seed production. To study the impact assessment of nutrient management i.e. farmyard manure (FYM) and vermi-compost (VC) in combination with chemical fertilizer on productivity of soybean- wheat cropping sequence, soil fertility and economics. The experiment was laid out in randomized block design with Nine treatments were replicated three times. The treatments were control T_1, 100% RDF T_2, 50% RDF + 50% FYM T_3, 50% RDF + 50% VC T_4, 100% FYM T_5, 100% VC T_6, 100% RDF + 25 kg $ZnSO_4$ (first year) T_7, 100% RDF (*DAP as source of P*) T_8 and 100% RDF + 0.5 kg Ammonium molybdate T_9 in both the crops i.e Soybean and wheat. 25 kg $ZnSO_4$ applied only in soybean crop in first year only in T_7 treatment and 0.5 kg ammonium molybdate applied only in soybean crop as seed treatment in T_9 treatment. In T_5 and T_6 treatment total nutrient were supplied through FYM and the quantity applied was @5 t and @2t in soybean and @20t and @8t in wheat crop, respectively. In treatment T_3 and T_4 half the quantity of FYM and VC applied in both the crops. The recommended fertilizer dose of nutrient for soybean (20:60:20 N, P_2O_5 and K_2O kg ha^{-1}) and for wheat (120:60:60 N, P_2O_5 and K_2O kg ha^{-1}) was applied as per the treatments through urea, single superphosphate and muriate of potash. The whole amount of nitrogen in soybean and 33 per cent of nitrogen in wheat and entire doses of P_2O_5, K_2O, Zn, FYM and Vermicompost were applied as basal before last harrowing at the time of sowing and the remaining 66 per cent of nitrogen of wheat was top dressed in two equal splits at 30 days and 50 days after sowing. In one of the treatment (100 % NPK), P was added through DAP to make it S free treatment. The quantity of FYM and Vermicompost required as per treatment were applied 15 to 20 days before sowing of both the crop in both the years. In one of the treatments required amount of seed was treated with Ammonium molybdate @0.5 Kg/ha. The soybean (cv JS 9560) was sown @ 80 kg ha^{-1} in last week of June in 2015 and first week of July in 2016 and harvested in first week of October in both the year. The Wheat (cv RVW 4106) was sown@ 100 kg ha^{-1} in Second week of November in 2015 and in 2016 and harvested in Second week of March in both the year. The data was analyzed statistically analyzed using RBD design as described in Gomez and Gomez[4] to find the differences among the treatment means and compared using LSD techniques at 5% probability. The soil samples were drawn from two depths (0-15, 15-30, cm) of soil profile with the help of screw and tube auger were drawn to study the impact of various fertility treatment on soil properties after harvest of each crop in both the year. The soil samples collected were air dried and processed to pass through 2 mm sieve Soil pH was estimated in suspension (1:2.5 Soil: water) using glass electrode on pH meter after equilibrating the soil with water for 30 minutes with occasional stirring Jackson[6]. The clear supernatant extract obtained from the suspension used for pH (Soil: water, 1:2.5) was utilized for EC measurement by conductivity bridge Richards[10] The oxidizable soil organic carbon (SOC) was determined by wet oxidation Walkley and Black [21]. Available nitrogen was estimated by alkaline $KMnO_4$ method Subbaiah and Asija[15]. Available phosphorus in soil was extracted with 0.5 M $NaHCO_3$ (pH 8.5) Olsen *et al.*[9] and content of phosphorus in the extract was determined by ascorbic acid reductant method and the absorbance was read at 660 nm wave length on spectrophotometer Jackson[6]. Available K in soil was extracted with neutral normal ammonium acetate and the content of potassium in the extract was estimated by flame photometer Jackson[6] using red filter. Available S in soil was determined by Turbid metric determination Chesnin and Yien[2]. Available Zn was determined by Atomic Absorption Spectrophotometer using 0.005M DTPA (Diethylene Triamine Penta Acetic Acid) as an extractant proposed by Lindsay and Norvell[8].

System productivity (wheat equivalent) of soybean wheat cropping system determined by the formula described as.

$$\text{System productivity (Wheat equivalent)} = \frac{\text{Soybean yield (Kg ha}^{-1}\text{) x price of soybean seed (Rs Kg}^{-1}\text{)}}{\text{Price of wheat (Rs Kg}^{-1}\text{)}} + \text{Seed yield of wheat (Kg ha}^{-1}\text{)}$$

RESULT AND DISCUSSION

Soybean and Wheat Grain yield (Kg ha^{-1}): The data on soybean and wheat grain yield recorded during both the years (2015-16 and 2016-17) of study and presented table 2 revealed that the grain yield of soybean and wheat were significantly affected on application of different treatments through organic, Inorganic and integrated ways. The Mean grain yield of Soybean varied between 1018 to 1608 Kg ha^{-1} and wheat from 2673 to 4603 Kg ha^{-1}. The maximum (1608 Kg ha^{-1}) grain yield of Soybean was recorded in treatments received 50%RDF+ 50% VC, followed by 50%RDF+ 50% FYM, 100% RDF + $ZnSO_4$, 100% N through VC,100% N through FYM which were 57.98%, 57.00%, 54.30%, 52.82% and 50.61% higher over control respectively but among themselves all the treatments are statistically at par. This means these treatments had similar effect on yields of soybean. This is due to supply of nutrient more or less in similar quantity. Perusal of soybean yield data of 2015 indicate that that yields are relatively poor than the yield of soybean recorded during 2016. Poor yield of soybean is due to excess rain during early stage of growth of crop. Rain fall data recorded supports the statement. During July and early August rainfall was 835 mm which water logged the soil for three to four weeks and roots at an early growth stage and many plants of soybean were rotted and due to poor aeration and soybean roots could not fix N for its growth. Likewise, mean grain yield of wheat was highest (4610 Kg ha^{-1}) in treatments received 50% RDF + 50% VC, followed by 4605 Kg ha^{-1} in treatments received 50% RDF + 50% FYM,100%RDF+$ZnSO_4$ and these were 72.49 % and 72.31% higher over the control. This increased grain yield may be due to higher availability of all the nutrients in balanced manner and better soil health for optimum growth and yield. It has been proved and numbers of reports are available that without external supply of nutrient increase in yield is not possible. Application of nutrient is essential to sustain yield at higher label. The similar effect of integrated nutrient management was reported by the Gosavi *et al.*[5] , Behera *et al.*[1], Dadhich and Somani[3] , Venkateswaralu *et al.*[18], Sharma *et al.*[12] Tabassum *et al.*[16] Singh *et al.*[14], Thakur *et al.*[17] and Sawarkar *et al.*[11]. They concluded that without external supply of nutrient higher productivity can't be achieved.

Straw yield (Kg ha^{-1}): A similar effect of nutrient management was also recorded on straw yield of both soybean and wheat (Table 2.) Straw yield of soybean ranged between 1523 to 2415 Kg ha^{-1} and wheat 3515 to 6093 Kg ha^{-1}. Implementation of various treatment resulted in statistical significant increase in straw yield of both the crops over control but is statistically at par among themselves as in case of their respective grain yields of Singh *et al.*[14] Thakur *et al.*[17] and Sawarkar *et al.*[11].

System Productivity: As expected data of system productivity kg ha^{-1} given in table 3 showed the lowest mean (5216 kg ha^{-1}) of two year in control T_1 and highest (8628 kg ha^{-1}) in T_4 fallowed by T_3 (8598 kg ha^{-1}), T_7 (8530 kg ha^{-1}), T_2 (8393 kg ha^{-1}) and T_9 (8336 kg ha^{-1}). The data in table 3 showed clearly that treatment T_4 and T_3 (INM options) had highest system productivity followed by Treatments T_7 and T_2 (Inorganic option) that indicate the soil health and availability of nutrients is better in INM options and then in inorganic options Behera *et al.*[1] and Thakur *et al.*[17].

Gross Income, Cost of Cultivation, Net Return and benefit cost ratio (B: C): Data in table 4 display the gross income, cost of cultivation, net return and B: C ratio of the soybean and wheat crop in year of 2015-16 and 2016-17. The gross income of Soybean is lowest 31580 and 58955 in controls and highest 43180 and 99910 in T_4 treatment respectively during 2015 and 2016 soybean. The gross income of wheat is lowest 45555 and 46995 in controls and highest 79935 and 79830 in T_4 and T_3 treatment. The cost of cultivation is highest in 100% organic nutrient options because of higher cost of FYM/VC, their transport and application cost which reduced the B: C ratio. Net return calculated by the gross income subtracted by cost of cultivation. The highest net return of soybean is Rs 19460 in T_7 fallowed by Rs 18680 in T_4 during 2015-16 and Rs 75410 in T_4 fallowed by T_7 Rs 75115 during the year 2016-17. The highest net return of wheat is Rs 46905 in T_7 fallowed by Rs 46245 in T_2 during 2015-16 and Rs 46665 in T_2 fallowed by T_7 Rs 46640 during the year 2016-17. The highest B: C ratio of soybean is 1.86 in T_7 fallowed by 1.85 in T_2 during 2015-16 and 4.32 in T_7 fallowed by T_2 4.31 during the year 2016-17.The highest B: C ratio of wheat is 2.42 in T_7 fallowed by 2.40 in T_2 during 2015-16 and 2.41 in T_7 and in T_2 during the year 2016-17. It would be more appropriate to compare system ratio which will minimized years effect Behera, *et al.*[1] and Thakur *et al.*[17].

Physico-Chemical Properties of Soil: Soil fertility parameters like soil pH is found in the range of 7.45 to 7.58 and EC is in the range of 0.32 to 0.39 dSm^{-1} and the pH and EC is almost same values in all the treatment and the difference is statistically no significant. The effect of different nutrient options on soil health parameters was studied during in the year 2015-16 and 2016-17 and the data are presented in table 5.The treatment showed the slightly higher OC in the treatment received 100 % FYM and 100% VC fallowed by 50% RDF+ 50% FYM or VC. It is apparent from data that the OC content all most similar in all inorganic treatments except control where it is slightly decreased. The OC content was found in the range of 0.45% to 0.68%. Interestingly the OC content of soil was higher after harvest of soybean than after harvest of wheat. It is because of the better microbial population in moist and cold climate, addition of leaves and residual fixed N after soybean in table 5. The similar trend found in respect to available N. The increased available N found in organic and integrated nutrient management options. The available P is found in the range of 7.4 kg ha^{-1} to 13.8 kg ha^{-1}. The Increased available P is showed in the organic and INM nutrient management option because of more increased microbial activities that is responsible for solublization of soil phosphorus by secretion of acids and enzymes. The available K is found in the range of 280 kg ha^{-1} to 325 kg ha^{-1}. The available K content is more or less same in all the nutrient management options except control where it is decreased. The effect of different nutrient options on soil health parameters viz soil Organic carbon (SOC), Available N, Available

P, Available K, EC and pH after two years growing of soybean and wheat sequence was assessed. In the table 6 Data on SOC presented in table 5 revealed that application of nutrient resulted increase in SOC with respect to its initial content irrespective treatment. The effect of treatment was more pronounced on conjunctive application of organic and inorganic. Increase in SOC on nutrient supply is due to addition of carbon in more quantity than control as a result of increase in biomass production. Lager increase in SOC on conjunctive use of nutrient is due to better growth and at the same time additional supply of carbon to soil through organics. So and so reported residual biomass is the main source of carbon in soil and addition of carbon is dependent on primary productivity of crop or system. Higher is the primary productivity greater is amount of residual biomass added to soil which ultimately results in increase soil carbon. Continuous application of mineral fertilizers and manures had significant effect on electrical conductivity. Application of inorganic fertilizers slightly increases EC of soil. The highest value of EC (0.341 dSm^{-1}) was recorded in 150 % NPK, followed by 100 % NPK + farmyard manure at 10 t/ha (0.336 dSm^{-1}) while lowest EC (0.270 dSm^{-1}) was recorded in control by the Katkar *et al*.[7].

Table 1: Treatment Details

Treatments	Description
T_1	Control
T_2	100% RDF(NPK-20:60:20)
T_3	50% RDF + 50% N through FYM
T_4	50% RDF + 50% Vermi Compost
T_5	100% N through FYM
T_6	100% N through Vermi Compost
T_7	100% RDF + Zn (First Year)
T_8	100% RDF (DAP as source of P)
T_9	100% RDF + 0.5 kg AM

Table 2: Effect of different nutrient management options on grain and straw yield (Kg ha^{-1}) of Soybean and Wheat (2015-2017)

Tr. No	Soybean yield (Kg ha^{-1})						Wheat yield (Kg ha^{-1})					
	2015-16		2016-17		Mean yield		2015-16		2016-17		Mean yield	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	710	1060	1325	1985	1018	1523	2630	3475	2715	3555	2673	3515
T_2	915	1375	2130	3190	1523	2283	4575	6045	4600	6065	4588	6055
T_3	965	1450	2230	3335	1595	2393	4595	5975	4615	5990	4605	5983
T_4	970	1460	2245	3370	1608	2415	4615	6095	4605	6035	4610	6065
T_5	925	1390	2140	3195	1533	2293	4155	5475	4215	5525	4185	5500
T_6	935	1405	2175	3265	1555	2335	4175	5510	4220	5525	4198	5518
T_7	945	1420	2195	3305	1570	2363	4610	6145	4600	6040	4605	6093
T_8	905	1360	2110	3170	1508	2265	4310	5685	4325	5665	4318	5675
T_9	930	1395	2155	3225	1543	2310	4535	5990	4525	5930	4530	5960
CD 5%	139	361	319	382	150	272	47.33	58.03	60.94	60.19	39.38	44.3

Table 3: System productivity (Kg ha^{-1}) in Soybean -Wheat system of different nutrient management option in 2015-16, 2016-17

Tr.No.	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
2015-16	4405	6862	7007	7040	6467	6512	6972	6572	6860
2016-17	6027	9925	10190	10217	9565	9657	10087	9600	9912
Mean	5216	8393	8598	8628	8016	8085	8530	8086	8336

Table 4: Gross Income, Cost of Cultivation, Net Return and benefit cost ratio (B:C) in different nutrient management options of Soybean and Wheat (2015-2017)

Tr.No.	Soybean								Wheat							
	2015-16				2016-17				2015-16				2016-17			
	GI	CC	NR	B:C	GI	CC	NR	B:C	GI	CC	NR	B:C	GI	CC	NR	B:C
T_1	31580	19000	12580	1.66	58955	19000	39955	3.1	45555	19000	20555	1.82	46995	19000	21995	1.88
T_2	40725	22000	18725	1.85	94770	22000	72770	4.31	79245	22000	46245	2.4	79665	22000	46665	2.41
T_3	42950	24500	18450	1.75	99205	24500	74705	4.05	79495	24500	42495	2.15	79830	24500	42830	2.16
T_4	43180	24500	18680	1.76	99910	24500	75410	4.08	79935	24500	42935	2.16	79715	24500	42715	2.15
T_5	41170	27000	14170	1.52	95185	27000	68185	3.53	71955	27000	30955	1.76	72965	27000	31965	1.78
T_6	41615	27000	14615	1.54	96795	27000	69795	3.59	72310	27000	31310	1.76	73045	27000	32045	1.78
T_7	42060	22600	19460	1.86	97715	22600	75115	4.32	79905	22600	46905	2.42	79640	22600	46640	2.41
T_8	40280	22500	17780	1.79	93910	22500	71410	4.17	74645	22500	40645	2.2	74865	22500	40865	2.20
T_9	41385	24000	17385	1.72	95875	24000	71875	3.99	78550	24000	45550	2.38	78330	24000	45330	2.37

Table 5: Physico-Chemical Properties affected by different nutrient management after harvesting of Soybean and Wheat (2015-2017)

Tr. No.	Soil pH				E.C.(dSm-1)				Organic carbon %			
	2015-16		2016-17		2015-16		2016-17		2015-16		2016-17	
	Soybean	Wheat	Soybean	Wheat	Soybean	Wheat	Soybean	Wheat	Soybean	Wheat	Soybean	Wheat
T_1	7.45	7.48	7.47	7.48	0.33	0.34	0.32	0.32	0.48	0.45	0.46	0.44
T_2	7.55	7.56	7.54	7.57	0.38	0.39	0.37	0.39	0.54	0.53	0.56	0.55
T_3	7.48	7.49	7.47	7.47	0.36	0.37	0.35	0.36	0.55	0.54	0.57	0.58
T_4	7.48	7.51	7.47	7.47	0.33	0.34	0.32	0.33	0.56	0.55	0.58	0.59
T_5	7.49	7.51	7.48	7.46	0.35	0.35	0.34	0.35	0.66	0.65	0.68	0.65
T_6	7.47	7.5	7.46	7.44	0.33	0.33	0.32	0.33	0.61	0.60	0.63	0.61
T_7	7.52	7.55	7.5	7.56	0.36	0.37	0.37	0.37	0.54	0.53	0.56	0.55
T_8	7.55	7.56	7.53	7.57	0.37	0.38	0.37	0.38	0.54	0.53	0.56	0.55
T_9	7.56	7.57	7.54	7.58	0.37	0.38	0.37	0.38	0.54	0.53	0.56	0.55
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS	0.031	0.035	0.033	0.032
	*Initial status of pH -7.5				*Initial status of E.C.(dSm^{-1})-0.34				*Initial status of O.C (%)-0.48			

Table 6: Effect of different treatment on Available NPK (Kg ha^{-1}) after harvesting of Soybean and Wheat (2015-2017)

Tr. No	Available N (Kg ha^{-1})				Available P (Kg ha^{-1})				Available K (Kg ha^{-1})			
	2015-16		2016-17		2015-16		2016-17		2015-16		2016-17	
	Soybean	Wheat	Soybean	Wheat	Soybean	Wheat	Soybean	Wheat	Soybean	Wheat	Soybean	Wheat
T_1	162	149	149	138	8.9	7.5	7.8	7.4	303	290	285	280
T_2	182	169	190	179	11.5	11.6	11.8	12.8	317	312	303	305
T_3	187	179	195	189	12.2	12.3	12.5	13.5	322	317	308	311
T_4	188	180	196	190	12.4	12.5	12.7	13.7	323	318	309	311
T_5	183	175	191	185	12.3	12.4	12.6	13.6	323	318	310	312
T_6	190	182	198	192	12.5	12.6	12.8	13.8	325	319	311	313
T_7	186	173	194	183	11.8	11.9	12.1	13.1	321	316	305	307
T_8	183	170	191	180	11.6	11.7	11.9	12.9	319	313	303	306
T_9	187	174	195	184	11.8	11.9	12.1	13.1	321	315	304	306
CD 5%	11.2	10.8	12.1	11.9	0.62	0.59	0.63	0.65	NS	NS	NS	NS
	*Initial status of N 158 (Kg ha-1)				*Initial status of P 9.1 (Kg ha-1)				*Initial status of K 298 (Kg ha^{-1})			

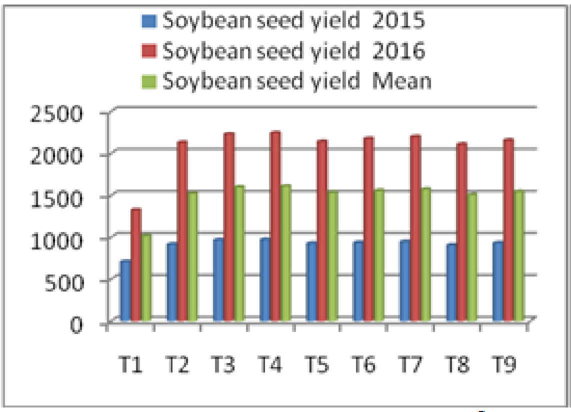

Figure 2a Soybean seed yield Kg ha^{-1} in 2015 -16, 2016-17 and mean seed yield

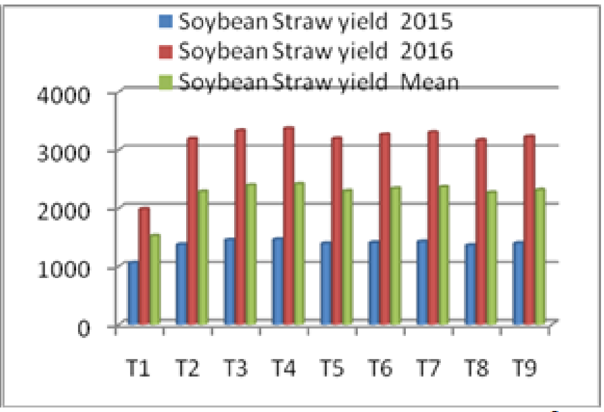

Figure 2b Soybean straw yield Kg ha^{-1} in 2015-16, 2016-17 and mean straw yield

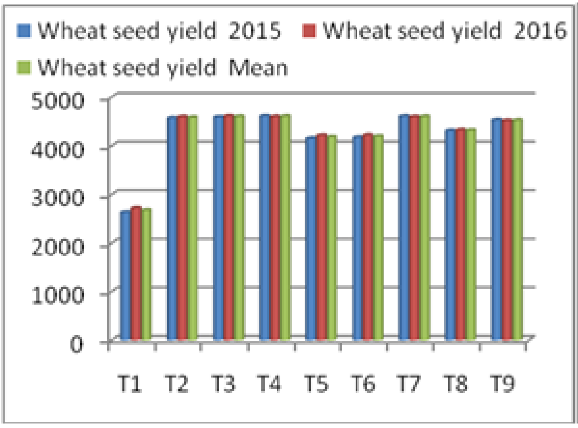

Figure 2c Wheat seed yield Kg ha-1 in 2015-16, 2016-17 and Mean seed yield

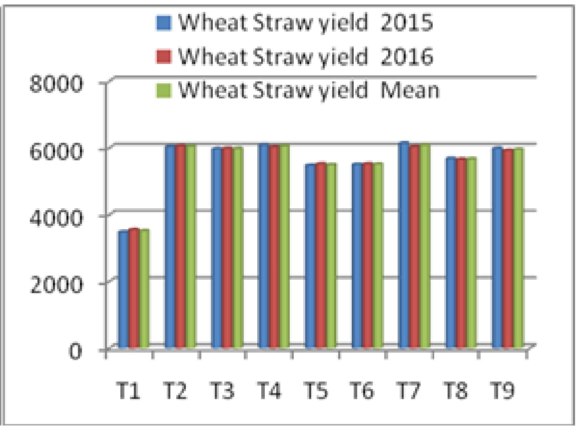

Figure 2d Wheat Straw yield Kg ha-1 in 2015-16, 2016-17 and mean straw yield

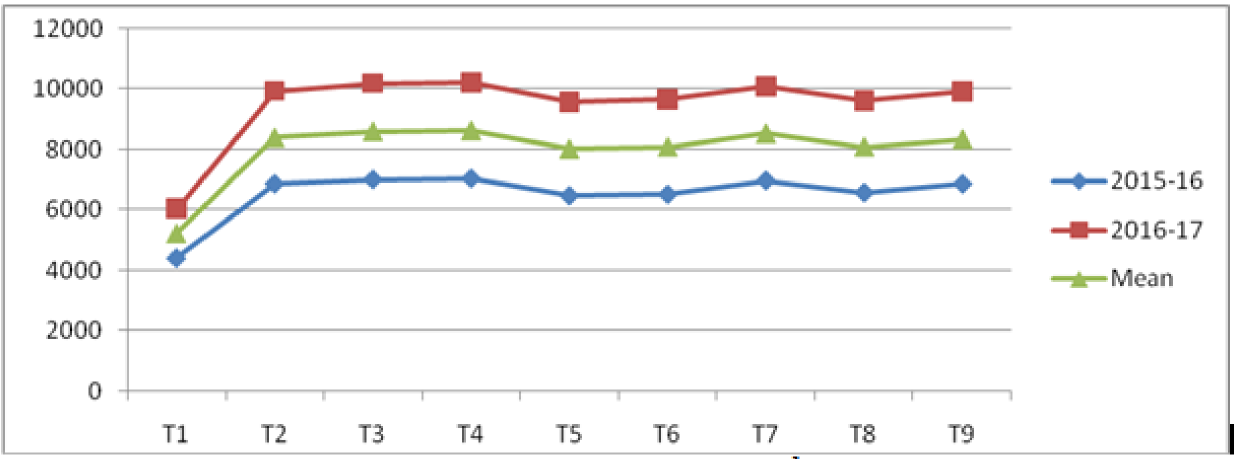

Figure 3: System productivity (Wheat equivalent) (Kg ha^{-1}) in Soybean -Wheat system of different nutrient management option in 2015-16, 2016-17 and Mean productivity of two year

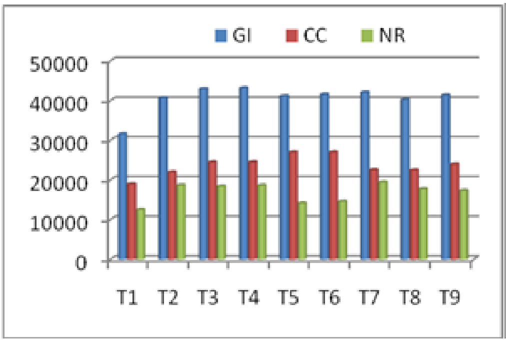

Figure 4a Gross income (Rs/ha), cost of cultivation cultivation and Net return of soybean in 2015-16

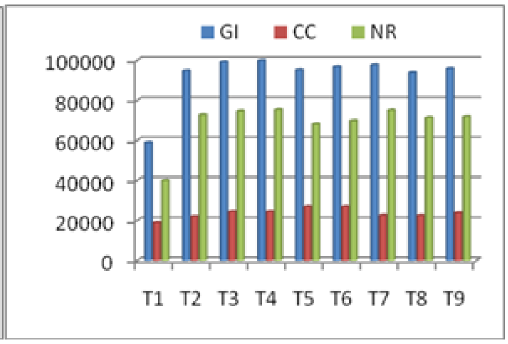

Figure 4b Gross income (Rs/ha), cost of and Net return of soybean in 2016-17

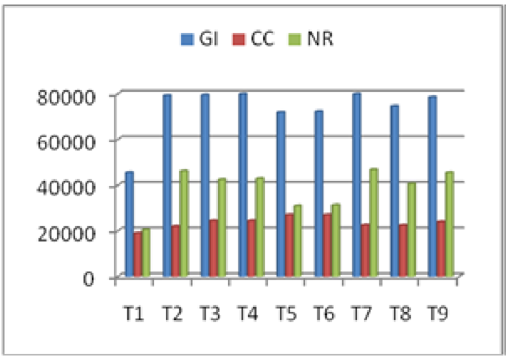

Figure 4c Gross income (Rs/ha), cost of Cultivation and Net return of Wheat in 2015-16

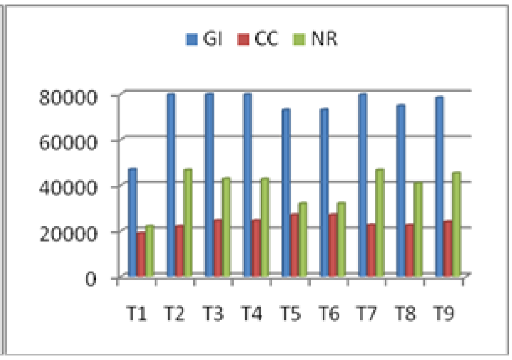

Figure 4d Gross income (Rs/ha), cost of cultivation and Net return of Wheat in 2016-17

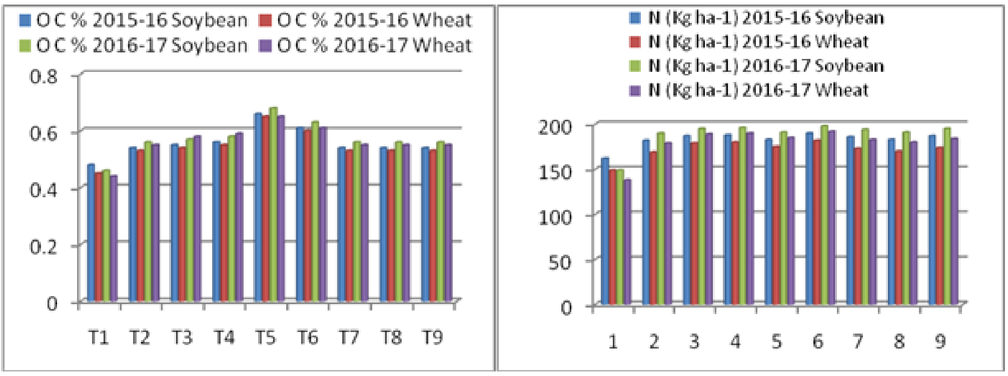

Figure 5 Effect of different nutrient management options on OC % and Available N (Kg ha^{-1}) after harvesting of Soybean and Wheat (2015-2017)

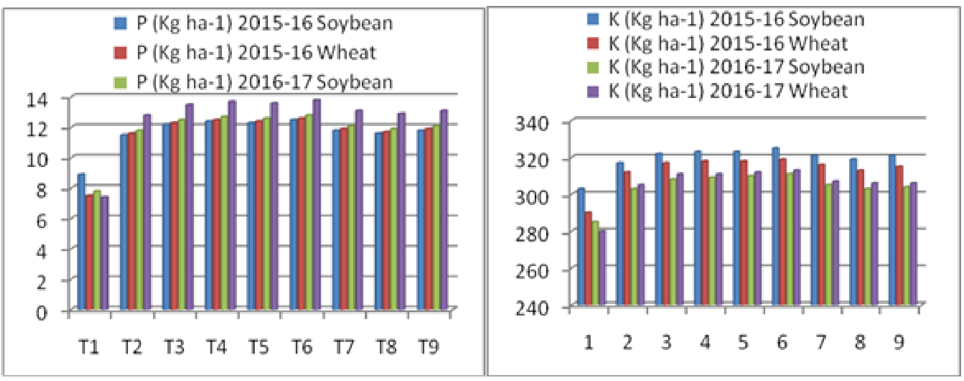

Figure 6b Effect of different nutrient management options on Available P (Kg ha-1) and Available K (Kg ha-1) after harvesting of Soybean and Wheat (2015-2017)

CONCLUSION

It may be concluded grain and straw yield of Soybean, wheat and System Productivity was highest recorded in treatment of 50%RDF+ 50% VC, followed by 50%RDF+ 50% FYM, 100% RDF + $ZnSO_4$, 100% N through VC,100% N through FYM. Average Gross Income, Cost of Cultivation, Net Return and benefit cost ratio (B:C) higher in the treatment of 100% RDF + Zn (First Year) and Available N.P.K higher in the treatment of 100% N through Vermi Compost followed by 50% RDF + 50% Vermi Compost and the significant impact of nutrient management improve system productivity and soil health.

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