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Effect of organic sources in combination with fertilizers on yield attributing characters, yield and economics of wheat (*Triticum aestivum*) in soybean-wheat cropping system in vindhyan plateau of Madhya Pradesh

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Abstract
The present investigation were conducted for two *rabi* seasons during 2014-15 and 2015-16 at a fixed site of farmers field Village Kakravada, Tehsil Ganj Basoda district Vidisha of Vindhyan Plateau of Madhya Pradesh to evaluate the effect of different organic sources (FYM, vermi-compost and poultry manure) in combinations with variable levels of optimal NPK on yield attributing characters, yield and economics of wheat in soybean-wheat cropping system. The results of the experiment indicated that the value of different attributes associated with 75 per cent optimal NPK coupled with application of poultry manure @ 5 t per ha was maximum plant height (cm), number of tillers and effective tillers per meter row length, length of ear head (cm), number of grains per spike, test weight (g), harvest index (%) and yield followed by 100 per cent optimal NPK. As compared with no fertilizer, the enhancement in grain yield 46.8 per cent and straw yield were 37.5 per cent by best treatment. However the minimum such yield and yield attributes were recorded in control. Thus, the combined use of different organic sources played a significant role in increasing grain, straw yields and economics of wheat.

Keywords: Yield attributing characters, fertilizers, organic sources, economics, soybean-wheat system

Introduction
Wheat (*Triticum aestivum* L.) has been described as "Staff of life or king of cereals" and one of the most important staple food crop. Wheat has its own outstanding importance as a human food, it is rich in carbohydrates and protein. Wheat is cultivated in at least 43 countries of the world. The leading countries in wheat cultivation are China, India, Thiland, Indonesia and U.S.A. and total production of wheat was 647 million tonnes under area of 218 million hectares with a productivity of 2960 kg/ha (FAO, 2012) [2]. Wheat is a dominant *rabi* cereal crop of central zone of India. It is producing about 93.50 million tonnes of wheat from an area of 30.23 million hectare with an average productivity of 3093 kg ha^{-1} in *P* 2015-16 (http://eands.dacnet.nic.in). Madhya Pradesh, which is one of the major wheat growing states, produces 1455 thousand tonnes of wheat from 5261 thousand hectares area with an average productivity of 2765 kg $ha^{-1}P$ in 2015-1 6(http://eands.dacnet.nic.in). Due to intensive cropping, where food grain production and fertilizer use run parallel, soil is degrading day by day with respect to soil fertility and productivity. This may be attributed to the minimum and extra removal of nutrient resources from the soil strata than they are replenished, so soil is becoming deficient in available nutrients. Since, agriculture becomes more intensive and chemical dependent, therefore soil toxicities and nutrient imbalance threaten sustainable production. So, we have to think about the cheap and easily available alternate source of nutrients, which not only supply the nutrients to the soil but also improve the physico-chemical properties of the soil. Thus, demand for fertilizers can be lowered by supplementing the nutrients through organic manures. In recent years due to unsuitable effect of chemical fertilizers on the soil, using of organic materials serves as a good and suitable source to supply soil food elements. In addition to supply nutrients, organic manures may improve the soil health, physico-chemical properties and biological conditions of the soil.

Judicious use of FYM with chemical fertilizers improves soil physical, chemical and biological properties and improves the crop productivity (Sharma *et al.* 2007) [9]. Application of organic manures may also improve availability of native nutrients in soil as well as the efficiency of applied fertilizers (Sawrup, 2010).

Material and Methods

Field experiment were conducted during *kharif* and *rabi* seasons of 2014-15 and 2015-16 at a fixed site of farmers field Village Kakravada, Tehsil Ganj Basoda district Vidisha of Vindhyan Plateau of Madhya Pradesh. The soil of experimental site was clay in texture with pH 7.58, organic carbon 0.56% and EC 0.14 dSm^{-1}. The available N, P_2O_5, K_2O and S contents were 252, 20.4, 360 and 16.22 kg per ha, respectively. The experiment was laid out in a randomized block design (RBD) with four replications and thirteen treatments encompassing graded doses of recommended doses of fertilizers and their combinations with different manures along with control *viz.*, T_1- Control, T_2- 50 % optimal NPK, T_3- 75 % optimal NPK, T_4- 100 % optimal NPK, T_5- 75 % optimal NPK + FYM @ 5 t/ha, T_6- 75 % optimal NPK + FYM @ 10 t/ha, T_7- 100% optimal NPK + FYM @ 5 t/ha, T_8- 75 % optimal NPK + vermicompost @ 2.5 t/ha, T_9- 75 % optimal NPK + vermicompost @5 t/ha, T_{10}-100% optimal NPK + vermicompost @ 2.5 t/ha, T_{11}-75 % optimal NPK + poultry manure @ 2.5 t/ha, T_{12}-75 % optimal NPK + poultry manure @5 t/ha,T_{13}-100% optimal NPK + poultry manure @ 2.5 t/ha (Table 1).The total rainfall received during the first (2014) and second (2015) year (June to October) of experimentation was 1239.4 and 678.4 mm, respectively. All the agronomic operations were carried out as per recommendations. The crop wheat (GW-366) was sown on 26th November 2014 and 22nd November 2015 and harvested on 20th March 2015 and 16th March, 2016 during the experimentations. The recommended dose of nutrients for wheat (120:80:40 kg N: P_2O_5:K_2O/ha) was applied as basal through urea, single super phosphate and murate of potash. The recommended dose of nutrient for soybean (20:60:20:20 kg N: P_2O_5:K_2O:S/ha), was also applied using the same nutrient carries. Full dose of phosphorus and potassium along with one third dose of nitrogen were applied as basal and the remaining dose of nitrogen was applied in two equal splits at the time of first and second irrigation to wheat. FYM, vermicompost and poultry manure were incorporated 15 days prior to sowing of soybean. The data on plant population, plant height, number of tillers, length of ear head, no of grains, test weight, harvest index and yields were recorded in different treatments and analyzed statistically (Panse and Sukhatme, 1978) [6] and pooled data for two years are utilized for presenting results. The economics of different treatments was also worked out and analyzed statistically. The prevailing cost of inputs and produce were used to perform economic evaluation of the treatments.

Result and Discussion

Different yield parameters were appreciably affected with the different treatment of integrated nutrient management. Application of 75 % optimal NPK + poultry manure @5 t/ha i.e. the treatment T_{12}, exerted its notable impact. The percent increase in plant height (cm) at 30DAS, 60 DAS and 90 DAS, number of tillers and effective tillers/mrl, length of ear head (cm), number of grains/ spike, test weight (g) and harvest index (%) were 22.3%, 15.6%, 21.3%, 18.6%, 19.6%, 16.9%, 9.8%, 7.5% and 7%, respectively over the 100% optimal NPK treatment T_4 (Table-1). This is might be due to the fact that addition of poultry manure in conjunction with all necessary all nutrients and their uptake by the wheat crop and as a resulted effect of higher dry matter accumulation and their translocation in plant parts favoured which growth and ultimately value of all yield parameters enhanced. These findings are in line with those reported by Singh, *et al.*, 2008 [10], Mubarak and Singh, 2011 [4] and Desai, *et al.*, 2015 [1].

The remarkable differences in grain and straw yield of wheat were also noted with different treatments of integrated nutrient management. The grain and straw yields increased with sole fertilization and combination of fertilizers with organic sources. However, in case of both the parameters, significant increase over other treatments was only noticed when vermicompost/poultry manure @ 5 t per ha with 75 per cent recommended dose of fertilizers or vermicompost /poultry @ 2.5 t with 100 per cent recommended dose of fertilizers or vermicompost @ 2.5 t per ha with 75 per cent recommended dose was incorporated. Maximum grain yield (5045 kg/ha) was recorded when poultry manure @ 5 t per ha was coupled with 75 per cent recommended dose of fertilizers, which was at par with application of poultry manure @ 2.5 t per ha with either 75 or 100 per cent of recommended dose of fertilizers. The combinations of poultry manure with 75 or 100 per cent of recommended dose were superior over combinations with vermicompost or FYM. This also brought out that 25 per cent of recommended dose can be shunned with coupling with poultry manure @ 5 t per ha. The magnitude of increase under the treatment T_{12}-75 % optimal NPK + poultry manure @5 t/ha was 27.% and 17.7%, respectively with respect to grain and straw yield as compared to the treatment T_4- 100% optimal NPK. Application organic sources in combination with fertilizer are known to increase the microbial activity, nutrient availability and improves soil physico-chemical environment in the soil for plant growth, the enhanced productivity was noticed in the combination treatments. Similar findings were observed by Pandey, *et al*., 2009 [5], Sepat.*et al.*, 2010 [8] and Desai, *et al.*, 2015 [1].

Highest net return of Rs. 62349 per hectare was recorded with application of 75 % optimal NPK + poultry manure @5 t/ha *i.e.* the treatment T_{12} and closely followed by 100% optimal NPK + poultry manure @ 2.5 t/ha i.e. the treatment T_{13} (Table-2). Treatment T_{12} gave an extra net profit of Rs.21358 per hectare over the treatment T_4 (100% optimal NPK) which was 34.3 percent higher. In the respect of benefit: cost ratio, the highest value (3.29) was recorded with the treatment T_{12}which was closely followed by the treatment T_{13}.However the lowest benefit: cost ratio (2.08) was recorded under the treatment T_1 due to low yield and higher cost of cultivation. Similar trend was also observed by Singh, *et al.*, 2008 [10], Sepat, *et al.*, 2010 [8] and Desai, *et al.*, 2015 [1].

Table 1: Effect of organic sources in combination with graded fertilizer levels on plant population, plant height, and number of tillers of wheat (Data pooled for two years)

Treatments	Plant Population (No/meter^2)	Plant height (cm)				No of Tillers/mrl	
		30 Das	60 Das	90 Das	At harvest	Total	Effective
Control	69.2	24.5	47.5	75.7	75.7	94.5	88.25
50 % optimal NPK	69.4	25.2	48.2	80.2	80.2	96.5	90.25
75 % optimal NPK	69.5	26.4	48.8	82.6	82.6	98.25	92.50
100 % optimal NPK	69.6	27.2	50.2	84.5	84.5	99.75	93.25
75 % optimal NPK + FYM @ 5 t/ha	69.7	28.3	51.4	91.2	91.2	101.50	95.25
75 % optimal NPK + FYM @ 10 t/ha	69.7	30.4	53.6	95.2	95.2	104.50	98.75
100% optimal NPK + FYM @ 5 t/ha	69.7	29.2	52.2	93.4	93.4	103.75	97.50
75 % optimal NPK + vermicompost @ 2.5 t/ha	69.8	31.2	54.3	97.8	97.8	106.50	100.25
75 % optimal NPK + vermicompost @5 t/ha	69.8	33.6	56.0	100.8	100.8	110.25	104.75
100% optimal NPK + vermicompost @ 2.5 t/ha	69.8	32.8	55.2	98.6	98.6	108.75	102.50
75 % optimal NPK + poultry manure @ 2.5 t/ha	69.9	34.0	57.4	102.2	102.2	114.75	108.25
75 % optimal NPK + poultry manure @5 t/ha	69.9	35.0	59.5	107.4	107.4	122.50	116.00
100% optimal NPK + poultry manure @ 2.5 t/ha	69.9	34.4	58.3	104.3	104.3	116.25	110.25
CD (P = 0.05)	NS	0.57	2.17	2.20	2.20	6.25	7.60

Table 2: Effect of organic sources in combination with graded fertilizer levels on length of ear head, no of grains, test weight, grain and straw yields, harvest index and economic viability of wheat (Data pooled for two years)

Treatments	Length of ear-head (cm)	No of grains spike^{-1}	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)	Net Return (Rs/ha)	B:C ratio`
Control	8.2	40.2	42.03	2685	4350	38.17	25475	2.08
50 % optimal NPK	8.4	41.4	42.75	3040	4864	38.46	31128	2.28
75 % optimal NPK	8.6	42.5	43.10	3315	5238	38.75	35501	2.42
100 % optimal NPK	8.8	43.1	43.65	3675	5733	39.06	40991	2.60
75 % optimal NPK + FYM @ 5 t/ha	9.0	44.2	43.95	4045	6229	39.37	45883	2.68
75 % optimal NPK + FYM @ 10 t/ha	9.4	45.1	44.50	4280	6420	40.00	49140	2.76
100% optimal NPK + FYM @ 5 t/ha	9.2	44.6	44.25	4160	6323	39.68	47446	2.72
75 % optimal NPK + vermicompost @ 2.5 t/ha	9.6	45.9	44.95	4320	6394	40.32	49838	2.80
75 % optimal NPK + vermicompost @5 t/ha	10.0	46.4	45.85	4560	6566	40.99	53282	2.89
100% optimal NPK + vermicompost @ 2.5 t/ha	9.8	46.1	45.25	4480	6541	40.64	52182	2.86
75 % optimal NPK + poultry manure @ 2.5 t/ha	10.2	46.9	46.20	4675	6639	41.32	56903	3.14
75 % optimal NPK + poultry manure @5 t/ha	10.6	47.8	47.20	5045	6962	42.02	62349	3.29
100% optimal NPK + poultry manure @ 2.5 t/ha	10.4	47.2	46.75	4865	6811	41.67	59747	3.22
CD (P = 0.05)	0.30	3.86	0.90	152	276	0.39	2537	0.08

Conclusion

The study suggested that combined application of fertilizers with organic sources leads to better performance of wheat than non application of nutrients. Higher yields and monetary returns can be achieved by combining poultry manure, vermicompost and FYM in that order. The treatment combination poultry manure @ 5 t per ha with 75 per cent optimal NPK (T_{12}) followed by 2.5 t per ha poultry manure with 100 per cent optimal NPK (T_{13}) proved to be best for higher yield and monetary returns.

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