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Impact of composts and zinc sulphate with and without bio fertilizers on productivity and quality of wheat (*Triticum aestivum* L.)

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Abstract
The present experiment was conducted during the *Rabi* season of 2018-19 at Crop Research Center (CRC), school of Agriculture, ITM University Gwalior, Madhya Pradesh to evaluated the combined effect of compost (Nadep & vermicompost), zinc sulphate with and without bio fertilizers applied along with inorganic NPK. The experiment was laid out in Randomized Block Design with three replications. Results revealed that the application of inorganic NPK either with 10 t Nadep compost or 05 t Vermicompost or 25 kg $ZnSO_4$ ha^{-1} recorded higher growth and yield attributes parameters of wheat. The maximum grain yield (44.16 q ha^{-1}) noted with NPK+ 5t Vermicompost + Azotobacter & PSB closely followed by NPK + 25 kg $ZnSo_4$ + Azotobacter & PSB treatment. Maximum protein content (11.54%) was found with NPK + 5t V C ha^{-1} + Azotobacter & PSB which were statistically at par with all other treatments except inorganic NPK as well as control. The maximum benefit cost ratio of 3.30 was observed with NPK + 25 kg $ZnSo_4$ followed by NPK + 25 kg $ZnSo_4$+ Azotobacter & PSB treatment.

Keywords: Azotobacter, Nadep Compost, PSB, Vermicompost, Wheat and $ZnSo_4$

Introduction
Wheat (*Triticum aestivum*) is a staple food of millions of people therefore this crop of global significance and it is grown in diversified environments. Approximately one-sixth of the total arable land in the world is cultivated with wheat. In India it grown in diverse agro-climatic conditions from 11°N - 35°N latitude and 72°E- 92°E longitudes. its productivity has played a key role in making the country self-sufficient in food grains. The continuous use of NPK fertilizers has remarkably increased production but simultaneously brought about problems related to secondary and micronutrient deficiencies, particularly those of sulphur and zinc in soils. Sulphur performs many physiological functions like synthesis of sulphur containing amino acids which have a positive role in improving quality of grains. Zinc is also an important micronutrient reported deficient in Indian's soils and plays a significant role in various enzymatic and physiological activities of plant bodies. Application of organic manures may also help to check the emerging deficiency of nutrients other than N, P and K. Further, it brings economy and efficiency in fertilizers. Judicious use of farm yard manure (FYM) or vermicompost with chemical fertilizers improves soil physical, chemical and biological properties and improves crop productivity (Sharma *et al*, 2007) [9]. The application of bio-fertilizer increased the efficiency of both organic and mineral fertilizer but alone was ineffective in increasing yield. Thus, bio-fertilizers could be used as value-added soil amendments by supplementing organic and low chemical fertilizer rates for improving soil fertility and sustaining crop productivity (Abbasi and Yousra, 2012) [1]. Wheat crop require more nutrients due to exhaustive nature and have posed a great threat to long term sustainability of higher production. The goal of sustainable production can be achieved without any alteration in soil health and productivity of crop by combined application of farm organic manure, chemical fertilizers and bio-fertilizers. Keeping all above views the present experiments was planned.

Materials and Methods
The experiment was laid out at Crop Research Center (CRC), school of Agriculture, ITM University Gwalior (Madhya Pradesh), during *Rabi* season of 2018-19. The experiment was laid out in Randomized Block Design (RBD) having three replications.

The experiment consists of eight treatments *viz*., T_1: - Absolute Control, T_2: NPK, T_3: NPK + Compost, T_4: NPK + Vermicompost, T_5: NPK + $ZnSo_4$, T_6: NPK + Compost +Azotobacter & PSB, T_7: NPK + Vermicompost + Azotobacter & PSB and T_8: NPK + $ZnSo_4$ + Azotobacter & PSB. The field soil was sandy loam having PH 7.64 and 0.40% organic carbon content with medium fertility status of available P and K status. In manure treatments Nadeep compost and vermicompost were applied before field preparation or before sowing of crop as per treatments. Biofetilizer (*Azotobacter* & *PSB*) was applied @ 5 kg /ha as per treatments with Nadeep compost and vermicompost. In some treatments $ZnSO_4$ @ 25 kg ha^{-1} was also applied as basal. Recommended dose of fertilizers were applied at the rate of 120: 60: 40 kg ha^{-1} as 100% NPK. Half of nitrogen and full dose of phosphorus and potash were applied at the time of sowing as per treatment combination. The remaining nitrogen as per treatment was top dressed after first irrigation. N, P, and K were applied through urea, DAP and muriate of potash respectively. Wheat seed (variety: Lok-1) was sown at the rate of 100 kg ha^{-1} on 28 November, 2018. Seeds were sown in open furrows at 3-4 cm depth and uniform distance of 20 cm between row to row and 05 cm between plant to plant was maintained. Protein content in wheat grain was determined by standard procedures. The treatment comparisons were made using t-test at 5% level of significance. The economics was calculated on the basis of prevailing local market price of wheat grains and cost of inputs.

Results and Discussion

Effect on growth and yield attributes

Integrated use of inorganic fertilizers with either compost i.e. Nadep and vermin or with zinc sulphate increased the plant height, number of effective tillers, spike length, grains $spike^{-1}$, grain weight of spike (g) and the test weight. The enhanced early vegetative growth in terms of height, dry matter accumulation and vigorous root system resulted in more spikes which consequently increased the number of spike bearing tillers significantly. Number of spike m^{-2} area produced by the application of 100 per cent RDF along with nadep compost 10 t ha^{-1} + Azoto +PSB (571.8 spike m^{-2}) or vermi compost 5 t ha^{-1} + Azoto (566.8 spike m^{-2}) were found to be the highest and the lowest from control (296.2 spike m^{-2}). It might be due to stimulated vegetative growth of wheat on account of adequate and prolonged supply of essential nutrients. The probable reason may be that adequate supply of all the nutrients, resulted in greater accumulation of carbohydrates, amino acids and their translocation to the productive organs, which, in-turn improved all the growth and yield attributing characters. Results confirm the finding of Tripathi and Kumar (2007) and Faujdar and Sharma (2013) [5]. Similarly, the number of effective tillers $plant^{-1}$, grains $spike^{-1}$, grain weight of spike and test weight produced by the application 100 per cent RDF + 5t vermicompost or 100 per cent RDF + 10 t nadep compost ha^{-1} or 25 kg $ZnSO_4$ were found to be significantly higher than the other treatments and the lowest from the control. Afzal *et al.* (2005) [3] also reported that organic manures with other combinations significantly increased the number of tillers m^{-2}. These results are in confirmatory with the findings of Kaushik *et al*. (2006) [6] and Rather and Sharma (2009) [7].

Effect on yield

Addition of either compost (Naded or vermicompost) or $ZnSO_4$ with or without Azotobacter + PSB together with 100% NPK levels produced significantly higher grain and straw yields than the application of 100% NPK alone (Table 2). Maximum grain yield (44.16 q ha^{-1}) and harvest index (42.60%) were obtained with the application of 100% NPK+ vermicompost @ 5 t ha^{-1}+ Azotobacter.+ PSB. The lowest grain yield (21.72 q ha-') and harvest index (37.10%) were recorded from control. The increase in grain and biological yield might be due to adequate quantities and balanced proportions of plant nutrients supplied to the crop as per need during the growth period resulting in favourable increase in yield attributing characters which ultimately led towards an increase in economic yield. Improved physico-chemical properties of the soil through the application of organic manure might be the other possible reason for higher productivity. The findings confirm the results of Devi *et al.* (2011) [4]. Supplemental application of Nadep compost (@ 10 t ha^{-1}) or vermicompost (@ 5 t ha^{-1}) or 25 kg $ZnSO_4$ with 100 per cent NPK noticed significantly higher grain yield over 100 per cent NPK treatments. The probable reason may be that the addition of Nadep compost or Vermicompost or $ZnSO_4$ provided adequate balanced quantity of sulphur and micronutrients to the plant which resulted in greater accumulation of carbohydrates, protein and their translocation to the productive organs, which in turn, improved all growth and yield attributing characters, The findings confirm the results of Singh and Pathak (2003) [11] and Shekhwat *et al.* (2004) [10].

Effect on quality parameters

It is evident from result that application of either compost or zinc sulphate increased the protein content as compared to NPK alone as inorganic fertilizers. Maximum content (11.54%) was observed with T_7 (NPK + 5t Vermicompost ha^{-1} + Azotobacter & PSB) which was statistically at par with all the treatments except NPK and control treatments. Higher N content in these two treatments is result of increased availability of nitrogen due to adequate and balanced supply, results are in line of well established fact that liberal N supply to the crops helps in increasing protein content. The results are quite in line with Abedi *et al.* (2010) [2] concluded that grain protein contents responded to organic and inorganic fertilizer application.

The application of organic manure (compost/vermicompost) or zinc sulphate with 100% NPK recorded significantly higher protein yield as compared to 100% NPK alone as inorganic fertilizers treatment. This might be due to Zn contributed in photosynthesis, chlorophyll, metabolism of starch formation and enzyme carbonic anhydrate accelerating carbohydrate formation, the maximum requirements Zn were enough to accumulate suitable carbohydrate contents. It also activate glutamic dehydrogenase enzyme, synthesis of RNA and DNA enhancing gliadin and glutenin content, which are main protein components of gluten accumulated in the later stages of grain filling. The results are in conformity with the findings of Seadh *et al*. (2009) [8].

Economics

The results reported in foregoing pages revealed that the net return and benefit: cost ratio increased with supplementation of Nadep compost (@ 10 t ha^{-1}) or vermicompost (@ 5 t ha^{-1}) with 100 per cent NPK. The maximum net return of Rs.68079 ha^{-1} was recorded under T_8 (NPK + 25 kg $ZnSo_4$+ Azotobacter & PSB) followed by T_5 (NPK + 25 kg $ZnSo_4$)

with Rs. 67228 ha^{-1}. However, the maximum benefit cost ratio of 3.30 was recorded with T_5 (RDF + 25 kg $ZnSo_4$) treatment followed by T_8 (NPK + 25 kg $ZnSo_4$+ Azotobacter & PSB) with 3.25 B: C ratio.

The net returns and benefits cost ratio was higher in $ZnSO_4$ applied treatment as compared to compost applied treatments due to low cost $ZnSO_4$ as compared to compost or vermin-compost. The net returns and benefits obtained were lowest in vermicompost due to the high cost of vermicompost (Rs. 2000 t^{-1}). These results are similar to yield of crop obtained from different treatments and confirm to the findings of Rather and Sharma (2009) [7] and Singh and Singh (2012) [12].

Table 1: Growth and yield attributes parameters of wheat as influenced by different treatments.

Treatments Number	Treatments	Growth parameters		Yield attributes parameters			
		Plant height (cm)	Number of tillers $plant^{-1}$	Number of spike m^{-2}	Length of spike (cm)	Number of grains $spike^{-1}$	Test weight (g)
T_1	Control	77.87	9.40	296.2	7.92	32.87	34.96
T_2	NPK (120:60:40 kg ha^{-1})	93.70	12.78	455.9	9.13	39.00	38.82
T_3	NPK + Compost (10t ha^{-1})	100.02	14.55	527.4	10.11	43.18	41.99
T_4	NPK + Vermicompost (5t ha^{-1})	100.74	14.05	518.0	10.34	44.14	42.32
T_5	NPK + $ZnSo_4$ (25 kg ha^{-1})	103.82	14.57	513.6	10.13	43.39	42.05
T_6	NPK + Compost (10t ha^{-1}) + Azotobacter & PSB	105.29	14.84	571.8	10.80	46.12	42.80
T_7	NPK + Vermicompost (5t ha^{-1}) + Azotobacter & PSB	107.15	15.22	566.8	11.01	46.09	42.66
T_8	NPK + $ZnSo_4$ (25 kg ha^{-1}) + Azotobacter & PSB	107.88	14.97	547.0	11.06	46.29	42.27
C.D. at 5%		5.13	1.03	37.9	0.58	2.05	2.33

Table 2: Yield, quality and economical parameters of wheat as influenced by different treatments

Tr. No.	Treatments	Yield parameters			Quality parameters		Economical parameters		
		Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	Protein content (%)	Protein yield (q ha^{-1})	Gross income* Rs ha^{-1}	Net Income (Rs ha^{-1})	B:C Ratio
T_1	Control	21.72	38.39	37.10	9.51	2.07	51420	28721	2.27
T_2	NPK (120:60:40 kg ha^{-1})	38.09	66.66	40.11	10.52	4.01	89999	61717	3.18
T_3	NPK + Compost (10t ha^{-1})	42.79	55.95	41.93	11.26	4.82	96372	63089	2.90
T_4	NPK + Vermicompost (5t ha^{-1})	43.15	52.97	41.82	11.39	4.91	96315	58033	2.52
T_5	NPK + $ZnSo_4$ (25 kg ha^{-1})	43.33	52.38	41.91	11.28	4.89	96511	67228	3.30
T_6	NPK + Compost (10t ha^{-1}) + Azotobacter & PSB	43.89	62.02	42.46	11.40	5.01	100009	65727	2.92
T_7	NPK + Vermicompost (5t ha^{-1}) + Azotobacter & PSB	44.16	56.13	42.60	11.54	5.09	99052	59770	2.52
T_8	NPK + $ZnSo_4$ (25 kg ha^{-1})+ Azotobacter & PSB	44.04	54.28	42.34	11.45	5.04	98361	68079	3.25
C.D. at 5%		3.71	3.84	1.50	0.75	0.53	-	-	-

- On the basis of wheat grain @ 1925 q^{-1} and straw @ 250 q^{-1}

Conclusion

From the present study it can be concluded, that application of 100 per cent RDF (120: 60: 40:: N:P:K kg ha^{-1}) along with 25 kg zinc sulphate alone or with bio fertilizers (*Azotobacter* & PSB) may be beneficial in terms of good quality higher grain yield of wheat at economically point of view in sandy loam soils of Gwalior district.

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