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Effect of Integrated nutrient management on productivity and quality of wheat (*Triticum aestivum* L.)

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Abstract

A field experiment was conducted at experimental farm, Agriculture Research and Development Centre, Gwalior (Madhya Pradesh), during *Rabi* season of 2025-26 on sandy clay loam soil to study the Integrated nutrient management on productivity and quality of wheat (*Triticum aestivum* L.). The experiment was laid out in randomized block design which consisting of nine treatments of INM component with three replications. The maximum grain yield ($4385.5 \text{ kg ha}^{-1}$) recorded with treatment T_5 (75% NPK + *Azotobacter* + PSB + Vermicompost @2.5t/ha) closely followed 75% NPK + *Azotobacter* + PSB + FYM @5t/ha and 100% NPK + 25 kg ZnSO_4/ha treatments with 4197.2 4312.0 and 4245.6 kg ha^{-1} grain yield. Integration of bio-fertilizer (*Azotobacter* + PSB), organic manure (FYM / Vermicompost) along with chemical fertilizer (75% RDF) recorded significantly higher protein content and its yield as compared to only 100% chemical fertilizers treatment. The maximum gross and net income was recorded under T_5 (75% NPK + *Azotobacter* + PSB + Vermicompost @2.5t/ha) followed by 75% NPK + *Azotobacter* + PSB + FYM @5t/ha and minimum under control treatment.

Keywords: *Azotobacter*, PSB, NPK, FYM, Vermicompos and ZnSO_4

Introduction

Wheat (*Triticum aestivum* L.) is the second important staple food crop of the world after rice and cultivated in almost all countries; In the world, wheat is grown in China, India, Thailand, Indonesia and U.S.A. with an area of 228.88 million hectares and produced 788.95 million tonnes with an average productivity of 3.5 tonnes per hectare. 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 grain. This crop occupies an area of about area of 31.23 million hectares and produced annually 112.92 million tones with the productivity of 3615 kg/ha during 2023-24 (DOR, 2024). Higher food production needs a balance amount of plant nutrients which is the key component because chemical fertilizers can cause yield loss and lower crop quality as a result of both under and over fertilization and decreasing use efficiency. Either chemical fertilizers or organic manures alone cannot supply the nutrients as desire quantity during the crop-growing season and sustain the crop production. Integrated nutrient management strives to improve the physical, chemical, and biological health of the soil and increases the availability of both applied and native soil nutrients. By encouraging carbon sequestration and limiting the loss of nutrients to atmosphere through different gases and the water bodies by leaching, this serves to slow down the deterioration of soil and the quality of water and the environment. It is also becoming clear that high yielding wheat cultivars and NPK fertiliser cannot be fully utilised without the administration of micronutrients. The availability of certain mineral nutrients that are vital to the completion of a plant's life cycle determines the plant's growth and production. Organic manures and bio fertilizers which are important components of integrated nutrient management (INM) not only supply macronutrients but also increasing the nutrient use efficiency through improving soil health. Boosting yield, reducing production cost and improving soil health are three inter-linked components of the sustainability triangle (Singh *et al.*, 2019) ^[11]. Keeping in view the present study was carried out with INM practices.

Materials and Methods

The field experiment was conducted at experimental Agriculture Research and Development Centre, Gwalior (Madhya Pradesh), during *Rabi* season of 2025-26. The soil was sandy clay loam that contained 4.25 g kg⁻¹ organic carbon, 187.2 kg ha⁻¹ N, 13.2 kg ha⁻¹ available phosphorus and 208.6 kg ha⁻¹ available K with pH 7.88. The experiment was laid out in randomized block design which consisting of nine treatments of INM component with three replications. The crop was sown in the last week of November, using the variety DBW-322 and harvested on second week of April. The recommended dose of fertilizers (RDF) for wheat is 120 kg N and 60 kg P and 40 kg K ha⁻¹. The full dose of phosphorus, potassium and half dose of nitrogen were given below the seed at the time of sowing as basal. Whereas, the remaining half dose of nitrogen was top-dressed after first and second irrigation. In manure treatments FYM and vermicompost were applied at field preparation of before sowing and *Azotobacter* and PSB was used as seed treatments @ 10 g kg⁻¹ seed as per treatments. Weeds were kept under control by using weedicide after first irrigation. Yield parameters were recorded at harvest and harvest index was computed with the ratio of economic yield to the total biological yield. Economical parameters were calculated by appropriate formula as per current market rates.

Results and Discussion

Effect of integrated nutrient management on growth and yield attributes parameters

It is clear from results that integration of organic manures, bio fertilizers and inorganic fertilizers produced significantly higher

value of growth and yield attributes parameters as compared to control and only inorganic fertilizer applied treatment. At maturity, maximum plant height, number of tillers were observed with 75% NPK + *Azoto* + PSB + Vermicompost @2.5t/ha was comparable with 100% NPK + 25 kg ZnSO₄/ha and 75% NPK + *Azoto* + PSB + FYM @5t/ha and these treatments produced significantly higher values over 100% NPK alone treatment. The longest spike (10.36 cm), maximum grains (30.04 spike⁻¹) and test weight (40.35 g) were noted in T₅ (75% NPK + *Azoto* + PSB + Vermicompost @2.5t/ha) being at par with T₇ (75% NPK + *Azoto* + PSB + FYM @5t/ha) but and these treatments show significantly higher value over 100% NPK treatment. 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 Karki *et al.* (2005) [4], Tripathi and Kumar (2007) [13] and Faujdar and Sharma (2013) [3].

Effect of integrated nutrient management on yield parameters

Under present study, Grain yield varied from 2482.7 to 4385.5 kg ha⁻¹ under different treatments and the magnitude of increase in yield due to treatments was 56.59 to 76.64 per cent over control treatment (Table-2). The maximum grain yield (4385.5 kg ha⁻¹) recorded with treatment T₅ (75% NPK + *Azoto* + PSB + Vermicompost @2.5t/ha) closely followed 75% NPK + *Azoto* + PSB + FYM @5t/ha and 100% NPK + 25 kg ZnSO₄/ha treatments with 4312.0 and 4245.6 kg ha⁻¹ grain yield.

Table 1: Effect of different treatments on growth and yield attributes parameters at harvest of wheat

Tr. No.	Treatments	Growth parameters		Yield attributes parameters		
		Length (cm)	Number of tillers plant ⁻¹	Length of spike (cm)	Number of grains spike ⁻¹	Test weight (g)
T ₁	100% NPK (120: 60: 40 kg ha ⁻¹)	102.11	16.94	9.45	27.26	37.68
T ₂	50% NPK + <i>Azotobacter</i> + PSB	99.84	13.62	8.12	26.02	36.92
T ₃	75% NPK + <i>Azotobacter</i> + PSB	100.19	14.05	8.75	26.44	37.07
T ₄	50% NPK + <i>Azotobacter</i> + PSB + Vermicompost @2.5t/ha	102.83	16.40	8.97	27.68	38.41
T ₅	75% NPK + <i>Azotobacter</i> + PSB + Vermicompost @2.5t/ha	107.24	18.20	10.36	30.04	40.35
T ₆	50% NPK + <i>Azotobacter</i> + PSB + FYM @5t/ha	101.23	16.59	8.88	28.02	38.28
T ₇	75% NPK + <i>Azotobacter</i> + PSB + FYM @5t/ha	106.04	18.08	10.16	29.92	40.15
T ₈	100% NPK (120: 60: 40 kg ha ⁻¹) + 25 kg ZnSO ₄ /ha	106.18	17.86	10.12	29.42	40.17
T ₉	Control	93.94	11.32	7.14	22.88	36.72
	S. Em. (±)	1.57	0.44	0.15	0.44	0.48
	C.D. at 5%	4.59	1.33	0.44	1.31	1.43

It is revealed from results that integration of bio-fertilizer (*Azotobacter* + PSB), organic manure (FYM / Vermicompost) along with chemical fertilizer (75% RDF) recorded significantly higher grain yield as compared to only 100% chemical fertilizers treatment (Fig.-1) The increase in grain yield with combined application of organic manure (Either vermicompost or FYM), bio fertilizers (*Azotobacter* + PSB) with 75% NPK as inorganic fertilizers might be due to adequate quantities and balanced proportions of all the essential 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. On the other hand improved physico-chemical properties of the soil through the application of organic manure and supply micronutrients to plants might be the other possible reason for higher productivity. The findings confirm the results of Ram and Mir (2006) [6], Mahapatra *et al.* (2007) [5], Devi *et al.* (2011) [1] and Sanjiv kumar (2014).

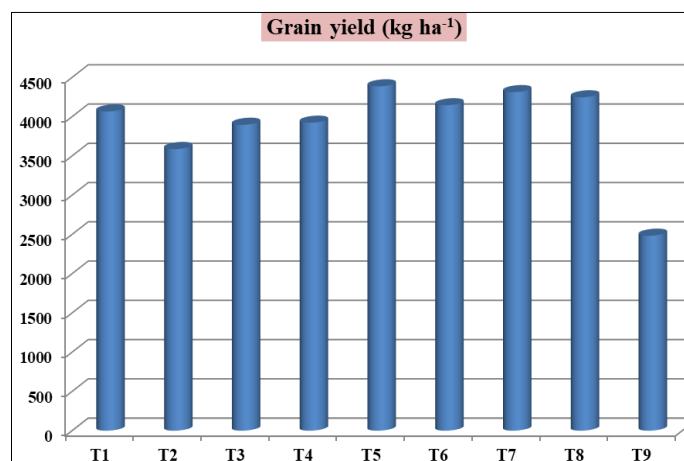


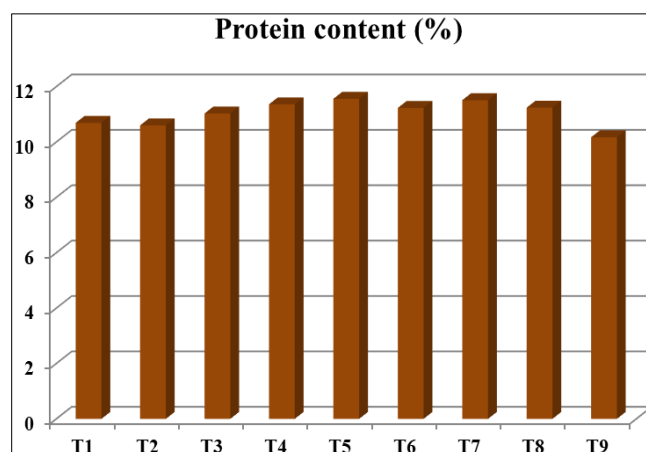
Fig 1: Grain yield under different INM treatments

Table 2: Effect of different INM treatments on yield, quality and economical parameters of wheat

Tr. No.	Treatments	Yield parameters			Quality parameters		Economical parameters(Rs ha ⁻¹)			B:C ratio
		Grain Yield (kg ha ⁻¹)	Straw Yield (kg ha ⁻¹)	Harvest index (%)	Protein content (%)	protein yield (kg ha ⁻¹)	Cost of cultivation	Gross return	Net return	
T ₁	100% NPK (120: 60: 40 kg ha ⁻¹)	4065.2	5189.1	43.93	10.69	434.57	41042	129955	88913	3.17
T ₂	50% NPK + <i>Azoto</i> + <i>PSB</i>	3587.6	4873.4	42.40	10.60	380.29	37646	115716	78070	3.07
T ₃	75% NPK + <i>Azoto</i> + <i>PSB</i>	3896.0	4916.7	44.21	11.03	429.73	39495	124348	84853	3.15
T ₄	50% NPK + <i>Azoto</i> + <i>PSB</i> + Vermicompost @2.5t/ha	3922.4	5040.3	43.76	11.36	445.58	45146	125507	80361	2.78
T ₅	75% NPK + <i>Azoto</i> + <i>PSB</i> +Vermicompost @2.5t/ha	4385.5	5134.9	46.06	11.56	506.96	46995	138573	91578	2.95
T ₆	50% NPK + <i>Azoto</i> + <i>PSB</i> + FYM @5t/ha	4144.5	4964.0	45.50	11.23	465.43	40646	131348	90702	3.23
T ₇	75% NPK + <i>Azoto</i> + <i>PSB</i> + FYM @5t/ha	4312.0	5158.7	45.53	11.51	496.31	42495	136635	94140	3.22
T ₈	100% NPK + 25 kg ZnSO ₄ /ha	4245.6	5331.2	44.33	11.24	477.21	42542	135413	92871	3.18
T ₉	Control	2482.7	3660.2	40.42	10.17	252.49	33650	81085	47435	2.41
	S. Em. (±)	43.7	86.0	0.42	0.13	6.61	-	-	-	-
	C.D. at 5%	128.2	252.4	1.23	0.38	19.40	-	-	-	-

Effect of integrated nutrient management on quality parameters

Results on quality parameters (Fig.-2), revealed that protein content ranged from 10.17 to 11.56 per cent under different treatment. Maximum protein content (11.56 per cent) was observed under T₅ (75% NPK + *Azoto* + *PSB* +Vermicompost @2.5t/ha) closely followed by 75% NPK + *Azotobacter* + *PSB* + FYM @5 t/ha with 11.51% value. It is clear from results that application of organic manure (FYM/VC) along with bio fertilizer (*Azotobacter* & *PSB*) with 75% NPK recorded significantly higher as protein content and protein yield as compared to 100% NPK alone treatment. This might be due to that application of FYM or Vermicompost supplied Zn and *Azotobacter* increased N-metabolism, which enhanced accumulation of amino acids and drastically increased the rate of protein synthesis and consequently, protein content in grain. FYM or Vermicompost application in soil enhanced the Zn concentration in the plant which associated with RNA and ribosome induction the result of which accelerates protein synthesis (Sharma *et al.*, 2013) [9].

**Fig 2:** Protein content (%) under different INM treatments

Effect of integrated nutrient management on economical parameters

The maximum gross (Rs.138573 ha⁻¹) and net (Rs. 91578 ha⁻¹) income was recorded under T₅ (75% NPK + *Azoto* + *PSB* +Vermicompost @2.5t/ha) followed by 75% NPK + *Azotobacter* + *PSB* + FYM @5t/ha and minimum under control treatment. The integration of bio-fertilizer (*Azoto* + *PSB*), organic manure (FYM / Vermicompost) along with chemical fertilizer applied treatments gave more benefit cost ratio over control treatment.

Maximum benefit cost ratio of 3.23 was recorded with T₆ (50% NPK + *Azotobacter* + *PSB* + FYM @5t/ha) treatment closely followed by T₇ (75% NPK + *Azotobacter* + *PSB* + FYM @5t/ha) and T₈ (100% NPK + 25 kg ZnSO₄/ha) with B:C ratio of 3.22 and 3.18. Minimum B: C ratio (2.41) was obtained in control treatment. 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) [10]. The net returns and benefits obtained were lowest in vermicompost applying treatments due to the high production cost of vermicompost (Rs. 2000 t⁻¹). The additional cost of organic manures (FYM) was compensated by the additional yield of wheat. Integrated application of NPK fertilizers along with FYM and *Azotobacter* in field crops not only influences growth and production of plant but at the same time also reduces the production budget (Suthar, 2006) [12].

Conclusion

From the present study it can be concluded, that application of 75% NPK+ *Azotobacter* + *PSB* along with either 2.5 t Vermicompost or 5.0 t FYM ha⁻¹ (depends on availability) produced higher economic and qualitative yield of wheat which gave more return under sandy clay loam soils of Northern Madhya Pradesh.

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