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Integrated Nutrient Management Approach on Wheat (*Triticum aestivum* L.) in Vertisols

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A B S T R A C T

The present investigation entitled "Integrated nutrient management approach on wheat (*Trilicum aestivum* L.) in vertisols" was carried out with the objective to evaluate the effective nutrient management for maximizing productivity of wheat. A field experiment was conducted during winter season of 2006-07 at College of Agriculture, Indore. The soil of the experimental field was sandy clay loam, slightly alkaline in reaction analyzing low in organic carbon available P, S and Zn as well as medium in available N and K contents. A set of ten treatments of nutrient management were tested in a randomized block design with four replications. The wheat variety Hl-8498 (Malwa Shakti) was sown on November 21, 2008 by drilling the seeds in rows at 28.5 cm apart. The crop was given N, P, K, S, Zn, B and Mn nutrient as per treatments through urea, single super phosphate, murate of potash, zinc sulphate, Borax and ammonium, manganese, respectively. In addition to these nutrients, farmyard manure and Azotobacter in respective treatments were also given with recommended dose of NPK. Five irrigations were given at different critical stages of the crop. Weed control was adopted for all the treatments and there were need of any plant production measures. The observations on growth parameters (plant height, number tillers/m row length, leaf area index, yield attributes (viz. effective tillers/m row length, characteristic of earhead, 1000-grain weight) and grain as well as straw yields were recorded. Nutrient (NPK) content and their uptake in grain and straw were also analyzed under all the treatments. The economic analysis (cost of cultivation, gross and net monetary returns and profitability of the treatments) on per hectare basis was circulated. After harvest of the crop soil samples from each plot were taken and analyzed to know the changes in chemical properties of the post-harvest soil. Finally, the data were statistically analyzed.

Introduction

In India during the past 3 decades intensive agriculture involving exhaustive high-yielding varieties of cereals has led to heavy withdrawal of nutrients from the soil. The concept of integrated nutrient management has been found to be quite promising not only in maintaining higher productivity but also in providing greater stability in crop production (Nambiar and Abrol, 1992). Wheat is a cereal crop of the Graminea family and of the genus Tribcum and its edible grain one of the oldest and most important of the cereal crops. During the last 4 decades with the release of high yielding varieties wheat has attained immense significance in terms of increase in area production and productivity. Today the area under wheat is 26.8 m hectare with the production potential of 6.93 m tones and productivity was 2586 kg/ha in 2005-06. The area under wheat in Madhya Pradesh was 3.68 m/ha with the production of 6.04 m. tones and the productivity of 1638 kg/ha (CMIE 2007).

Area under cultivation of Wheat cannot be stretched beyond certain limits only possibility is the maximization of production per unit area per unit time and maintenance of soil fertility. Wheat is nutrient exhaustive and had resulted in decline of soil organic carbon and deteriorating soil health in general for sustainability of the system well as the overall soil health, organic sources play an important role. Incorporation of organic manures and micro nutrients in combination with inorganic fertilizers improves the productivity of wheat, ameliorates and sustains soil health and also economize fertilizers gave higher yield, owing to adequate availability of nutrients (Mundra *et al.,* 2003). To curb this trend of declining yield, there is a need to adopt the concept of integrated nutrient management. The appropriate combination of mineral fertilizer, organic manures, compost or biofertilizers along with incorporation of micronutrients can be feasible and viable to sustain agriculture as a commercial and profitable means ensuring high – yield of crop without deterioration in quality of the produce. Now days the soils of the region are deficient in major and micronutrients this situation arises through the indiscriminate use of chemical fertilizers. That ultimately reduced the yield. To overcome the problem, it is essential to use integrated nutrient management system in these areas. Looking to these facts, the study was conducted to evaluate the use of chemical fertilizer comprising of recommended dose with micro nutrients and inoculants entitled Study of integrated nutrient management on productivity of wheat with the following objectives: To study the effect of nutrient management on growth, yield attributes and yields of wheat crop, To study the effect of nutrient management on chemical composition of seed and plant, To monitoring the changes in soil fertility due to different nutrient management practices and To work out economics of the treatments under study.

Materials and Methods

The present experiment was laid out in the field no. 2 of Research farm, J.N. Krishi Vishwa Vidyalaya, College of Agriculture, Indore during Rabi 2006-07. Indore is situated in Malwa plateau in the western M.P. at an altitude of 555.7 meters above mean sea level (MSL). The rainfall in the region is mostly inadequate and erratic. The average rain is 733 mm and it was below normal (803 mm) in 2006. Representative soil sample were collected from the experimental field soil samples were taken randomly with the help of auger up to a depth of 10-30 cm after the land preparation but prior to sowing wheat.

Details of treatments

The details of treatments presented below: It is the leaf area per unit land and is more important than leaf area of individual plants from crop production point of view. Leaf area index is the ratio between leaf area and ground area and is estimated as below.

$$LAI = \frac{Axn}{P}$$

Where

A = Leaf Area (in square meter)
n = number of plants (in square meter)
P = Ground Area (in square meter)

Observational plants having proper label were removed from the field before harvesting the crop from net plot area. These plants were brought to the laboratory for post-harvest studies. Following parameters were noted: Length of ear head (cm), Weight of ear head (g), Number of grains per ear head, Test weight of grains(g), Grain yield (kg ha) and Straw yield (kg ha). The uptake of nutrients viz. nitrogen, phosphorous and potassium (kg/ha) was calculated on the basis of nutrient content on dry weight basis of grain and straw. It was calculated by using the following formula.

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{\% content of nutrient in grain/straw x Yield of grain/straw/ha}}{100}$$

The economics of the treatment is very important to find out the most profitable treatment and for determining the overall economic advantages of wheat crop from practical point of view to farmers. Therefore, an economics of different treatments were worked out in terms of cost of cultivation, gross monetary return (GMR), net monetary return (NMR) and benefit cost ratio (B C ratio) to ascertain economic viability of the treatments.

Benefit: cost ratio (B: C ratio)

B.C. ratio of each treatment was calculated as below:

$$\text{B.C. ratio} = \frac{\text{Gross Monetary Return (Rs/ha}}{\text{Cost of cultivation/ha}}$$

Composite soil samples were collected randomly. So prepared were analyzed for Soil pH was determined by using Beckman glass electrode pH meter in 1:2 soil water suspension (Piper, 1967), Electrical conductivity was also determined by electrical conductivity meter, Organic carbon was determined by Walkley and Black (1934) wet digestion method, Determination of available nitrogen was done by alkaline permanganate method suggested by Subblah and Asija (1958), The estimation of available P was done by using Olsen's extract, The available amount of potassium was determined by using N-neutral ammonium acetate as mentioned by Black (1965), Available sulphur was extracted by sodium acetate-acetic acid butter solution pH 4.8 method, Available Zn was estimated by the method suggested by (Lindsay and Norwell, 1978), Available Mn was estimated by (Lindsay and Norwell, 1978), Hot water soluble boron was determined calprimetrically by curcumine method as described by Black (1967), Nitrogen was determined by micro Kjeldahl method.

Determination of phosphorus was done by the following method: One gram of oven dried plant sample was disgusted in diacid mixture consisting of concentrated nitric acid and 72% perchloric acid in the ratio of 2:1. The digested material was filtered through Whatman filter paper number 40 and diluted to 100 ml mark. Filtrate was used for determination of phosphorus, potassium and sulphur.

The potassium content extract was estimated by flame photometer as described by Black (1965), The amount of Sulphur was expressed as S in percent (Tandon, 1993), Zn content were determined by atomic absorption spectrophotometer Expressed in mg kg),

The data recorded were analyzed by the method of analysis of variance technique.

The standard error of mean was calculated by formula

SEm + EMSr

Details of treatments

Treatments	Combinations
T_1	N_2, P_2, K_2, S, Zn, Mn, B
T_2	N_2, P_2, K_2, S, Zn, Mn, B
T_3	N_2, P_2, K_2, S, Zn, Mn, B
T_4	N_2, P_2, K_2, S, Zn, B Mn_0
T_5	N_2, P_2, K_2, S, Zn, Mn, B_0
T_6	N_2, P_2, K_2, S, Mn, B, Zn_0
T_7	N_2, P_2, K_2, Zn, Mn, B, S_0
T_8	N_1,P_1,K_1 (Control)
T_9	N_1,P_1,K_1 +101 FYM/ha
T_{10}	N_1,P_1,K_1 +51 FYM/ha + Biofertilizer

Table.1 Chemical properties of experimental field

Chemical properties	Value	Method of analysis
pH	7.7	Glass electrode method (pH meter piper 1967)
EC (dSm1)	0.21	Solubridge method (Black 1965
Organic C (g kg)	0.39	Walkley and Black's rapid literation method (Walkley and Black, 1934)
Available – N (mg kg)	266	Alkaline permanganate method (Subblah and Asija, 1956)
Available – P (mg kg)	9.80	Calorimetric method (Olsen et.al.1954)
Exchangeable –K (mg kg)	391.02	Flame photometer method (Black, 1965)
Available – S (mg kg)	26.72	Turbiden method (Tandon, 1993)
Available – Zn (mg kg)	1.35	Atomic absorption spectrophotometer (Lindsay and Norwell, 1978)
Available – Mn (mg kg)	17.04	Atomic absorption spectrophotometer (Lindsay and Norwell, 1978)
Available – Boron (mg kg)	0.25	Hot water soluble boron (Gupta, 1967)

Table.2 Skeleton of ANOVA table

Source of varience	DF	SS	MSS	Calculated F value	F table value
Replication	3				
Treatment	9				2.57
Error	27				
Total	39				

Table.3 Mean plant height (cm of wheat as affected by various treatments at successive growth stages

S. No	Treatment	Growth stages (DAS)		
		45	90	At harvest
1	$N_2 P_2 K_2$ S, Zn, Mn, B	67.5	79.02	79.31
2	$N_2 P_1 K_2$ S, Zn, Mn, B	61.6	77.57	77.83
3	$N_2 P_2 K_1$ S, Zn, Mn, B	60.2	75.13	75.18
4	$N_2 P_2 K_2$ S, Zn, B, Mn_0	64.4	76.03	78.09
5	$N_2 P_2 K_2$ S, Zn, Mn, B_0	63.0	75.53	76.03
6	$N_2 P_2 K_2$ S, Mn, B, Zn_0	61.8	75.71	76.16
7	$N_2 P_2 K_2$, Zn, Mn, B, S_0	60.0	75.22	75.92
8	$N_1 P_1 K_1$ (Control)	68.2	74.36	74.39
9	$N_1 P_1 K_1$ + 10 FYM/ha	86.4	78.44	79.05
10	$N_1 P_1 K_1$ + 5 FYM/ha + Biofertilizer 500 g ha (azotobacter)	65.0	76.20	77.69
	SEm +	0.15	0.309	0.245
	CD (P=0.05)	0.45	0.879	0.698

Table.4 Yield attributing characters of wheat as affected by various treatments

S. No.	Treatment	Length of earhead (cm)	Weight of earhead	Test weight of grains (g)
1	$N_2 P_2 K_2$ S, Zn, Mn, B	7.92	2.41	43.85
2	$N_2 P_1 K_2$ S, Zn, Mn, B	7.35	2.28	42.20
3	$N_2 P_2 K_1$ S, Zn, Mn, B	7.72	2.21	42.37
4	$N_2 P_2 K_2$ S, Zn, B, Mn_0	7.12	2.06	41.93
5	$N_2 P_2 K_2$ S, Zn, Mn, B_0	7.15	2.09	41.30
6	$N_2 P_2 K_2$ S, Mn, B, Zn_0	7.26	2.15	41.15
7	$N_2 P_2 K_2$, Zn, Mn, B, S_0	7.58	1.85	40.81
8	$N_1 P_1 K_1$ (Control)	6.69	1.77	40.63
9	$N_1 P_1 K_1$ + 10 FYM/ha	7.72	2.36	42.99
10	$N_1 P_1 K_1$ + 5 FYM/ha + Biofertilizer 500 g ha (azotobacter)	7.77	2.21	43.40
	SEm +	0.23	0.05	0.33
	CD (P=0.05)	0.66	0.16	0.93

Table.5 Mean leaf area index of wheat as affected by various treatments at successive growth stages

S. No.	Treatment	45 DAS
1	$N_2 P_2 K_2$ S, Zn, Mn, B	6.80
2	$N_2 P_1 K_2$ S, Zn, Mn, B	5.56
3	$N_2 P_2 K_1$ S, Zn, Mn, B	5.58
4	$N_2 P_2 K_2$ S, Zn, B, Mn_0	5.85
5	$N_2 P_2 K_2$ S, Zn, Mn, B_0	5.85
6	$N_2 P_2 K_2$ S, Mn, B, Zn_0	5.68
7	$N_2 P_2 K_2$, Zn, Mn, B, S_0	5.69
8	$N_1 P_1 K_1$ (Control)	5.35
9	$N_1 P_1 K_1$ + 10 FYM/ha	6.77
10	$N_1 P_1 K_1$ + 5 FYM/ha + Biofertilizer 500 g ha (azotobacter)	6.25
	SEm +	0.02
	CD (P=0.05)	0.07

Table.6 Grain and straw yield of wheat as affected by various treatments

S. No.	Treatments	Grain yield (q/ha)	Straw yield (q/ha)
1	$N_2 P_2 K_2$ S, Zn, Mn, B	53.45	76.92
2	$N_2 P_1 K_2$ S, Zn, Mn, B	47.64	68.80
3	$N_2 P_2 K_1$ S, Zn, Mn, B	49.40	68.80
4	$N_2 P_2 K_2$ S, Zn, B, Mn_0	51.68	74.96
5	$N_2 P_2 K_2$ S, Zn, Mn, B_0	49.00	73.33
6	$N_2 P_2 K_2$ S, Mn, B, Zn_0	51.74	79.15
7	$N_2 P_2 K_2$, Zn, Mn, B, S_0	43.70	69.83
8	$N_1 P_1 K_1$ (Control)	42.45	65.81
9	$N_1 P_1 K_1$ + 10 FYM/ha	53.28	77.35
10	$N_1 P_1 K_1$ + 5 FYM/ha + Biofertilizer 500 g ha (azotobacter)	49.91	83.80
	SEm +	0.669	1.118
	CD (P=0.05)	1.901	3.178

Table.7 The mean nitrogen content influenced by various treatments at successive growth stages and harvest

S. No.	Treatments	Nitrogen content %			
		45 DAS	90 DAS	At Harvest	
				Grain	Straw
1	$N_2 P_2 K_2$ S, Zn, Mn, B	2.24	1.64	1.76	0.47
2	$N_2 P_1 K_2$ S, Zn, Mn, B	2.03	1.05	1.20	0.42
3	$N_2 P_2 K_1$ S, Zn, Mn, B	2.02	1.04	1.07	0.45
4	$N_2 P_2 K_2$ S, Zn, B, Mn_0	2.18	1.33	1.34	0.44
5	$N_2 P_2 K_2$ S, Zn, Mn, B_0	2.03	1.14	1.17	0.36
6	$N_2 P_2 K_2$ S, Mn, B, Zn_0	2.14	1.22	1.23	0.43
7	$N_2 P_2 K_2$, Zn, Mn, B, S_0	2.07	1.03	1.65	0.32
8	$N_1 P_1 K_1$ (Control)	1.97	0.95	1.07	0.32
9	$N_1 P_1 K_1$ + 10 FYM/ha	2.20	1.43	1.45	0.46
10	$N_1 P_1 K_1$ + 5 FYM/ha + Biofertilizer 500 g ha (azotobacter)	2.12	1.18	1.22	0.44
	SEm +	0.02	0.03	0.03	0.009
	CD (P=0.05)	0.06	0.09	0.09	0.027

Table.8 The mean phosphorus content influenced by various treatments at successive growth stages and at harvest

S. No.	Treatments	Phosphorus content %			
		45 DAS	90 DAS	At Harvest	
				Grain	Straw
1	$N_2 P_2 K_2$ S, Zn, Mn, B	0.32	0.25	0.32	0.23
2	$N_2 P_1 K_2$ S, Zn, Mn, B	0.20	0.14	0.22	0.14
3	$N_2 P_2 K_1$ S, Zn, Mn, B	0.19	0.15	0.21	0.14
4	$N_2 P_2 K_2$ S, Zn, B, Mn_0	0.24	0.24	0.26	0.15
5	$N_2 P_2 K_2$ S, Zn, Mn, B_0	0.21	0.17	0.22	0.14
6	$N_2 P_2 K_2$ S, Mn, B, Zn_0	0.24	0.20	0.25	0.16
7	$N_2 P_2 K_2$, Zn, Mn, B, S_0	0.19	0.14	0.20	0.16
8	$N_1 P_1 K_1$ (Control)	0.18	0.12	0.19	0.11
9	$N_1 P_1 K_1$ + 10 FYM/ha	0.30	0.23	0.31	0.21
10	$N_1 P_1 K_1$ + 5 FYM/ha + Biofertilizer 500 g ha (azotobacter)	0.24	0.18	0.24	0.12
	SEm +	0.008	0.005	0.007	0.009
	CD (P=0.05)	0.023	0.015	0.020	0.028

Table.9 The mean potassium content influenced by various treatments at successive growth stages and at harvest

S. No.	Treatments	Potassium content %			
		45 DAS	90 DAS	At Harvest	
				Grain	Straw
1	$N_2 P_2 K_2$ S, Zn, Mn, B	3.70	2.58	1.42	2.72
2	$N_2 P_1 K_2$ S, Zn, Mn, B	3.53	2.44	1.26	2.04
3	$N_2 P_2 K_1$ S, Zn, Mn, B	3.52	2.44	1.25	2.18
4	$N_2 P_2 K_2$ S, Zn, B, Mn_0	3.63	2.43	1.35	2.17
5	$N_2 P_2 K_2$ S, Zn, Mn, B_0	3.57	2.45	1.29	2.06
6	$N_2 P_2 K_2$ S, Mn, B, Zn_0	3.63	2.52	1.32	2.16
7	$N_2 P_2 K_2$, Zn, Mn, B, S_0	3.47	2.38	1.22	2.05
8	$N_1 P_1 K_1$ (Control)	3.40	2.32	1.18	1.93
9	$N_1 P_1 K_1$ + 10 FYM/ha	3.64	2.56	1.38	2.60
10	$N_1 P_1 K_1$ + 5 FYM/ha + Biofertilizer 500 g ha (azotobacter)	3.67	2.54	1.32	2.13
	SEm +	0.017	0.011	0.009	0.037
	CD (P=0.05)	0.048	0.033	0.025	0.106

Table.10 The mean sulphur content influenced by various treatments at successive growth stages and at harvest

S. No.	Treatments	Sulphur content %			
		45 DAS	90 DAS	At Harvest	
				Grain	Straw
1	$N_2 P_2 K_2$ S, Zn, Mn, B	0.95	0.66	0.56	0.50
2	$N_2 P_1 K_2$ S, Zn, Mn, B	0.75	0.44	0.30	0.27
3	$N_2 P_2 K_1$ S, Zn, Mn, B	0.72	0.46	0.33	0.23
4	$N_2 P_2 K_2$ S, Zn, B, Mn_0	0.82	0.57	0.45	0.32
5	$N_2 P_2 K_2$ S, Zn, Mn, B_0	0.75	0.45	0.41	0.34
6	$N_2 P_2 K_2$ S, Mn, B, Zn_0	0.81	0.54	0.44	0.35
7	$N_2 P_2 K_2$, Zn, Mn, B, S_0	0.71	0.43	0.34	0.34
8	$N_1 P_1 K_1$ (Control)	0.71	0.35	0.32	0.20
9	$N_1 P_1 K_1$ + 10 FYM/ha	0.85	0.59	0.47	0.39
10	$N_1 P_1 K_1$ + 5 FYM/ha + Biofertilizer 500 g ha (azotobacter)	0.77	0.53	0.43	0.23
	SEm +	0.010	0.010	0.008	0.012
	CD (P=0.05)	0.029	0.029	0.024	0.034

Table.11 The mean zinc content influenced by various treatments at successive growth stages and at harvest

S. No.	Treatments	Zinc content (mg/kg)			
		45 DAS	90 DAS	At Harvest	
				Grain	Straw
1	$N_2 P_2 K_2$ S, Zn, Mn, B	100	70	50	30
2	$N_2 P_1 K_2$ S, Zn, Mn, B	155	64	44	28
3	$N_2 P_2 K_1$ S, Zn, Mn, B	152	66	42	24
4	$N_2 P_2 K_2$ S, Zn, B, Mn_0	150	63	40	27
5	$N_2 P_2 K_2$ S, Zn, Mn, B_0	151	65	38	25
6	$N_2 P_2 K_2$ S, Mn, B, Zn_0	125	58	26	20
7	$N_2 P_2 K_2$, Zn, Mn, B, S_0	145	66.9	35	26
8	$N_1 P_1 K_1$ (Control)	135	60	28	21
9	$N_1 P_1 K_1$ + 10 FYM/ha	158	68	48	28
10	$N_1 P_1 K_1$ + 5 FYM/ha + Biofertilizer 500 g ha (azotobacter)	154	65	46	27
	SEm +	2.22	1.64	2.41	2.24
	CD (P=0.05)	6.33	4.68	7.06	6.37

Table.12 The mean nutrient uptake influenced by various treatments in grain and straw

S. No.	Treatment No.	N uptake (kg/ha)		P uptake (kg/ha)		K uptake(kg/ha)		S uptake(kg/ha)		Zn uptake kg/ha	
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
1	T_1	94.07	36.15	17.10	17.69	75.66	209.22	29.93	41.53	2.67	2.31
2	T_2	57.17	28.90	10.48	9.63	60.03	140.35	17.15	18.58	2.10	1.93
3	T_3	52.85	30.96	10.37	9.63	61.75	149.98	16.30	15.82	2.07	1.65
4	T_4	69.25	32.98	13.43	11.24	69.77	162.66	23.26	28.48	2.07	2.02
5	T_5	57.33	26.40	10.78	10.27	63.21	151.19	20.09	24.93	1.86	1.83
6	T_6	63.64	34.03	12.94	12.66	68.43	171.00	22.77	27.70	1.35	1.58
7	T_7	72.10	22.35	8.74	11.17	53.31	143.22	14.88	23.74	1.53	1.82
8	T_8	45.43	21.06	8.04	7.24	50.09	127.01	13.57	13.16	1.19	1.38
9	T_9	77.24	35.58	16.52	16.24	75.53	201.11	25.04	30.17	2.56	2.26
10	T_{10}	60.89	36.22	11.98	9.97	65.88	176.96	21.46	19.10	2.30	2.24
	SEm+	0.377	0.326	0.353	0.316	0.407	0.623	0.256	0.226	0.236	0.043
	CD	1.13	0.98	1.06	0.95	1.22	1.87	0.77	0.68	0.71	0.13

Table.13 Chemical properties of post-harvest soil as influenced by different nutrient – Available nutrients (Kg/ha)

Tr.No.	Soil PH	E(dsm)	%	N	P	K	S	Zn	Mn	B
Initial	7.7	0.21	0.39	266	9.80	391.02	26.72	1.35	17.04	0.25
T_1	7.71	0.45	0.56	270.33	11.38	495.00	27.26	1.58	11.13	0.23
T_2	7.73	0.34	0.53	233.00	10.80	497.00	37.16	1.34	13.55	0.22
T_3	7.76	0.29	0.51	262.66	10.75	438.00	37.16	1.33	15.22	0.21
T_4	7.76	0.39	0.55	255.00	11.25	486.00	29.24	1.38	8.74	0.20
T_5	7.76	0.34	0.50	266.00	10.94	463.00	31.22	1.35	11.17	0.18
T_6	7.70	0.38	0.45	262.66	11.01	480.00	29.40	1.30	14.11	0.21
T_7	7.73	0.29	0.43	262.66	10.69	421.00	20.28	1.36	14.50	0.22
T_8	7.73	0.25	0.42	244.00	10.56	396.66	20.80	1.32	10.47	0.11
T_9	7.69	0.40	0.67	257.00	11.35	490.00	26.01	1.41	10.64	0.19
T_{10}	7.72	0.36	0.62	258.00	10.96	470.00	25.08	1.39	10.87	0.20

Table.14 Cost of cultivation, gross and net monetary returns and B: C ratio as influenced by different nutrient management treatments.

S. No.	Treatment	Cost of cultivation (Rs)	Gross Monetary return (Rs)	Net Monetary return (Rs)	B:C ratio
T_1	$N_2 P_2 K_2$ S, Zn, Mn, B	16296	47394.90	31098.90	2.91
T_2	$N_2 P_1 K_2$ S, Zn, Mn, B	15606	42266.00	26660.00	2.71
T_3	$N_2 P_2 K_1$ S, Zn, Mn, B	16211	43586.00	27375.00	2.69
T_4	$N_2 P_2 K_2$ S, Zn, B, Mn_0	16306	45881.20	29575.20	2.81
T_5	$N_2 P_2 K_2$ S, Zn, Mn, B_0	16246	43716.35	27470.35	2.69
T_6	$N_2 P_2 K_2$ S, Mn, B, Zn_0	16351	46324.25	29973.25	2.83
T_7	$N_2 P_2 K_2$, Zn, Mn, B, S_0	16065	39408.85	23343.85	2.45
T_8	$N_1 P_1 K_1$ (Control)	14620	38089.45	23469.45	2.61
T_9	$N_1 P_1 K_1$ + 10 FYM/ha	16550	47308.25	30758.25	2.86
T_{10}	$N_1 P_1 K_1$ + 5 FYM/ha + Biofertilizer 500 g ha (azotobacter)	16256	45325.10	29069.10	2.78
	CD (P=0.05)	-	2129	1641	-

Where

EMS = Error Mean Sum of Square

R = Replication

CD was compared for judging the difference between two treatments. It was calculated from formulae.

CD (at 5%) = SEm x 2 x

Where

SEm = Standard Error of Mean

Edf = Table value of at 5% level of significance and error degrees of freedom

Experimental findings

The mean height of the plant as influenced by different nutrient management treatments at successive growth stages is presented in Table 3

The Table 4 indicates that different nutrient management treatments significantly influenced the earhead length.

The data given in Table 4 shows that the weight of earhed.

The LAI as influenced by different nutrient management treatments at successive growth stages is presented in Table 5.

Data related to grain yield as affected by different nutrient management treatments are given in Table 6.

Date pertaining to phosphorous content at 45.90 DAS and at harvest stage (grain and straw) as influenced by different treatments are given in Table 8.

Date pertaining to potassium content at 45, 90 DAS and at harvest stage (grain and straw) as influenced by different treatments are given in Table 9.

Data pertaining to S – content at 45, 90 DAS and at harvest stage (grain and straw) as influenced by different treatments are given in Table 10.

Date pertaining to Zn – content at 45, 90 DAS and at harvest stage (grain and straw) as influenced by different treatments are given in Table 11.

The date pertaining to nitrogen uptake (kg/ha) in grain was also presented in Table 12, showed significant variation with different levels of nutrients.

Data pertaining to P-uptake in grain and straw as influenced by different treatments are given in Table 12, Data pertaining to potassium uptake in grain and straw as influenced by different levels of nutrients are given in Table 12. Data pertaining to S uptake in grain and straw as influenced by different levels of nutrients are given in Table 12. Data pertaining to N uptake at 45, 90 DAS and at harvest stage (grain and straw) as influenced by different treatments are given in Table 12.

Cost of grain and straw of wheat was taken as Rs.750 and 95/q respectively (Table 14).

Following conclusion could be drawn from the above findings: It was found that the application of N, P, K, S, Zn, B and Mn as balanced nutrient management improved growth parameters and increased grain yield as compared to recommended dose of NPK under prevailing eco-system. Addition of N, P, K, S, Zn, B and Mn nutrients on the basis of integrated nutrient management practices resulted in maximum gross and net monetary returns as well as profitability. The use of N, P, K, S, Zn, B and Mn nutrients on the basis of integrated nutrient management practices revealed that the application of Nitrogen 217 kg/ha, Phosphorus (P_2O_5) 164 kg/ha. Potassium (K_2O) 118 kg/ha, Sulphur 6 kg/ha, Zinc 0.7 kh/ha, Manganese 0.6 kg/ha and Boron 0.3 kg/ha was found more productive, remunerative and suitable for maintaining the residual status of the soil after harvest of wheat crop.

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