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Differential Rates of NPK, FYM and Zinc on Growth, Yield and Economics of Wheat (*Triticum aestivum* L.) under Indo-Gangetic Plain Zone

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Abstract A field experiment was carried out for two consecutive years during the *rabi* seasons of 2005-06 and 2006-07 to determine the effects of NPK, FYM and Zn rates on growth and yield of wheat cv HUW 234. Three levels of NPK (75%, 100%, and 125% RFD) and three levels of FYM (0, 6 and 12 tonnes ha^{-1}) were allotted to main plot treatments and three levels of Zn (0, 5, and 10 kg ha^{-1}) as sub plot in a split plot design with three replications studied. Plant growth and yield attributes significantly differed with NPK levels. Grain and straw yield was significantly higher with 125% RFD and was at par with 100% RFD. Application of 12 tonnes FYM ha^{-1} recorded higher growth and yield being at par with 6 tonnes FYM ha^{-1} and significantly superior over control. Amongst Zn levels, 10 kg Zn ha^{-1} recorded higher growth and yield but the increase was significant only up to 5 kg Zn ha^{-1}.

Keywords Growth attributes, Yield attributes, NPK, FYM, Zn, Wheat.

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Introduction

Wheat (*Triticum aestivum* L.) is the second most important food crop of India. During 2013-14, the crop occupied an area of 31.19 million hectare with annual production of 95.9 million tonnes and average yield of 3.07 tonnes per hectare [1]. It is the staple food for 35% of the world's population and provided more calories and protein than any other crop. Wheat is Asia's second most important staple food and its consumption has been increasing much faster than that of rice. Wheat is the important cereal crop in India but its productivity is very low, particularly in eastern U.P. Out of many factors, fertilizer is still an important and inescapable input in increasing the production of wheat. Judicious use of a combination of organic waste such as farm yard manure and inorganic fertilizers will maintain long term soil fertility and productivity [2].

In India, among micro-nutrients, Zn deficiency is the most widespread in areas where high yield crop varieties are grown [3]. Soil fertility status is declin-

Table 1. Effect of differential rates of NPK, FYM and zinc on growth attributes of wheat.

Treatments	Plant height (cm)		Number of shoots/m row length		Number of green leaves/m row length		Dry matter production (g)/m row length	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
NPK levels								
75% NPK	83.37	85.99	71.96	76.30	162.38	171.87	211.68	218.75
100% NPK	91.43	94.31	78.93	83.68	178.09	188.49	232.16	239.91
125% NPK	94.12	97.08	81.25	86.14	183.33	194.04	238.99	246.97
SEm±	1.28	1.37	1.29	1.19	2.42	2.99	3.16	3.80
CD	3.83	4.10	3.87	3.57	7.26	8.96	9.47	11.40
FYM levels								
0	86.05	87.84	74.28	77.94	167.62	175.56	218.51	223.45
6	90.54	93.38	78.15	82.86	176.34	186.66	229.89	237.56
12	92.33	96.16	79.70	85.32	179.84	192.18	234.44	244.62
SEm±	1.28	1.37	1.29	1.19	2.42	2.99	3.16	3.80
CD	3.83	4.10	3.87	3.57	7.26	8.96	9.47	11.40
Zinc levels (kg/ha)								
0	85.16	87.84	73.51	77.94	165.86	175.55	216.23	223.45
5	91.43	94.31	78.93	83.68	178.10	188.50	232.16	239.91
10	92.33	95.23	79.70	84.50	179.84	190.35	234.44	242.27
SEm±	1.24	1.26	0.94	1.12	2.39	2.30	3.11	2.93
CD	3.55	3.61	2.68	3.21	6.84	6.60	8.92	8.40

ing due to injudicious use of resources. Application of chemical fertilizers even in balanced amount does not sustain the soil health under sequential cropping system. Inclusion of organic sources of nutrients regulates the removal of nutrients and improves the physico-chemical properties of soil. Farm yard manure (FYM) is considered as an important source of macro and micro nutrient that has the capacity to increase crop yield. It has, thus, become imperative to use the matching doses of required NPK and micronutrients along with FYM. Therefore, keeping these facts in view the present investigation was undertaken to study the effect of NPK, FYM and Zn rates on growth, yield and the content of NPK, and Zn in wheat.

Materials and Methods

The field experiment was conducted at the Agricultural Research Farm, Institute of Agricultural Science, Banaras Hindu University Varanasi during *rabi* seasons of 2005-06 and 2006-07. The soil of the experimental field was Gangetic alluvial (Ustochrept) with a pH of 7.1 it was moderately fertile being low in organic carbon (0.45%), available nitrogen (202.5%) and zinc (0.56 kg ha^{-1}) and medium in available P_2O_5 (23.2 kg ha^{-1}) and K_2O (232 kg ha^{-1}). The experiment was laid out in split plot design with 3 replications and 27 treatment combinations consisting of 3 levels of NPK (75%, 100%, and 125% RFD), 3 levels of FYM (0, 6 and 12 tonnes ha^{-1}) in main plots and 3 levels of Zn (0, 5 and 10 kg Zn ha^{-1}) in sub plot. The wheat variety HUW-234 was the test crop.

Nutrients were applied as per treatment, for nitrogen DAP and urea; for P_2O_5 di-ammonium phosphate, for K_2O muriate of potash, for Zn-$ZnSO_4$ was used. FYM applied in the field 15 days before sowing; however 50% N and full amount of P, K and Zn were applied at the time of sowing. Remaining N was applied in two equal splits as top dressing (first at 30 DAS and second at 60 DAS). Crop received 5 irrigations each at CRI, late tillering, jointing, flowering and dough stage during both the years. Recommended agronomic practices were followed during the crop growth period. The observations on important yield attributing characters like, effective tillers m^{-1} row

Table 2. Effect of differential rates of NPK, FYM and zinc on yield attributing characters, yield and B:C ratio of wheat.

	Yield attributing characters and yield											
	Ear Head m^{-2}		Grain/ear head		Test weight		Grain yield		Straw yield		B:C ratio	
Treatments	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
NPK levels												
75% NPK	69.66	73.84	37.92	39.95	36.27	37.23	35.19	37.15	44.33	46.72	2.15	2.27
100% NPK	76.40	80.99	41.59	43.82	38.16	39.17	38.60	40.75	48.62	51.22	2.28	2.40
125% NPK	78.65	83.37	42.81	45.11	38.91	39.94	39.73	41.95	50.05	52.66	2.27	2.39
SEm±	1.07	1.18	0.57	0.69	0.46	0.49	0.63	0.58	0.66	0.81	0.03	0.03
CD	3.20	3.52	1.70	2.08	1.37	1.48	1.89	1.74	1.98	2.43	0.10	0.10
FYM levels (t/ha)												
0	71.90	75.43	39.14	40.81	36.65	37.62	36.33	37.95	45.77	47.72	2.26	2.37
6	75.65	80.19	41.18	43.39	38.16	39.17	38.22	40.35	48.15	50.72	2.26	2.38
12	77.15	82.58	41.99	44.68	38.54	39.56	38.97	41.55	49.09	52.16	2.18	2.32
SEm±	1.07	1.18	0.57	0.69	0.46	0.49	0.63	0.58	0.66	0.81	0.03	0.03
CD	3.20	3.52	1.70	2.08	1.37	1.48	1.89	1.74	1.98	2.43	NS	NS
Zinc levels (kg/ha)												
0	71.16	75.43	38.73	40.81	37.02	38.00	35.95	37.95	45.29	47.70	2.13	2.25
5	76.40	80.99	41.59	43.82	37.97	38.97	38.60	40.75	48.63	51.17	`2.28	2.40
10	77.15	81.78	41.99	44.25	38.35	39.36	38.97	41.15	49.09	51.72	2.29	2.41
SEm±	1.03	1.08	0.56	0.53	0.33	0.33	0.46	0.54	0.65	0.62	0.03	0.03
CD	2.96	3.10	1.60	1.53	0.95	0.94	1.31	1.56	1.87	1.79	0.09	0.09

length, number of grains earhead^{-1}, test weight and growth parameter were recorded along with grain yield. Data were subjected to statistical analysis and standard procedure as described by Gomez and Gomez [4].

Results and Discussion

Effect of NPK rates

The growth (plant height, dry matter production, number of shoot and number of green leaves/m row length) and yield attributing characters (effective tillers m^{-1} row length, number of grains earhead^{-1}, test weight and grain yield) enhanced significantly with increase in NPK levels, value being maximum at 125% RFD (Tables 1 and 2). However, increase in these traits found at 125% RFD and 100% RFD being at par and significantly superior to 75% RFD. Application of 100% NPK significantly improved the grain yield of wheat by 21.5% over application of 75% NPK [5]. Application of N 120 kg N ha^{-1} helps to increased uptake of N by wheat significantly [6]. More grain yield production was recorded with increased levels of NPK accrued mainly because of more dry matter accumulation and increase in yield-attributing traits.

Effect of FYM

Application of increasing levels of FYM increased the growth and yield attributing characters but the increase was significant only up to 6 tonnes FYM ha^{-1}. This may be attributed primarily to the beneficial role of FYM in improving the soil physical properties due to formation of acids during decomposition of organic matter and increased available nutrient for plant growth [7]. Addition of organic nutrient source might have created environment conducive for formation of humic acid, stimulated the activity of soil microorganism resulted in an increase in the organic carbon content of the soil [8].

Effect of Zn

The data reveal that application of zinc upto increasing levels of 5 kg ha^{-1} showed significant improvement in the growth and yield attributing characters but further increase in level of Zn to 10 kg ha^{-1} though

increased these traits but the increase was insignificant in both the years. The response to zinc application may be attributed to the low available zinc in the soil and also its role in various enzymatic reactions and it acts as a catalyst in various growth processes and in hormone production and protein synthesis which result in increasing the growth and yield attributes and ultimately the grain yield. Similar results in wheat with the application of 5 kg Zn ha^{-1} were reported by earlier (9, 10].

Effect of treatments
on economics

In order to assured the profitability of treatments NPK (90-45-45 kg NPK ha^{-1}, 120-60-60 kg NPK ha^{-1} and 150-75-75 kg NPK ha^{-1}), FYM (0 ton FYM ha^{-1}, 6 tonnes FYM ha^{-1} and 12 tonnes FYM ha^{-1}) and Zn (0 kg Zn ha^{-1}, 5 kg Zn ha^{-1} and 10 kg Zn ha^{-1}), net return and output: input ratio was worked out. Treatment 150-75-75 kg NPK ha^{-1} gave significantly higher net return but highest output: input ratio recorded with 120-60-60 kg NPK ha^{-1} during the both the years of studies. In case of FYM, higher net return in 2005-06 recorded with 6 tonnes FYM ha^{-1} while in 2006-07 recorded with 12 tonnes FYM ha^{-1} and maximum output: input ratio recorded with 6 tonnes FYM ha^{-1} during the both the years of studies. In case of zinc treatment 10 kg Zn ha^{-1} gave significantly higher net return and output: input ratio during the both the years of studies. These results are in accordance with the earlier findings [11].

Conclusion

On the basis of economic analysis of two years of experimental findings, it is recommended that wheat crop treated with 100% recommended dose of NPK (120-60-60 kg NPK ha^{-1}) + 6 tonnes FYM ha^{-1} + 5 kg Zn ha^{-1} proved to be the effective for obtaining sustainable yield with higher economic returns.

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