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Effect of integrated nutrient management modules on yield, quality and economics of wheat

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Abstract
The field experiment was conducted to study the effect of integrated nutrient management modules on wheat with variety NW-1014, at student's instructional farm, Narendra Deva university of Agriculture & Technology Narendra Nagar Faizabad in during *Rabi* season of 2014-15 and 2015-16. The experiment consists of fourteen treatments viz. T_1: RDF (150:60:40 kg ha^{-1} NPK), T_2 : RDF + 20kg $ZnSO_4$ ha^{-1}, T_3 : RDF + 5 t FYM ha^{-1}, T_4 : RDF + 2.5 t VC ha^{-1}, T_5: RDF + 5 t FYM + 20 kg $ZnSO_4$ ha^{-1}, T_6: RDF +2.5 t VC + 20 kg $ZnSO_4$ ha^{-1}, T_7: 75% RDF, T_8: 75 % RDF +20kg $ZnSO_4$ ha^{-1}, T_9: 75 % RDF + 10 t FYM ha^{-1}, T_{10}: 75 % RDF + 5 t VC ha^{-1}, T_{11}: 75 % RDF +10 t FYM + 20 kg $ZnSO_4$ ha^{-1}, T_{12}: 75 % RDF + 5 t VC +20 kg $ZnSO_4$ ha^{-1}, T_{13}: 125 % RDF, T_{14}: 125 % RDF + 20 kg $ZnSO_4$ ha^{-1}. The results revealed that the application of 100% recommended dose of fertilizer (RDF) *i.e.*150:60:40 N:P:K kg ha^{-1} + vermicompost @ 2.5 t ha^{-1} + $ZnSO_4$ @ 20 kg ha^{-1} produced highest grain yield (50.80 q ha^{-1}), straw yield (71.07 q ha^{-1}), protein content (11.71 %), net return (68538.48 ha^{-1}) and B:C ratio (2.71%).

Keywords: yield, protein content, economics, wheat, FYM and vermicompost.

Introduction
Wheat (*Triticum aestivum* L.) is one of the most important cereal crops of the world. Among the world's most important food grain, it ranks next to rice. It is eaten in various forms by more than one billion in the world. Wheat straw is a good source of feed for a large population of the cattle in our country. It ranks second in the world among the cereals both in respect of acreage (231.0 m ha) and production (727.87 metric t.) (Ministry of Agri. GOI 2015-16). India is the second largest producer of wheat in the world. It is the second most important cereal crop after rice and this is a pre-dominant winter season crop of north western plain zones and during 2015-16 production in India was 95.85 million tons from an area of 30.47 million hectares with a productivity of 2.99 tones ha^{-1} (Economic survey, GOI, 2015-16).
UP ranks first in respect of crop coverage area (9.64 million hectares) and production (30.00 million tones) but average productivity is low (3.11 t ha^{-1}) (FAO, STATE -2014-15).
The most significant results are obtained, when we use organic manures in the combination of inorganic fertilizers (Patra *et al.*, 1999) [4]. Nitrogen is major structural nutrient of the cell along with P and K. It helps in building up vegetative growth of plants. The deficiency of nitrogen badly affect the crop growth and causes shrivelling of grain and poor crop yield. Phosphorus is also important major plant nutrient for better crop production. It is necessary for photosyntehsis. Potassium is the third major plant nutrient and plays very important in photosynthesis and translocation of nutrients from leaves to the seed. Organic manures with the combination of chemical fertilizer increases growth, grain and straw yield of wheat crop. Zinc is involved in protein and carbohydrate metabolism through several enzyme systems. Zinc increases the grain and straw yield of wheat with increasing levels of zinc application.

Materials and methods
Field experiments were conducted during the ravi season 2014-15 and 2015-16 at students instructional farm, Narendra Deva university of Agriculture & Technology Narendra Nagar Faizabad. The soil was silty loam having organic carbon 3.40 g kg^{-1} with pH 8.58, available N 170.50 kg ha^{-1}, P_2O_5 11.80 kg ha^{-1}, K_2O 215.50 kg ha^{-1}, S 6.10 ppm and Zn 0.38 ppm at the start of the experiment in 0 to 30 cm soil layer during 2014-15. The experiment was laid out in randomized block design with three replications. Vermicompost and FYM were applied 15 days before sowing as per treatment. Wheat cultivar NW-1014 was sown in row 20 cm apart on 26 November in 2014 and 17 November in 2015 and harvested on 25th March 2015 and 29th March in 2016 repectivly.

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, K and Zn were applied through urea, DAP, muriate of potash and zinc sulphate respectively. The crop received three uniform irrigations (at crown root initiation, flowering and milking stages). The plant height, dry matter accumulation, yield ttributes, grain and straw yield and harvest index were recorded. The yield parameters and yields were recorded and analyzed as per Gomez and Gomez (1984) [2]. The treatment comparisons were made using t-test at 5% level of significance.

Results and discussion

Effect on yield

The pooled data of yield (grain and straw) were influenced by different nutrient management modules (Table-1). Treatment T_6 (100%RDF+2.5 t VC+20 kg ZnSO4 ha^{-1}) recorded highest grain and straw yield (50.80 and 71.07 q ha^{-1}, respectively). In case of grain yield, it was statistically at par with treatment T_5 (100% RDF + 5 t FYM + 20 kg ZnSO4 ha^{-1}) and T_{12} (75 % RDF+5 t VC +20 kg $ZnSO_4$ ha^{-1}) and significantly superior over rest of the treatments and in case of it straw yield, was significantly superior over T_1, T_2, T_7, T_8, T_9, T_{10} and T_{13} and statistically at par with rest of the treatments. The minimum grain and straw yield (35.61 and 56.97 q ha^{-1}, respectively) were recorded under the treatment T_7 (75% RDF). Higher grain and straw yields in T_6, T_5, $T_{12\ and}$ T_{11} treatment might be due to the combined effect of availability of various nutrients to the plant at proper growth stages through the various means i.e. chemical (macro and micro nutrients) and organic sources (FYM and vermicompost). Treatment T_6 showed highest yield due to the balanced use of essential macro and micro nutrients. Several other workers such as Patil and Bhilare (2000) [5], Davari *et al.* (2012) [1] and Kausik and Ray (2008) [3] reported similar results.

Grain quality

The results of pooled protein content in grain revealed that the maximum content (11.71%) in the treatment T_6 (100% RDF+2.5 t VC + 20 kg ZnSO4 ha^{-1}) which was statistically at par with T_4, T_5, T_{11}, and T_{12} and significantly superior over rest of the treatments. The increase of protein content (wheat grain) in different treatments might be due to increase nitrogen uptake. The minimum protein content (9.40 %) was recorded in the treatment T_7 (75 % RDF). Similar findings were reported by Randhe *et al.* (2009) [7].

Economics

The economics of different treatment combinations have been presented in Table 1. It was worked out on the basis of input and output analysis. The application of T_6 (100% RDF+2.5 t VC + 20 kg ZnSO4 ha^{-1}) recorded to highest net return of 68538.48 ha^{-1} followed by T_5 (100% RDF + 5 t FYM + 20 kg ZnSO4 ha^{-1}), 65424.18 ha^{-1}. Similarly, the highest benefit cost ratio (BCR) of 2.71 were recorded with treatment T_6followed by T_5 which (2.70). These results corroborate with the findings of Rather and Sharma (2009) [8].

Table 4: Effect of integrated nutrient management modules on grain, straw yield and protein content and economics of wheat crop (pooled of two years).

Treatment	Yield (q ha^{-1})		Protein content (%)	Economics	
	Grain	Straw		Net return	B:C ratio
T_1	41.78	62.67	10.08	57041.48	2.65
T_2	42.73	66.23	10.19	59489.78	2.69
T_3	45.10	67.17	10.76	60829.62	2.61
T_4	45.81	68.21	10.93	60624.21	2.54
T_5	48.05	69.28	11.55	65424.18	2.70
T_6	50.80	71.07	11.71	68538.48	2.71
T_7	35.61	56.97	9.40	46864.34	2.42
T_8	36.22	57.96	9.51	47547.25	2.41
T_9	36.92	59.26	9.95	43220.02	2.10
T_{10}	42.35	64.09	10.19	50137.39	2.17
T_{11}	46.53	67.31	11.10	60563.11	2.51
T_{12}	47.95	68.24	11.21	59581.00	2.37
T_{13}	42.06	63.67	10.76	56386.36	2.56
T_{14}	44.39	66.59	10.80	60497.70	2.65
SEm±	1.34	1.89	0.31		
C.D. at 5%	3.79	5.35	0.87		

T_1: RDF (150:60:40 kg ha^{-1} NPK), T_2 : RDF + 20kg $ZnSO_4$ ha^{-1}, T_3 : RDF + 5 t FYM ha^{-1}, T_4 : RDF + 2.5 t VC ha^{-1}, T_5: RDF + 5 t FYM + 20 kg $ZnSO_4$ ha^{-1}, T_6: RDF +2.5 t VC + 20 kg $ZnSO_4$ ha^{-1}, T_7: 75% RDF(112.50:50:45 kg ha^{-1}), T_8: 75 % RDF +20kg $ZnSO_4$ ha^{-1}, T_9: 75 % RDF + 10 t FYM ha^{-1}, T_{10}: 75 % RDF + 5 t VC ha^{-1}, T_{11}: 75 % RDF +10 t FYM + 20 kg $ZnSO_4$ ha^{-1}, T_{12}: 75 % RDF + 5 t VC +20 kg $ZnSO_4$ ha^{-1}, T_{13}: 125 % RDF(187.50:75:50 kg ha^{-1}), T_{14}: 125 % RDF + 20 kg $ZnSO_4$ ha^{-1},

Conclusion

On the basis of results summarized above the following specific conclusion are being warranted that treatment module of T_6 - 100% RDF +2.5 t VC + 20 kg $ZnSO_4$ ha^{-1} resulted in highest growth and yield, quality and economics of wheat.

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