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Integrated nutrient management for sustaining wheat (*Triticum aestivum*) production under late sown condition

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ABSTRACT

A field experiment was conducted at research farm of Rajendra Agricultural University, Pusa, Samastipur during the *rabi* seasons of 2002-03 and 2003-04 to find out the effect of integrated nutrient management on productivity of late sown wheat (*Triticum aestivum L.*). Addition of 10 t/ha FYM + 25 kg $ZnSO_4$/ha together with RDF (recommended dose of fertilizers i.e. 120-26.2-33.3 kg N-P-K/ha), 125% RDF and 150% RDF recorded significantly higher values of yield attributes, grain (3.5-3.7, 3.6-3.8 and 3.8-3.9 t/ha, respectively) and straw (5.2-5.4, 5.3-5.5 and 5.5-5.6 t/ha, respectively) yields than application of RDF (2.9-3.1 t/ha), 125% RDF (3.2-3.5 t/ha) and 150% RDF (3.3-3.6 t/ha) alone. Application of 10 t FYM/ha with RDF produced similar grain yield (3.4-3.6 t/ha) as the yield obtained under 150% RDF alone (3.3-3.6 t/ha). Application of 150% RDF together with 10 tonnes FYM + 25 kg $ZnSO_4$/ha although produced maximum grain yield (3.8-3.9 t/ha), however, highest benefit : cost ratio (1.5-1.7) was obtained with 10 t FYM/ha together with RDF only. Addition of 10 t FYM with fertilizers levels significantly increased the nutrient uptake by the crop, improved the organic carbon content, N, P and K status and significantly reduced the bulk density of the soil as compared to chemical fertilizer alone.

Key words : Economics, Integrated nutrient management, Nutrient uptake, Wheat, Yield

Rice and wheat are the hub of food security of the global population. In 21st century, there will be a need of about 250 m t of food grains to feed the rapidly increasing population. To meet the challenges intensive cropping patterns were adopted which resulted in declining nutrient status of soil and therefore the use of chemical fertilizers is increasing day-by-day (Balyan and Idnani, 2000). Indiscrimate use of fertilizers adversely affects the physico-chemical properties of the soil resulting in poor rice-wheat production. The declining response to inputs has been received to be the major issue challenging the sustainability of wheat based cropping system (Mishra, 2006). Application of nutrients in judicious amount and manner helped in improving the physico-chemical properties of the soil for sustained production. To get maximum benefit from applied fertilizers, they need to be applied in right quantity, and through right sources and combination under timely as well as late sown wheat crop. To cope-up with the situation, the use of organic manures and micronutrients with fertilizers is receiving attention in intensive agriculture. In the present investigation, an attempt has been made to evaluate the effect of varying levels of nutrients and organic manure alone and in combination with zinc on the physico-chemical properties of soil and crop yield.

MATERIALS AND METHODS

A field experiment was conducted at research farm of Rajendra Agricultural University, Pusa (Samastipur) during 2 consecutive *rabi* seasons of 2002-03 and 2003-04. The soil of the experimental field was clay loam in texture and calcareous in nature with pH 7.8. It was low in organic carbon (0.46%), available N (232.0 kg/ha), P (7.7 kg/ha) and K (108 kg/ha). It contained 0.68 ppm of available zinc. The experiment was laid out in randomised block design, comprising twelve treatment combinations, i.e. T_1 (recommended dose of fertilizer, (RDF), i.e. 120: 26.2 : 33.3 kg N:P:K/ha), T_2 (T_1 + 25 kg $ZnSO_4$/ha), T_3 (T_1 + 10 t FYM/ha), T_4 (T_1 + 25 kg $ZnSO_4$ + 10 t FYM/ha), T_5 (125% RDF), T_6 (T_5 + 25 kg $ZnSO_4$/ha), T_7 (T_5 + 10 t FYM/ha), T_8 (T_5 + 25 kg $ZnSO_4$ + 10 t FYM/ha), T_9 (150% RDF), T_{10} (T_9 + 25 kg $ZnSO_4$/ha), T_{11} (T_9 + 10 t FYM/ha), T_{12} (T_9 + 25 kg $ZnSO_4$ + 10 t FYM/ha) and were replicated thrice. FYM was applied one month before sowing. Wheat 'HUW 234' was sown on 12th and 13th of December in 2002 and 2003, respectively. Half of nitrogen as per treatment and full dose of phosphorus, potassium and $ZnSO_4$ were applied at the sowing as basal application and remaining nitrogen as per treatment was

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top dressed after first irrigation. The minimum and maximum temperature ranges from 6.6 to 19.8^{0}C and 16.3 to 28.9^{0}C in first year and 8.8 to 17.0^{0}C and 18.5 to 31.9^{0}C in second year of experimentation. The crop received 93.5 and 84.1 mm rainfall during the crop period in first and second year, respectively. N, P and K were applied through urea, single super phosphate and muriate of potash, respectively. The crop received three uniform irrigations. Physico-chemical properties of soil and nutrient uptake by the wheat crop were analysed through prescribed laboratory procedures.

RESULTS AND DISCUSSION

Effect on yield attributes

Application of FYM or zinc at varying fertility levels produced significantly higher values for yield attributing characters, i.e. effective tillers/m row length, number of grains/earhead and test weight in both the years than the application of chemical fertilizers alone (Table-1). However, the number of grains/earhead in second year was higher only at combined application of FYM + $ZnSO_4$ with RDF and 125% RDF when compared with RDF and 125% RDF alone. Although, the application of FYM + $ZnSO_4$ together with fertilizer levels recorded higher value of these indices but the same was found to be at par with the application of only FYM together with each fertilizer levels. Application of FYM with 150% RDF recorded higher values of yield indices and was found to be at par with the application of FYM with 125% RDF and significantly surpassed over RDF with FYM. Application of 125% RDF also recorded significantly higher values of these indices except the number of grains/earhead in both the years than the application of FYM with RDF. Dwivedi and Thakur (2004) have recorded significantly higher yield attributes of wheat under residual fertility of FYM with recommended dose of fertilizers.

Effect on grain and straw yield

Addition of FYM and FYM + zinc together with different fertilizer levels produced significantly higher grain and straw yields than the application of fertilizers alone and addition of zinc alongwith the fertilizer levels in both the years (Table 1), except the straw yield at 125% RDF and 150% RDF than the RDF, where only the application of FYM + zinc together with fertilizer levels produced significantly higher straw yield than the application of fertilizer alone and addition of zinc alongwith fertilizer. Maximum grain yield was obtained with the application of FYM + zinc together with 150% RDF than the RDF and was found to be at par with the application of FYM and zinc together with 125% RDF. Although, higher grain yield was associated with 150% RDF together with FYM + zinc but it was similar to the yield obtained by the application of FYM alone with 125% RDF than RDF. Higher harvest index was also associated with these treatment combinations. The result is in agreement with the findings of Bhatia and Kaur (2003) and Singh and Agrawal (2004). The increase in grain and straw yields 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

Table 1. Effect of different treatment on yield attributing characters, grain yield and economics of wheat

Treatment	Effective tillers/m row length		Number of grains/ earhead		Test weight (g)		Grain yield (tonnes/ha)		Straw yield (tonnes/ha)		Net return (Rs x 10^3/ha)		Benefit : cost ratio	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II
RDF	49.7	54.5	39	35	38.5	36.4	2.9	3.1	4.6	4.7	11.01	11.81	1.3	1.4
RDF+Zn	52.3	60.0	43	36	38.9	37.3	3.0	3.3	4.6	5.0	11.38	13.96	1.3	1.6
RDF+FYM	57.3	68.3	49	38	39.1	38.6	3.4	3.6	5.2	5.3	13.58	14.52	1.5	1.7
RDF+Zn+FYM	59.7	71.5	52	41	39.6	39.1	3.5	3.7	5.2	5.4	13.55	14.57	1.5	1.6
125% RDF	53.0	65.3	45	37	39.1	36.8	3.2	3.5	4.8	5.2	11.94	14.11	1.4	1.6
125% RDF+Zn	53.7	65.5	46	39	39.3	37.5	3.2	3.6	4.8	5.2	11.78	13.94	1.3	1.5
125% RDF+FYM	64.7	74.3	53	41	39.8	38.9	3.5	3.7	5.2	5.4	13.62	14.72	1.5	1.6
125% RDF+Zn+FYM	66.0	75.0	54	44	40.1	39.2	3.6	3.8	5.3	5.5	13.66	14.48	1.4	1.5
150% RDF	56.0	67.8	47	39	39.8	37.1	3.3	3.6	4.9	5.3	11.94	13.84	1.4	1.5
150% RDF+Zn	57.0	74.3	48	39	40.1	38.5	3.3	3.6	5.0	5.3	11.99	13.54	1.2	1.4
150% RDF+FYM	67.0	76.5	58	45	40.3	39.1	3.7	3.8	5.4	5.6	13.81	14.32	1.4	1.4
150% RDF+Zn+FYM	69.0	78.3	59	47	40.6	39.7	3.8	3.9	5.5	5.6	14.06	14.55	1.4	1.4
SEm $\pm$	2.2	2.1	2	2	0.2	0.17	0.1	0.07	0.17	0.07	0.51	0.46	0.07	0.07
CD (P=0.05)	7.0	6.6	5	5	0.7	0.5	0.3	0.2	0.3	0.2	1.51	1.38	0.2	0.2

RDF: 120-26.2-33.3 kg N-P-K/ha; Zn=$ZnSO_4$ 25kg/ha; FYM: 10 t/ha; I: 2002-03; II: 2003-04

economic yield. Improved physico-chemical properties of the soil through the application of organic manure might be the other possible reason for higher productivity.

Economics

Application of FYM and FYM + zinc together with fertilizer levels recorded higher net return than the application of fertilizers alone and even with zinc. Application of FYM + zinc with 150% RDF recorded maximum net return (Rs 14.06 x 10^3/ha) in first year. However, it was maximum (Rs 14.72 x 10^3/ha) with the application of FYM + 125% RDF in the second year which was at par with all other combination of FYM or FYM + zinc with fertilizer levels. The maximum net return per rupee of investment (1.5 and 1.7) was obtained with the application of FYM at RDF in both the years. Singh and Agrawal (2004) also obtained maximum net return and benefit : cost ratio with the application of recommended fertility level + 10 t FYM + 25 kg $ZnSO_4$/ha in wheat crop.

Effect on nutrients uptake

Uptake of N, P and K increased with progressive increase in the supply of N, P and K nutrients to the crop, probably because of high availability of these nutrients and higher grain and straw yield at higher fertility levels. Application of FYM with fertilizer levels significantly increased the NPK uptake by the crop than the application of fertilizers alone or in combination with zinc and being at par with the application of FYM + zinc together with fertilizer levels (Table 2). Maximum NPK uptake by the crop was recorded at 150% RDF with FYM + zinc together and was similar to the NPK uptake by the crop at 125% RDF with FYM + zinc together, but significantly higher than the RDF with FYM + zinc together. Although, application of FYM and zinc together with 150% RDF recorded higher nutrients uptake than RDF but it was at par in respect of P uptake in both the years and K uptake in second year by the crop at 125% RDF with FYM alone. This might be due to increased efficiency of fertilizers in the presence of FYM resulting in increased uptake (Dwivedi and Thakur, 2000).

Effect on physico-chemical properties of soil

Application of FYM and FYM + zinc along with fertilizer levels significantly increased the organic carbon, available nitrogen, phosphORUS and potash status of the soil and resulted in significant decrease in bulk density of the soil when compared with application of fertilizers alone and in combination with zinc (Table 2). Application of FYM + zinc alongwith fertilizer levels slightly increased the organic carbon, and nutrient status of the soil and decreased the bulk density of the soil than the application of FYM alone with fertilizer levels but the differences were non-significant. Dwivedi and Thakur (2004) also reported that pH and EC of soil decreased and the nutrient status of soil increased due to application of FYM @ 10 t/ha + RDF under rice-wheat system. The reduction in bulk density of the soil may be attributed to an increase in the amount of soil micro-aggregates due to the application of FYM. The reduction in bulk density due to formation of stable micro-aggregates which in turn increased the porosity of the soil is well known (Upadhyay *et al*., 1995).

Table 2. Effect of different treatment on nutrients uptake of crop and soil nutrient status (kg/ha) and other properties of soil

Treatment	N		P		K		After second year of wheat harvest					
	I	II	I	II	I	II	pH	OC (%)	N	P	K	Bulk density (g/cm^3)
RDF	71.9	75.9	20.0	21.6	64.8	67.8	7.8	0.47	233.6	21.2	130.8	1.57
RDF + Zn	74.9	84.0	20.4	23.4	66.1	73.2	7.8	0.47	233.8	21.6	131.3	1.57
RDF + FYM	89.4	94.5	24.9	27.6	78.6	82.6	7.6	0.52	237.6	23.1	132.6	1.51
RDF + Zn + FYM	91.6	97.1	25.2	28.1	79.8	84.1	7.5	0.52	238.2	23.4	133.0	1.50
125% RDF	80.6	89.9	21.8	25.0	69.2	77.4	7.8	0.48	233.9	21.6	131.3	1.56
125% RDF + Zn	82.2	91.1	22.1	25.3	70.0	78.1	7.8	0.48	234.3	21.8	131.5	1.56
125% RDF + FYM	94.4	100.2	26.1	28.8	81.1	86.5	7.5	0.54	238.2	23.8	133.0	1.49
125% RDF + Zn + FYM	97.2	101.6	26.6	29.1	82.5	87.0	7.4	0.55	238.6	24.2	133.3	1.49
150% RDF	84.6	92.8	22.7	25.5	71.9	78.7	7.8	0.48	234.3	21.8	131.6	1.55
150% RDF + Zn	87.4	94.0	23.2	25.6	73.1	78.9	7.8	0.48	234.7	22.0	131.8	1.55
150% RDF + FYM	98.4	102.7	27.4	29.5	84.8	88.1	7.5	0.55	239.1	24.0	133.8	1.47
150% RDF + Zn + FYM	101.9	105.6	28.1	30.2	87.1	90.3	7.5	0.56	239.6	24.4	134.1	1.46
SEm ±	1.7	1.5	0.7	0.6	1.6	1.5	0.8	0.01	1.2	0.6	0.4	0.02
CD (P=0.05)	5.3	4.6	2.4	2.0	5.1	4.6	NS	0.04	3.2	1.8	1.2	0.05

I: 2002-03; II: 2003-04

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