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Research Paper

Effect of nutrient management modules on soil properties, yield and quality of wheat (*Triticum aestivum*)

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ABSTRACT

A field experiment was conducted to study the effect of nutrient management modules on wheat (*Triticum aestivum* L.)-('NW 1014') yield and quality at students instructional farm, Narendra Deva University of Agriculture and Technology, Narendra Nagar, Ayodhya during winter season (*rabi*) of 2014–15 and 2015–16. The experimental soil was silty loam having organic carbon 3.4 g/kg with *p*H 8.38, available N 170.50, P 11.80 and K 215.50 kg/ha, S 6.10 and Zn 0.38 ppm. The experiment consisted of 14 treatments, viz. T_1, RDF (150:60:40 kg/ha N, P_2O_5 and K_2O); T_2, RDF + 20 kg $ZnSO_4$/ha; T_3, RDF + 5 t FYM/ha; T_4, RDF + 2.5 t VC /ha; T_5, RDF + 5 t FYM + 20 kg $ZnSO_4$/ha; T_6, RDF + 2.5 t VC + 20 kg $ZnSO_4$/ha; T_7, 75% RDF; T_8, 75% RDF + 20 kg $ZnSO_4$/ha; T_9, 75% RDF + 10 t FYM/ha; T_{10}, 75% RDF + 5 t VC/ha; T_{11}, 75% RDF + 10 t FYM + 20 kg $ZnSO_4$/ha; T_{12}, 75% RDF + 5 t VC + 20 kg $ZnSO_4$/ha; T_{13}, 125% RDF; T_{14}, 125% RDF + 20 kg $ZnSO_4$/ha. Pooled analysis revealed that the application of 100% recommended dose of fertilizer (RDF) + vermicompost at 2.5 t/ha + $ZnSO_4$ at 20 kg/ha recorded highest grain yield (4.91 t/ha), straw yield (6.75 t/ha) and protein content (11.71 %) followed by 100% RDF + FYM at 5 t/ha + $ZnSO_4$ at 20 kg/ha. Similar trend was also noted in soil properties after wheat harvest.

Key words: FYM, Protein content, Vermicompost, Wheat, Yield

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops of the world after rice. It is eaten in various forms by more than one billion people in the world. Wheat straw is a good source of feed for a large population of the cattle in India. It ranks second in the world among the cereals both in respect of acreage (231.0 m ha) and production (727.87 metric tonnes) (MOA & FW, GoI 2015–16). India is the second largest producer of wheat in the world. It is a pre-dominant winter season crop and during 2018–19, production in India was 101.20 million tonnes from an area of 29.55 million ha with a productivity of 3.44 tonnes/ha (ICAR-IIWBR, 2018–19).

Uttar Pradesh ranks first in respect of wheat crop coverage area (9.64 million ha) and production (30.00 million tonnes) but average productivity is low (3.11 t/ha) (FAO, 2014–15).

Integrated nutrient management plays a key role in maximizing the wheat productivity (Trapathi *et al.,* 2016). The most significant results are obtained, when we use organic manures in the combination of inorganic fertilizers (Patra *et al.,* 1999). 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 affects the crop growth and causes shriveling of grain and poor crop yield. Phosphorus is also important major plant nutrient for better crop production. It is necessary for photosynthesis. Potassium is the third major plant nutrient and plays very important role in photosynthesis and translocation of nutrients from leaves to the seed. Organic manures with the combination of chemical fertilizers, increase growth as well as 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 MATHODS

A field experiment was conducted during the winter season (*rabi*) of 2014–15 and 2015–16 at students' Instructional Farm, Narendra Deva University of Agriculture and Technology, Narendra Nagar, Ayodhya. The experimental

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soil was silty loam having organic carbon 3.40 g/kg with *p*H 8.38, available N 170.50, P 11.80 and K 215.50 kg/ha, S 6.10 and Zn 0.38 ppm. The soil samples were analyzed for *p*H, EC (Jackson, 1967); organic carbon (Walkley and Black, 1934); available N by alkaline permagnate (Subbiah and Asija, 1956); available P by $NaHCO_3$-extractable P (Olsen *et al.,* 1954); available K by flame photometer (Jackson, 1967); available sulphur by Turbidimeteric method (Williams and Steinbergs, 1959) and available zinc by DTPA extraction method (Lindsay and Norvell, 1978). 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 rows 20 cm apart on 26 November 2014 and 17 November 2015 and harvested on 14 April 2015 and 29 April 2016, respectively. 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 four uniform irrigations (at crown-root initiation, tillering, flowering and milking stages). The yield parameters and yields were recorded and analyzed as per Gomez and Gomez (1984). The treatment comparisons were made using t-test at 5% level of significance.

RESULTS AND DISCUSSION

Yield-contributing characters of wheat were influenced significantly by the application of organics in combination with inorganic fertilizers (Table 1). Application of T_6, RDF + 2.5 t VC + 20 kg $ZnSO_4$ resulted in maximum earhead/m^2, grains/earhead, thousand-grain weight, grain yield, straw yield and protein content. This treatment (T_6) produced insignificantly higher values in all the parameters as compared with recommended fertilizer application (T_1). This was followed by T_5, RDF + 5 t FYM + 20 kg $ZnSO_4$/ha treatment application. Maximum values of yield contributing characters were recorded under combined application of 100% RDF + 2.5 t VC + 20 kg $ZnSO_4$/ha, indicating that supplementing the inorganic fertilizers with FYM and vermin- compost improved the general soil environment, which helped to improve the wheat growth and yield contributing characters. These findings are corroboration with observations of Sharma *et al.* (2007).

The grain and straw yield were influenced by different nutrient management modules. The maximum grain yield (49.09 q/ha) recorded with the treatment T_6 having 100% RDF + 2.5 t VC + 20 kg $ZnSO_4$/ha was statistically at par with 100% RDF + 5 t FYM + 20 kg $ZnSO_4$/ha; 75% RDF + 10 t FYM + 20 kg $ZnSO_4$/ha and 75% RDF + 5 t VC + 20 kg $ZnSO_4$/ha and significantly superior over rest of the treatments. Similar trend was observed in straw yield also. Patil and Bhilare (2000), Davari *et al.* (2012) and Kausik and Ray (2008) also reported similar results.

The maximum protein content (11.71%) was observed with the treatment T_6 (100% RDF + 2.5 t VC + 20 kg $ZnSO_4$/ha), which was statistically at par with T_4, T_5, T_{11}

Table 1. Effect of nutrient management modules on yield attributes, yield and quality of wheat (pooled of 2 years)

Treatment	Earhead/m^2	Grains/ earhead	1,000-grain weight (g)	Yield (t/ha)		Protein content (%)
				Grain	Straw	
T_1	360.05	42.75	39.14	4.18	6.61	10.1
T_2	380.50	44.62	39.37	4.42	6.66	10.2
T_3	388.69	45.29	39.56	4.51	6.68	10.8
T_4	394.82	48.64	39.90	4.58	6.69	10.9
T_5	417.33	51.33	40.82	4.84	6.74	11.6
T_6	423.05	52.67	41.99	4.91	6.75	11.7
T_7	345.83	38.91	37.06	4.01	5.72	9.4
T_8	352.44	39.25	37.82	4.09	5.75	9.5
T_9	357.15	40.92	38.49	4.14	5.81	9.9
T_{10}	368.23	43.28	39.30	4.27	6.63	10.2
T_{11}	400.96	49.98	40.08	4.65	6.71	11.1
T_{12}	405.05	50.66	40.57	4.70	6.73	11.2
T_{13}	364.14	41.93	38.65	4.23	6.62	10.8
T_{14}	382.55	46.30	39.66	4.44	6.66	10.8
SEm±	11.78	1.42	1.23	1.37	1.89	0.31
CD (*P*=0.05)	33.44	4.03	3.68	3.88	5.36	0.87

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

Table 2. Effect of nutrient management modules on available nutrients in soil after harvest of 2nd year wheat crop

Treatment	*p*H	EC (dSm)	Organic carbon (g/kg)	Available nutrients (kg/ha)			Available nutrients (mg/kg)	
				N	P	K	S	Zn
T_1	8.57	0.35	3.6	154.7	13.6	213.0	6.7	0.40
T_2	8.58	0.35	3.6	163.5	14.4	225.1	7.1	0.47
T_3	8.43	0.34	4.1	167.0	14.7	229.9	7.3	0.43
T_4	8.41	0.27	4.1	169.6	15.0	233.5	7.4	0.44
T_5	8.42	0.29	4.4	179.3	15.8	246.9	7.8	0.48
T_6	8.41	0.28	4.5	181.8	16.0	250.2	7.9	0.48
T_7	8.56	0.33	3.6	145.9	12.9	200.9	6.4	0.39
T_8	8.56	0.34	3.6	149.4	13.2	205.7	6.5	0.46
T_9	8.44	0.27	4.2	153.5	13.5	211.3	6.7	0.46
T_{10}	8.41	0.28	4.2	158.2	14.0	217.8	6.9	0.46
T_{11}	8.39	0.27	4.4	172.3	15.2	237.2	7.5	0.48
T_{12}	8.39	0.27	4.4	174.0	15.4	239.6	7.6	0.49
T_{13}	8.56	0.34	3.8	156.5	13.8	215.4	6.8	0.42
T_{14}	8.57	0.35	3.8	164.4	14.5	226.3	7.2	0.47
SEm±	0.24	0.041	0.13	5.06	0.45	6.76	0.22	0.14
CD (*P*=0.05)	NS	NS	0.36	14.35	1.26	19.76	0.63	0.40

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

and T_{12} and significantly superior over rest of the treatments. The results reported by Randhe *et al.* (2009) are in conformity with the observation of present study.

Soil properties: Perusal of data in Table 2 showed that use of chemical fertilizers and their combination with organics resulted in non-significant changes in *p*H and EC of the soil after 2 years.

The treatment (T_6) RDF + 2.5 t VC + 20 kg $ZnSO_4$/ha application recorded maximum and significantly higher organic carbon, available nitrogen, phosphorus, potassium, sulphur and zinc content as compared to RDF (T_1). In treatment T_6, this increase was to the tune of 24.4% for organic carbon, 17.49% for available N, 19.52% for available P, 17.5% available K, 17.5% for S and 20% for Zn as compared to RDF (T_1).

Application of vermicompost and FYM alone and in combination with 100% NPK improved the status of organic carbon in soil. These findings are in agreement with the observations of Verma and Mathur (2009). The benefits might be due to the integrated use of fertilizers and manures which is also evident from the yield data. Similar results were also reported by Sharma *et al.* (2007). The beneficial effect of FYM and vermicompost on available nutrients may be ascribed to release of nutrients due to decomposition of organic matter. Application of 100% RDF +2.5 t VC + 20 kg $ZnSO_4$/ha was the best treatment as the maximum value of available sulphur and zinc (7.92 and 0.48 ppm, respectively) were recorded. The build-up in these two elements (S and Zn) might be due to accretion of amounts of added Zn and S through organic manure and $ZnSO_4$. Similar results were also reported by Kumar *et al.* (2011).

On the basis of results discussed above, it may be concluded that nutrient management module 100% RDF + 2.5 t VC + 20 kg $ZnSO_4$/ha resulted higher yield attributes, yield and protein content of wheat through its favourable effect on nutrient supply and soil properties.

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