Eco. Env. & Cons. 28 (3) : 2022; pp. (1411-1419)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i03.044

The role of tillage practices, nitrogen management by inorganic and organic manure and fertilizers and foliar applied of zinc on wheat (*Triticum aestivum* L.) crop performance and physico-chemical properties of soil under rainfed conditions

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(Received 23 May, 2021; Accepted 6 December, 2021)

ABSTRACT

Field studies were conducted during rabi season of 2014-15 to 2015–16 to at Crop Research Farm, Block E of SHUATS, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, to study effect of tillage implementations inorganic and organic nitrogen utilization and foliar applied zinc sulfate on wheat (*Triticum aestivum* L.) productivity and quality in the NEPZ. The experiment comprising two treatments in main plots (conventional and minimum tillage) in sub plots six organic and inorganic nitrogen management (*viz.*, NU_0; Control, NU_1; 50% RDN through inorganic with 50% RDN through organic, NU_2; 25% RDN through inorganic with 75% RDN through organic, NU_3; 50% RDN through inorganic with 50% RDN through organic, NU_4; 25% RDN through inorganic with 75% RDN through vermicompost organic NU_5; 100% RDN through inorganic and sub plots *viz.*, control and zinc,was laid out in split split plot design with three replications. Results revealed that significant and maximum (grain yield, 3.89 t/ha; number of leaves per plant, 17.25 and 18.12 at 75 and 90 DAS) respectively were recorded in crop cultivated by conventional tillage. Further, significantly the highest soil organic carbon (0.451%) was recorded in minimum tillage compare to conventional tillage. Significant and maximum yield and yield attributes (grain yield, 4.14 t/ ha; straw yield, 8.39 t/ha; plant height, 84.42 and 94.58 cm at 90 and 105 DAS; number of leaves per plant, 17.82 and 18.25 at 75 and growth attributes 105 DAS, respectively were recorded in applied nitrogen management NU_3 50% RDN through inorganic with 50% RDN through organic treatment. Based on teh pooled data significant maximum organic carbon (0.46%) Pore space (48.407 and 48.135% at depth 0-15 and 15-30 cm) were recorded in NU_4, respectively. Further minimum value of soil pH (7.24), mm (4.56 ppm) Cu (0.53ppm), Bulk density 1.329 and 1.316 gcm^3 at 0-15 and 15-30cm), Particle density (2.517gcm^{-3} at 15-30 cm), respectively were recorded in NU_4 treatment. The foliar application of 0.5% zinc sulphate had pronounced effect on soil properties and crop performance of wheat under rainfed conditions.

Key words : *Fertilization, Cultivation, Growth, Yield, Wheat*

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Introduction

The productivity of rainfed crops is primarily affected by the distribution of crop seasonal rainfall received from sowing to harvesting soil fertility and applied fertilizer nutrients. Wheat (*Triticum aestivum* L.) is the predominant rainfed rabi crop grown but crop yield remains stagnant due to low moisture retention, high evaporation and nutrient deficiencies in soil. The situation is further aggravated by occurrence of recurring dry spells during critical stage of crop growth period which leads to substantial loss of crop productivity. Of late, it has been established that disturbing the soil too much through tillage operations is not actually required to obtain good crop yields (Prasad *et al.,* 2006), and also a major portion of energy (25-30%) in agriculture is utilized for either field preparation or crop establishment (Tomar *et al,*. 2006), where conventional tillage is mostly followed (Saha *et al.,* 2010).

The interactive advantages of combining organic and inorganic sources of nutrients in integrated nutrient management have proved superior to the use of each component separately (Palaniappan and Annadurai, 2007). Judicious use of organic manures, such as farmyard manure and vermicompost along with chemical fertilizers improves soil physical, chemical and biological properties and enhance productivity in both the seasons. It is essential to identify such practices which bring more sustainability to the production system, besides improving the productivity of the system and soil health (Urkurkar *et al.,* 2010).

Zinc (Zn) deciency is widespread in the world, particularly in the Asian and African continents and aecting both human health and crop production. Wheat is more relevant to both of these concerns, as wheat is more susceptible to soil Zn deciency and is a staple food crop for some of the Zn-decient human population (Impa and Johnson, 2012). The regions with Zn-decient soils are also regions of widespread Zn deciency in human beings, including India, Pakistan, China, Iran and Turkey (Brown, 2004). Producing staple food crop grains richer in Zn could certainly help in alleviating Zn deciencies in both humans and animals (Dass *et al.,* 2017). Low solubility of Zn is the major cause for the extensive occurrence of Zn deciency in crops (Bukvic *et al.,* 2003). Likewise, iron is also an essential micronutrient for plant growth and metabolism, especially in chlorophyll synthesis and for the maintenance of chloroplast structure and function. Any practice of nutrient management, which either decreases or increases the supply of another nutrient element or its absorption from the soil by plants or translocation and mobility within the plant, will influence its nutrition and, thereby, the nutrient use eciency and crop yield (Rehim *et al.,* 1954).

Materials and Methods

Study area

Field experiment was conducted on wheat during rabi 2014–15 to 2015–16 under rainfed conditions at Crop Research Farm, Block E of SHUATS, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India. The experimental site experiences sub-humid climate and was located at latitude of 25^0 24' 42" N and longitude of 81^0 50' 56" E at 98 m above mean sea level.

Soil sampling and experimental design

Initial soil sample at the start of the study was sandy loam in texture, low in soil organic carbon 0.39, 0.40 at 2014–15 and, available nitrogen (243.39 kg/ha), available potassium (261.76 kg/ha) and medium in available phosphorus (22.19 kg/ha) respectively. The experiment having plot size of 4 m × 3.6 m (14.4 m^2) was laid out in a split split plot design with three replications.

Crop husbandry

All treatments received 100% recommended dose of fertilizers of NPK (120:60:40) soil application in addition and zinc foliar sprays as per treatments except in control. Wheat crop was sown with recommended seed rate of 125 kg/ha with row to row spacing of 22.5 cm. Recommended cultural practices of growing wheat were followed and the plant samples of one-meter row were taken at random from the middle rows of each plot from the three replicates to measure plant height (cm), number of tillers per hill, number of leaves per plant of crop. The data of two years were pooled and statistically analyzed using analysis of variance (ANOVA) for split split plot design. The treatment means were tested for significance at P = 0.05.

Treatment details of experiment

Tillage practices (T)

CT_1; Conventional tillage (1 ploughing by tractor drawn disc plough + 2 harrowing + 1 fb cultivators with planking) and MT_2; Minimum tillage (1 ploughing by tractor drawn rotavator).

Nitrogen Management

NU_0; Control, NU_1; 50% RDN through (Urea 111.30 kg/ha and DAP 49.00 kg/ha Fertilizer) with 50% RDN through FYM 12000 kg/ha, NU_2; 25% RDN through (Urea 52.47 kg/ha and DAP 32.60 kg/ha Fertilizer) with 75% RDN through FYM 18000 kg/ha, NU_3; 50% RDN through (Urea 117.69 kg/ha and 32.60 DAP kg/ha fertilizer) with 50% RDN through vermicompost 3000 kg/ha, NU_4; 25% RDN through (Urea 44.16 kg/ha and 48.91 DAP kg/ha Fertilizer) with 75% RDN through vermicompost 4500 kg/ha and NU_5; 100% RDN through (Urea 209.84 kg/ha and 130.43 DAP kg/ha Fertilizer).

Zinc foliar spray (Z)

ZC; Control and ZW;0.5% Zinc foliar spray/ha through $ZnSO_4$ in which 5 kg of $ZnSO_4$ and 2.5 kg of slaked lime is dissolved in 1,000 liters of water to spray an area of 1 hectare after 35 days of sowing.

Physical properties of soil

The physical properties of soil were determined by core sample method described by Blake (1965) to a depth of 0-15 cm before the application of the treatment and after harvest. Soil core were taken from each plot using cylindrical iron ring of 5 cm height and 5 cm internal diameter. A concentric collar of 5 cm internal diameter and 2 cm height was placed above the ring to avoid compaction. Soil then dried at 105^{0}C for 24 hour and calculate bulk density, particle density and pore space by following formulas-

Bulk density (g cm^{-3}) = Oven dry weight of soil/ Volume of the air-dry soil

Particle density (g cm^{-3}) = Oven dry weight of the total soil/Particle volume of the soil

Pore space (%) = 1- (Bulk density/Particle density) *100

Results and Discussion

Grain and straw yield

Tillage practices significantly influenced the growth attributes and grain yield of wheat (Table 2). The highest grain yield and number of leaves per plant were observed with conventional tillage (1 ploughing by tractor drawn disc plough + 2 harrowing + 1 fb cultivators with planking). Lowest values of the entire yield attributing characters were recorded with minimum tillage (1 ploughing by tractor drawn rotavator). Increase in yield under conventional system with residue was associated with better root growth and increased water use by the crop. Similarly, decrease in yield under minimum tillage might be attributed to increased soil strength (as evidenced by bulk density and soil penetration re-

Table 1. Initial soil condition of experimental site.

Soil Properties	Experimental year			Method	References
	2014-15	2015-16	Average		
Chemical properties					
Organic carbon (%)	0.39	0.40	0.40	Walkley and Black method	Jackson, 1973
Available copper (ppm)	0.44	0.46	0.45	DTPA extractable method	Lindsay and Norvell, 1978
Available manganese (ppm)	4.22	4.44	4.33	–	–
Available sulfur (ppm)	13.16	13.20	13.18	Turbidimetric method	Wolf, 1982
Physico-chemical properties					
Soil pH	7.52	7.42	7.47	Glass electrode pH meter	Jackson, 1973
EC (dSm^{-1})	0.38	0.37	0.38	Method No.4 USDA Hand Book No.16	Richards, 1954
Sand (%)	59.60	59.60	59.60	Bouyoucos hydrometer method	Bouyoucos, 1927
Silt (%)	25.27	25.26	25.27	–	–
Clay (%)	15.13	15.14	15.14	–	–
Textural class	Sandy loam	Sandy loam	Sandy loam	Triangular method	Piper, 1950
Bulk density (g cm^{-3})	1.40	1.39	1.40	Core sample method	Blake, 1965
Particle density (g cm^{-3})	2.61	2.60	2.61	–	–
Pore space (%)	46.36	46.53	46.45	–	–

sistance values) and consequent retardation in root growth and reduction in water utilization from deeper layers (Saha *et al.* 2010). Crop yield pooled data presented in Table 2 showed that grain and straw yields were statistically under conventional tillage as compared to minimum tillage. It right be due to cultivated by minimum tillage does not create favourable tilth and roots growth of plants it remain shallow and they may not able to extract nutrients and moisture from deeper layers of the soil (Kharub, and Chander, 2010).

Significantly higher grain yield (4.14 t/ha) was found (Table 2) in treatment NU_3 and this could be ascribed to the provision of nutrients at later stages which might have enhanced accumulation of assimilates in the grains of wheat. This may be due to the effects of combined use of organic and inorganic nitrogen management in form of vermicompost organic matter it occurred mineralisation in soil and the release of micronutrients and/or an increase in the growth of root system and its activity and effect of NH_4 + on rhizosphere reaction.The higher average grain (4.14 kg/ha) and straw yield (8.39 kg/ha) was recorded with NU_3 which showed statistical at par with all treatments except in grain yield NU_2 and NU_0 and straw yield NU_0, NU_1 and NU_5 and this treatment proved significantly superior to other treatments (Table 2). Increase in yield by nitrogen through 50 % organic and 50 % inorganic combination of nutrients might be due to increased vegetative growth, more synthesis of carbohydrates and their translocation for the synthesis of organic nitrogen compounds which are constituents of protoplasm and chloroplasts. The results are substantiated by the findings of the studies conducted by Mattas *et al.* (2011) and Roshan *et al.* (2011) at different locations.The increase may also be due to nutrients supply in a variable manner depending on their source quality, which ultimately increase yield components (Ahmad *et al.*, 2007). The increase in yield components was greatly due to more availability of plant essential nutrients on decomposition throughout the growing season. The increase may also be due to nutrients supply in a variable manner depending on their source quality, which ultimately increase yield components (Alamzeb *et al.*, 2017) and (Ahmad *et al.*, 2007).

Significant and highest grain and straw yield (3.86 and 7.86 t/ha) were recorded (Table 2) in foliar spray of zinc 0.5% by zinc sulphate monohydrate compare to control. Availability of nutrients at vital growth period (Javad *et al.*, 2013) and synthesis of carbohydrates and their translocation with foliar spray which in turn increased the crop yield. Higher grain and straw yields significantly influenced by foliar spray. Increase in the crop growth attributes by foliar zinc was also observed that crop readily absorbs more nutrients through foliar application which in turn produced more tillers. It might be due this increment may be due to the stimulating effect of zinc that improve the physiological performance of plants and foliar application improved the efficiency and rapidity of utilization of a nutrient urgently required by the plant for maximum growth and yield (Abrol *et al.*, 2020). It might be due to enhancement of various enzymatic activities leading to increased photosynthetic activity and dry matter accumulation, which in turn led to higher yield attributes and yield (Hussain *et al.*, 2004 and Paramesh *et al.*, 2014). (Alloway, 2008) described that Zn improves photosynthesis, transformation of carbohydrates and seed development. These results are supported by the findings of (Nawaz *et al.*, 2015), who reported that Zn application improved the wheat yield over control (Imran and Rehim, 2017) and (Paramesh *et al.*, 2020).

Growth attributes

Tillage practices significant and highest was recorded (Table 2) number of leaves per plant (17.25 and 18.12 at 75 and 90 DAS), respectively in conventional tillage (1 ploughing by tractor drawn disc plough + 2 harrowing + 1 fb cultivators with planking) compare to minimum tillage (1 ploughing by tractor drawn rotavator).

Significant and maximum growth attributes in which combination (Table 2) of fertilizers and manures NU_5 represented of plant height (5.83, 1.26, 2.32, 0.66, 0.76 and 0.00 cm at 75 DAS) and number of leaves per plant (15.10, 2.65, 2.88, 0.43, 4.26 and 0.00 at 90 DAS) per cent over treatments NU_0, NU_1, NU_2, NU_3, and NU_5, respectively. Growth attributes with application of NU_3 was significantly higher recorded plant height (6.83, 0.46, 0.45, 0.00, 0.11 and 1.41 at 90 DAS) and (4.12, 1.11, 0.51, 0.00, 0.78 and 0.41 at 105 DAS), number of tillers per hill (12.04, 4.09, 6.84, 0.00, 6.37 and 0.62 at 75 DAS), (17.58, 2.03, 2.38, 0.00, 4.51 and 1.69 at 90 DAS) and (9.71, 1.33, 0.99, 0.00, 2.69 and 0.33 at 105 DAS) and number of leaves per plant (17.16, 4.03, 2.18, 0.00, 6.20 and 0.34 at 75 DAS) and (29.89, 12.45, 7.54, 0.00, 8.31 and 0.88 at 105 DAS) per cent over treatments NU_0, NU_1,

NU_2, NU_3, and NU_5, respectively. This may be on account of better availability of N at critical growth stages, resulting in reduced tiller mortality and build-up of high reserve pool of assimilates. The results corroborate the findings of Kumar and Yadav (2005) and (Meena, 2010). This might be due to higher availability of applied nutrients and improved physical properties of soil which favors better environment for plant growth along with balanced nutrition and improving the efficiency of chemical fertilizers. The margin of difference with respect to crop growth between different fertility levels was less during initial growth stage and then increased markedly during advanced stage of growth. It can be attributed to slow mineralization of organic matter at initial stage of crop growth (Yadav *et al.*, 2014). Similar findings were reported by Ram and Mir (2006). This might be due to better root and shoot growth and healthy plants in presence of organic and inorganic combination of applied nutrients. As a result, the plants might have taken up higher amount of nutrients through vermicompost manure including macro and micronutrients. Similar observations were reported by Lin *et al.* (2007) and Kumar *et al.*, 2019a; Kumar *et al.*, 2019b).

Foliar spray of zinc by 0.5 % zinc sulphate was noticed (Table 2) significant and highest plant height (83.70 cm at 90 DAS), number of tillers (4.76 at 75 DAS) and number of leaves per plant (17.22 and 17.04 at 75 and 105 DAS), respectively compared to the control.

Soil properties

Soil pH affected by minimum tillage (Table 3) it converts to natural by percentage of 0.82 decreased compare to conventional tillage. Minimum tillage enhanced the organic carbon (0.451%) as well as available S (12.87 ppm), Mn (4.39 ppm) and Cu (0.50 ppm) in soil at harvest might be owing to previous crop residue retained on soil surface maintained thermal heat and season long moisture retention ul-

Table 2. Growth attributes at different growth stage and yield of wheat crop as influenced by tillage practices, nitrogen management and zinc foliar spray treatments (pooled data of 2 years)

Treatments	Grain yield (t/ha)	Straw yield (t/ha)	Plant height (cm)			Number of tillers per hill			Number of leaves per plant		
			75 DAS	90 DAS	105 DAS	75 DAS	90 DAS	105 DAS	75 DAS	90 DAS	105 DAS
Tillage practices											
CT_1	3.89 a	7.77	78.97	83.72	93.65	4.65	2.90	3.02	17.25 a	18.12 a	17.26
MT_2	3.60 b	7.56	77.90	82.65	93.39	4.58	2.87	2.93	16.79 b	17.65 b	16.22
F-test	S	NS	NS	NS	NS	NS	NS	NS	S	S	NS
SEm±	0.02	0.07	0.32	0.57	0.23	0.14	0.05	0.03	0.06	0.05	0.21
CD (P=0.05)	0.10	-	-	-	-	-	-	-	0.35	0.30	-
CV (%)	2.54	5.62	3.54	4.09	1.44	17.87	11.34	7.00	2.03	1.63	7.58
Nitrogen utilization											
NU_0	2.66 c	5.65 c	75.42 c	79.02 b	90.84 b	4.32 b	2.56 b	2.78 b	15.21 c	16.16 b	14.05 c
NU_1	3.93 a	7.82 b	78.83 b	84.03 a	93.54 a	4.65 a	2.95 a	3.01 a	17.13 b	18.12 a	16.23 b
NU_2	3.81 b	8.09 a	78.01 b	84.04 a	94.10 a	4.53 b	2.94 a	3.02 a	17.44 a	18.08 a	16.97 b
NU_3	4.14 a	8.39 a	79.30 a	84.42 a	94.58 a	4.84 a	3.01 a	3.05 a	17.82 a	18.52 a	18.25 a
NU_4	3.96 a	8.23 a	79.22 b	84.33 a	93.85 a	4.55 a	2.88 a	2.97 a	16.78 b	17.84 a	16.85 b
NU_5	3.95 a	7.82 b	79.82 a	83.25 a	94.19 a	4.81 a	2.96 a	3.04 a	17.76 a	18.60 a	18.09 a
F-test	S	S	S	S	S	S	S	S	S	S	S
SEm±	0.09	0.13	0.79	0.89	0.46	0.10	0.07	0.06	0.18	0.26	0.36
CD (P=0.05)	0.27	0.39	2.34	2.63	1.37	0.29	0.20	0.16	0.53	0.77	1.05
CV (%)	8.36	5.90	3.38	3.71	1.72	7.36	8.09	6.48	3.67	5.05	7.39
Zinc foliar spray											
ZC	3.63 b	7.48 b	78.46	82.66 b	93.34	4.47 b	2.86	2.94	16.83 b	17.83	16.44 b
ZW	3.86 a	7.86 a	78.41	83.70 a	93.70	4.76 a	2.91	3.01	17.22 a	17.94	17.04 a
F-test	S	S	NS	S	NS	S	NS	NS	S	NS	S
SEm±	0.05	0.09	0.40	0.25	0.26	0.07	0.04	0.04	0.13	0.08	0.14
CD (P=0.05)	0.16	0.25	-	0.73	-	0.21	-	-	0.37	-	0.41
CV (%)	8.63	6.78	3.13	1.80	1.65	9.23	8.05	7.83	4.52	2.73	5.00

Table 3. Physico-chemical properties of soil after the harvest of wheat crop as influenced by tillage practices, nitrogen management and zinc foliar spray treatments (pooled data of 2 years)

Treatments	Soil pH	Electrical conductivity (dS/m)	Organic carbon (%)	Available nutrients (ppm)			Bulk density ($g\ cm^{-3}$)		Particle density ($g\ cm^{-3}$)		Pore space (%)	
				S	Mn	Cu	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Tillage practices												
CT_1	7.39	0.36	0.447 b	12.78	4.36	0.48	1.398	1.358	2.605	2.591	46.310	47.284
MT_2	7.33	0.36	0.451 a	12.87	4.39	0.50	1.409	1.374	2.594	2.569	45.642	46.359
F-test	NS	NS	S	NS	NS	NS	NS	NS	NS	NS	NS	NS
SEm±	0.04	0.01	0.000	0.20	0.02	0.01	0.010	0.010	0.012	0.012	0.554	0.837
CD (P=0.05)	-	-	0.002	-	-	-	-	-	-	-	-	-
CV (%)	3.49	11.27	0.41	9.53	3.09	12.47	3.02	3.20	1.992	2.053	5.112	7.580
Nitrogen utilization												
NU_0	7.47 b	0.37	0.429 c	11.98 b	4.09 b	0.42 c	1.419 b	1.414 c	2.614	2.608 b	45.599 b	44.399 b
NU_1	7.43 b	0.37	0.449 b	12.78 a	4.38 a	0.49 a	1.436 b	1.353 b	2.577	2.578 b	44.227 b	47.194 a
NU_2	7.35 a	0.37	0.452 b	12.77 a	4.39 a	0.52 a	1.429 b	1.355 b	2.634	2.619 b	45.738 b	48.052 a
NU_3	7.28 a	0.36	0.452 b	13.15 a	4.43 a	0.49 a	1.403 b	1.360 b	2.589	2.555 a	45.770 b	47.175 a
NU_4	7.24 a	0.35	0.462 a	13.19 a	4.56 a	0.53 a	1.329 a	1.316 a	2.576	2.517 a	48.407 a	48.135 a
NU_5	7.38 b	0.36	0.451 b	13.09 a	4.41 a	0.47 b	1.406	1.397	2.608	2.602 b	46.116 a	45.973 b
F-test	S	NS	S	S	S	S	S	S	NS	S	S	S
SEm±	0.04	0.01	0.002	0.27	0.07	0.01	0.020	0.015	0.021	0.027	0.980	0.876
CD (P=0.05)	0.12	-	0.005	0.79	0.21	0.04	0.042	0.032	-	0.056	2.045	1.828
CV (%)	1.98	7.89	1.18	7.27	5.71	8.70	3.50	2.77	2.013	2.552	5.222	4.583
Zinc foliar spray												
ZC	7.37	0.36	0.448 a	12.80	4.37	0.49	1.463 b	1.414 b	2.607	2.574	43.846 b	44.839 b
ZW	7.35	0.36	0.450 a	12.86	4.39	0.49	1.345 a	1.318 a	2.592	2.586	48.106 a	48.803 a
F-test	NS	NS	S	NS	NS	NS	S	S	NS	NS	S	S
SEm±	0.03	0.01	0.001	0.13	0.05	0.01	0.011	0.008	0.009	0.013	0.446	0.478
CD (P=0.05)	-	-	0.002	-	-	-	0.023	0.016	-	-	0.921	0.987
CV (%)	2.81	9.26	0.90	6.20	6.95	11.54	3.36	2.38	1.495	2.163	4.117	4.332

S: Sulphur, Mn: Manganese Cu: Copper

timately increase organic C and available micronutrients. Further, the maximum particle density and pore space build-up the tune of by (0.42 and 0.86%) and (1.46 and 2.00%), respectively observed in conventional tillage compare to minimum tillage. The lowest bulk density also found in conventional tillage. This might be due to soil was well pulverized repeatedly by ploughing and planking under conventional tillage. Similar findings were given by Singh *et al.* (2002) and Yadav and Kumar (2004). Porosity is directly related to bulk density because as bulk density decreases, porosity increases. These results suggest that increased crop residue can lead to the improvement of soil physical properties (Singh *et al.*, 2018). Organic inputs improve and help in stabilization of the aggregates through formation of clay-humus complexes. On the other hand, conventional tillage disrupts the network of fungal hyphae by mechanical breakdown of macroaggregates and then releasing particulate organic matter from macroaggregates resulting in decrease of aggregate stability (Ashagrie *et al.*, 2007).

In nutrients utilization (Table 3) of nitrogen attained by 25 % inorganic fertilizer and 75 % organic manure decreased significantly the soil pH (7.24) and non-significant electrical conductivity (0.35 dS/m) compared to other treatments and the highest pH (7.47) in control. Application of Vermicompost 75 % enhances the soil organic carbon (0.462 %) content and has direct and indirect effects on soil properties and processes. The potential benefits of organic manure in maintaining and sustaining soil health and productivity has been reported by several workers (Lenka *et al.,* 2012; Lenka *et al.,* 2011; Mohanty *et al.,* 2006 and Singh *et al.,* 2014). Further, NU_4 treatment was the most efficient in utilization of organic and inorganic manure and fertilizers resulted increased the micronutrients nutrients in soil *viz.,* S, Mn and Cu (13.19, 4.56 and 0.53 ppm) over other treatments, respectively. Shiva Kant and Rajkumar (1992) have also reported improvement in soil properties by the use of organic materials. This may be ascribed to the acidic effect, supply of calcium and magnesium and salt leaching facilitated by improved soil permeability to water. Available nitrogen and zinc in post-harvest soil increased on account of their addition and chelating action of organic materials and mobilization from their native insoluble compounds (Ram *et al.*, 2000).

Crop fertilized by foliar spray by zinc sulphate (Table 3) significantly the highest was recorded (organic carbon, 0.450 %), pore space (48.106 and 48.803% at depth, 0-15 and 15-30 cm) respectively. However minimum value of particle density (2.592 and 2.586 g cm^3 at depth, 0-15 and 15-30 cm) and bulk density (1.345 and 1.318 g cm^3 at depth, 0-15 and 15-30 cm), respectively were recorded during both the year. The increase in Zn concentration might be due to synergistic effect between nitrogen and zinc as adequate supply of N enhanced the translocation of Zn from roots to other parts of plants. Further better root and shoot growth with the application of N might have led to better utilization of the zinc and other cations from the soil solution.

Conclusion

The results obtained from the experiment provide us major findings on the influence of tillage, nitrogen management and Zn foliar spray on yield and quality parameters of wheat. Soil cultivated by conventional tillage and nitrogen applied 50% of recommended N through chemical fertilizer and 50% of recommended N through organic with foliar application of Zn increased growth attributes and yield,over other treatments. Soil fertility and favourable chemical and physical soil properties achieved in CT + 25% RDN through (Urea 44.16 kg/ha and 48.91 DAP kg/ha Fertilizer) with 75% RDN through vermicompost + ZW compare to other treatment.

Acknowledgement

My final thanks are due to my post graduate major advisor Dr. J. J. Patel Retd. Professor of agronomy, Department of Agronomy, B.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, 388 10 who helped me a lot to brought this research into its present existence.

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