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Nutrient Content and Uptake by Wheat (*Triticum aestivum* L) as Influenced by Iron and Zinc Enriched FYM in Salt Affected Soils of Gujarat

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A B S T R A C T

A field experiment was conducted for 4 successive years, consisting of eight treatments laid out in randomized block design to evaluate the nutrient content and uptake by wheat (*Triticum aestivum* L) as influenced by iron and zinc enriched FYM on salt affected soils of Gujarat. The results reveal that application of recommended dose of fertilizer (120-60-00 NPK kg ha^{-1}) on the basis of STV + 0.5 t FYM ha^{-1} enriched with 0.75 kg Zn and 1.5 kg Fe (T_8) recorded significantly higher grain and straw yields of wheat over T_1 (Recommended dose of fertilizer on the basis of STV only) on pooled basis. Significantly higher nitrogen (2.41%), phosphorus (0.33%) and iron (59.07 mg kg^{-1}) content in grain and highest nitrogen (1.09%), phosphorus (0.173%), potassium (1.32%), iron (265.2 mg kg^{-1}) and zinc (42.75 mg kg^{-1}) content in wheat straw were observed with the application of RDF (based on STV) along with 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe on pooled basis. While, significantly higher potassium content in wheat grain was observed with the application of recommended dose of fertilizer (120-60-00 NPK kg ha^{-1}) on the basis of STV+1.0 t FYM ha^{-1} (T_5) on pooled basis. The results revealed that significantly maximum nitrogen (119.82 and 84.97 kg ha^{-1}), phosphorus (16.25 and 14.02 kg ha^{-1}), potassium (31.54 and 104.2 kg ha^{-1}) and iron (305.8 and 2098 g ha^{-1}) uptake by wheat grain and straw was recorded under treatment T_8 (T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe) on pooled basis; but in case of zinc uptake by wheat grain (88.88 g ha^{-1}) was higher under treatment T_5 (T_1 + 1.5 kg Zn + 3.0 kg Fe ha^{-1}) on pooled basis.

Keywords

Wheat, Nutrient, Content, Uptake, FYM

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Introduction

Wheat is the prevailing grain crop of the world commerce. It is occupying a significant ingredient of the daily diet of millions of people. It plays an imperative role in human diet and also provides a strong monetary support of the country (Singh *et al.*, 2012). In high input agriculture, deficiency of micronutrients has become major constraint to productivity, stability and sustainability of soils. These deficiencies appeared much faster primarily due to the fast adoption of new agricultural technology, including cultivation of high yielding crop varieties, increase in cropping intensity, expansion of irrigation facilities, more use of high analysis fertilizers and poor quality irrigation water. Among micronutrients, Zn is now being regarded as the third most limiting nutrient element in crop production after N and P. The extent of Fe deficiency in India is next to the Zn. About 11% of Indian soils are deficient in iron and recently Mn has become critical. Cereal crops are inherently very low in grain Zn and Fe concentrations and growing them on potentially Zn and Fe deficient soils further reduces Fe and Zn concentrations in grain (Cakmak *et al.,* 2010). Organic source of plant nutrients helps in increasing soil organic matter and improving soil environments as well as meeting a part of nutrients need of crops. Organic matter like FYM also helped in improving micronutrient status of soil. Zn, Fe and Mn plays very important role in photosynthesis and growth of plants. To obtain high yields without deterioration of soil fertility, it is important to workout optimal combination of fertilizers and manures in the cropping system (Pullicinoa *et al.,* 2009).

In India, increasing productivity of wheat becomes a most to overcome unusual increase in population. In literatures several workers showed the importance of farmyard manure on increasing cereal grain yield. The various physico-chemical processes also mediated the Zn and Fe availability in alkaline soils (Meena *et al.,* 2013), *i.e.* variation in chemical composition of salt affected soils, precipitation-dissolution reactions, adsorption kinetics, transformations of nutrients and crop responses to applied nutrients greatly vary (Katyal and Sharma, 1980; Datta *et al.,* 2013). Application of micronutrients decides the yield potential of crops in deficient soil with low carbon content (Shukla *et al.,* 2014; Ray *et al.,* 2014). Use of FYM and other organic manures produces various types of organic acids during the microbial decomposition and converted the plant nutrients from immobile to mobile in the soil solution (Dotaniya *et al.,* 2016). Combined soil application of micronutrients with FYM significantly enhanced the mustard yield in normal soil (Meena *et al.,* 2006).

Organic manures not only supply micronutrients but also influence the transformation of native micronutrients in soil, thereby enhancing their availability to crops (Pal *et al.,* 2008; Meena *et al.,* 2018). The contributions of soil organic matter to available pools of micronutrients are limited and thus, prone to deficiency of one or more micronutrients especially Zn and Fe in salt affected soils (Sharma *et al.,* 2009). Straight or alone application of zinc and Fe fertilizer in normal soil increased the biological produce in mustard (Singh *et al.,* 2010) and in pearl millet (Shukla *et al.,* 2014). In contrast to Zn fertilizer, soil application of inorganic Fe salts is ineffective in controlling Fe-deficiency in alkaline soil, except when application rates are as higher as 150 kg $FeSO_4$ ha^{-1} under aerobic rice (Pal *et al.,* 2008). Also, the efficacy of foliar spray of Zn and Fe varies with species and cultivars (Meena *et al.,* 2016). It is well documented that application of Zn in saline soil increased the its concentration in maize (Rahman *et al.,* 1993) and tomato (Knight *et al.,* 1992) and decreased in case of cucumber leaves (Al-Harbi, 1995).

Influences of Fe application in plants were also inconsistent as Zn concentration in plants (Achakzai *et al.,* 2010). Ferrous iron (Fe^{2+}) content in rice and other plants proved to be a better index of Fe-nutrition status compared to total plant Fe and chemically extractable soil Fe (Katyal and Sharma, 1980; Meena *et al.,* 2016). Limited information is available on the adequate level of Fe^{2+} in pearl millet and mustard under field conditions which can be used for monitoring purpose. The available information pertaining to ways and means for optimizing Zn and Fe requirements to ameliorate deficiencies of these nutrients in various crops have mostly been confined to normal soil conditions. Such information is yet to be generated for pearl millet and mustard cropping sequence grown under salt affected soils. Therefore, the judicious Zn and Fe management of plant nutrition in salt affected soils can enhance the food grain production potential of degraded soils. Keeping in view the above facts, this study was initiated to assess the nutrient content and uptake by wheat as influenced by iron and zinc enriched FYM in salt affected soils of Gujarat.

Materials and Methods

A field experiment was conducted from 2014-15 to 2015-16, 2016-17 and 2017-18 at Agricultural Research Station, Sardarkrushinagar Dantiwada Agricultural University, Adiya, Gujarat. This experiment consisting of eight treatment combinations *viz.,* T_1: RDF (Based on STV), T_2: T_1 +1.0 t FYM ha^{-1}; T_3: T_1 + 1.5 kg Zn ha^{-1}; T_4: T_1 + 3.0 kg Fe ha^{-1}; T_5: T_1 +1.5 kg Zn ha^{-1} + 3.0 kg Fe ha^{-1}; T_6: T_1 + 0.5 t FYM ha^{-1} enriched with 0.75 kg Zn; T_7: T_1 + 0.5 t FYM ha^{-1} enriched with 1.5 kg Fe; T_8: T_1 + 0.5 t FYM ha^{-1} enriched with 0.75 kg Zn and 1.5 kg Fe in randomized block design, which was replicated four times and wheat variety Raj-3077 was sown. The soil of the experimental field was loamy sand in texture, alkaline in reaction and soluble salt content under unsafe limit. It was low in organic carbon, medium in available P_2O_5 and medium to high available K_2O and DTPA extrable Zn and low status of DTPA extrable Fe (Table 1).

Treatment-wise representative grain and straw samples were collected from each plot after harvest. After harvest of the crop, wheat grain/seed and straw samples were taken for analysis. The samples were washed with dilute 0.03 N HCl, single and double deionized water in a sequence and air dried. Then samples were dried in paper bags at 70^0C till constant weight in a hot air oven and preserved for further analysis. These samples were ground in a stainless steel Wiley mill to avoid contamination of micronutrients. The processed samples were preserved in airtight polyethylene bags for further analysis.

Dried plant samples (grain and straw) were ground in a stainless steel blade Willey mill and digested in di-acid mixture (HNO_3: $HClO_4$ – 4:1) and volume was made with double distilled water (Jackson, 1979). The extract was filtered through Whatman filter paper No. 42. The digested extract of plant samples was used for analysis of phosphorus (Vanadomolybdate yellow colour), potassium (Flame photometric method) and micronutrients (Atomic absorption spectrophotometer). The data of seed yield and straw yield recorded from net plot and converted on hectare basis. The collected data for various parameters were statistically analyzed using Fishers' analysis of variance (ANOVA) technique and the treatments were compared at 5% level of significance.

Results and Discussion

Grain and straw yield

The vital effect of experimental variable was reflected in the final yield of wheat crop. The consequences obtainable in Table 2 make known that application of suggested quantity of fertilizer (120-60-00 NPK kg ha^{-1}) on the basis of STV + 0.5 t FYM ha^{-1} enriched with 0.75 kg Zn and 1.5 kg Fe (T_8) recorded significantly higher grain (4790 kg ha^{-1}) and straw (7833 kg ha^{-1}) yields of wheat over T_1 (Recommended dose of fertilizer on the basis of STV only) on pooled basis. But, it was at par with T_5 on pooled basis in case of grain (4682 kg ha^{-1}) and straw (7447 kg ha^{-1}) yield. Cakmak *et al.,* (2008) reported that there is increasing evidence showing that foliar or combined soil foliar application of Zn fertilizers under field conditions are highly effective and very practical way to maximize uptake and accumulation of Zn in whole wheat grain, raising concentration up to 60 mg Zn kg^{-1}. Increase in yield was due to improved availability of iron and zinc which could be attributed to the formation of stable organometalic complexes with organic matter, especially during the enrichment process to last for a longer time and release the nutrients slowly in the soil system in such a way that the nutrients are protected from fixation and made available to the plant root system throughout the crop growth (Meena *et al.*, 2006). This could be due to the favorite effect of adding FYM as a good source of plant nutrients. Furthermore, FYM acts as a natural soil conditioner which improved soil properties and consequently soil productivity. These results are in accordance with those obtained by More (1994).

Nutrient content

The data obtained by the influence of different levels of iron and zinc enriched with FYM and without enriched with FYM on nitrogen, phosphorus, potassium content in grain are presented in Table 3. From the perusal of the data, it was observed that N, P and K content in wheat grain show the significant change due to iron and zinc enriched with FYM and without enriched FYM on pooled basis. Significantly higher nitrogen (2.41%) and phosphorus (0.33%) content in grain was observed by the application of recommended dose of fertilizer (120-60-00 NPK kg ha^{-1}) on the basis of STV + 0.5 t FYM ha^{-1} enriched with 0.75 kg Zn and 1.5 kg Fe (T_8) on pooled basis. While, significantly higher potassium content in wheat grain was observed with the application of recommended dose of fertilizer (120-60-00 NPK kg ha^{-1}) on the basis of STV + 1.0 t FYM ha^{-1} (T_5) on pooled basis. But, nitrogen content was at par with that under T_4, T_5, T_6 and T_7 on pooled basis. However, phosphorus content in wheat grain under T_8 was at par treatments T_2, T_3, T_4, T_5, T_6 and T_7. Whereas, potassium content (0.67%) in wheat grain under T_2 and T_5 was at par with treatments T_3 T_4, T_5, T_7 and T_8 on pooled basis.

From the data presented in Table 4, it was observed that significantly higher Fe content in wheat grain (59.07 mg kg^{-1}) was recorded due to the application of recommended dose of fertilizer (120-60-00 NPK kg ha^{-1}) on the basis of STV + 0.5 t FYM ha^{-1} enriched with 0.75 kg Zn and 1.5 kg Fe (T_8) on pooled basis; which was at par with treatment T_4 (T_1 + 3.0 kg Fe ha^{-1}), T_5 ($T_{1\,+}$ 1.5 kg Zn + 3.0 kg Fe ha^{-1}) and T_7 ($T_{1\,+}$ 0.5 t FYM ha^{-1} En. with 1.5 kg Fe). Amongst the different treatments, significant increase in the Zn content in grain (19.47 mg kg^{-1}) was observed under treatment which received RDF (based on STV) along with 1.5 kg Zn ha^{-1} + 3.0 kg Fe ha^{-1} in all the years as well as on pooled basis (Table 4); but it was at par with treatment T_8 (T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe).

The data obtained by the influence of different levels of iron and zinc enriched with FYM and without enriched FYM on nitrogen, phosphorus, potassium, Fe and Zn contents in wheat straw are presented in Table 5 and Table 6. From the perusal of the data, it was observed that N, P, K, Fe and Zn content in wheat straw show significant change due to iron and zinc enriched with FYM and without enriched FYM. Significantly the highest nitrogen (1.09%), phosphorus (0.173%), potassium (1.32%), iron (265.2 mg kg^{-1}) and zinc (42.75 mg kg^{-1}) contents in wheat straw were observed with the application of RDF (based on STV) along with 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe on pooled basis. However, nitrogen content in wheat straw was at par with treatments T_5, T_6 and T_7; whereas, P content in wheat straw was at par with treatments T_4 and T_7; K content in wheat straw was at par with treatments T_2, T_5 and T_7. Similarly, iron content in wheat straw was at par with treatments T_4 (T_1 + 3.0 kg Fe ha^{-1}), T_5 (T_1 + 1.5 kg Zn ha^{-1}+ 3.0 kg Fe ha^{-1}) and T_7 (T_1 + 0.5 t FYM ha^{-1} En. with 1.5 kg Fe) whereas, Zn content in wheat straw was at par with treatments T_5 (T_1 + 1.5 kg Zn ha^{-1} + 3.0 kg Fe ha^{-1}) and T_6 (T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn). It is well known that, during the decomposition of organic matter, macro and micronutrients are incorporated into the soil matrix, allowing the soil to act as a reservoir of these nutrients. These nutrients will be released, to become available for uptake by plants. Otherwise, humus which is the final component of organic matter decomposition, accumulate in the environmental systems to increase moisture retention and nutrient supply potentials of soils (Suganya, and Sivasamy, 2006). The obtained data are confirmed with the results found by Tolba *et al.*, 2003 and Khater *et al.*, 2004, who mentioned that FYM plays an important role for supplying plants by some required nutrients.

Similar results were reported by Li *et al.*, 2007, where it was suggested that the application of compost increased the organic matter content. By contrast, the results of a long-term field experiment showed that as the soil organic matter contents increased, there were decreases in the mobility of Cu, Fe, and Mn in the soil solution, whereas that of Zn increased (Rutkowska *et al.*, 2014). The mechanisms responsible for these effects were not investigated (Ai *et al.*, 2012), but the variability may be due to the strong buffering capacity of the soil, or the micronutrient levels may depend on soil characteristics, including the pH, texture, organic matter, redox conditions (Keshavarzi *et al.*, 2015) and the type and quantity of oxyhydroxides present, as well as the crop species considered (Marcussen *et al.*, 2009). This difference indicates that the soil properties have significant effects on the absorption of Fe and Zn by plants. According to Campbell, 2009, the critical concentration of Fe in wheat plants during the vegetative phase is 25 mg kg^{-1}, and the sufficiency concentration range for Fe in wheat flag leaves during the grain-filling stage is 30–200 mg kg^{-1}. Thus, our results and those of other studies indicate that organic fertilizer enhanced the concentration of Zn in wheat but decreased the concentration of Mn compared with the use of a chemical fertilizer (Li *et al.*, 2007). This finding might be explained by the addition of organic material, which increased the soil organic matter content, thereby affecting the transfer of Zn and Mn from the soil to plants. In the present study, manure compost increased the available Zn in the soil, which might be the main reason why the Zn concentration increased in the wheat straw and grain.

Nutrient uptake

A perusal of the data presented in Table 7 and Table 8 indicates that the nitrogen, phosphorus, potassium, iron and zinc uptake by wheat grain were significantly influenced by different combinations of iron and zinc enriched with FYM and without enriched FYM. From the perusal of the data, it was observed that maximum nitrogen (119.82 kg ha^{-1}), phosphorus (16.25 kg ha^{-1}), potassium (31.54 kg ha^{-1}) and iron (305.8 g ha^{-1}) uptake by wheat grain was recorded under treatment T_8 (T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe) on pooled basis; but in case of zinc uptake by wheat grain (88.88 g ha^{-1}) was higher under treatment T_5 (T_1 + 1.5 kg Zn +

3.0 kg Fe ha^{-1}) on pooled basis. However, in case of nitrogen uptake by wheat grain, T_8 was at par with treatments T_5 (T_1 + 1.5 kg Zn ha^{-1}+ 3.0 kg Fe ha^{-1}); in case of phosphorus uptake by wheat grain, T_8 was at par with treatments T_5 and T_7; in case of potassium uptake by wheat grain, T_8 was at par with treatments T_5; in case of iron uptake by wheat grain, T_8 was at par with treatments T_5 and T_7 on pooled basis. On the other hand in case of zinc uptake by wheat grain, T_5 was at par with treatments T_8 (T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe) on pooled basis.

Table.1 Physicochemical properties of the experimental soil

Sr. No.	Parameters	Years			
		2014-15	**2015-16**	**2016-17**	**2017-18**
1.	pH	7.70	8.12	7.64	6.98
2.	EC (dSm^{-1})	1.10	1.18	1.35	1.45
3.	OC %	0.31	0.25	0.38	0.26
4.	Available P_2O_5 (kg/ha)	45.87	41.25	43.25	46.58
5.	Available K_2O (kg/ha)	241.25	285.54	356.14	266.14
6.	DTPA extractable Fe (mg kg^{-1})	3.78	3.95	3.51	2.25
7.	DTPA extractable Zn (mg kg^{-1})	0.89	1.08	0.89	0.76
	RDF Based on STV	**140:60:0**	**150:60:0**	**140:60:0**	**140:60:0**

Table.2 Effect of iron and zinc enriched with FYM and without enriched FYM on grain and straw yield of wheat (Pooled data 4 years)

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1 RDF (Based on STV)	3781	6270
T_2 T_1 + 1.0 t FYM ha^{-1}	4234	6953
T_3 T_1 + 1.5 kg Zn ha^{-1}	4043	6571
T_4 T_1 + 3.0 kg Fe ha^{-1}	4189	6666
T_5 T_1 + 1.5 kg Zn ha^{-1} + 3.0 kg Fe ha^{-1}	4682	7447
T_6 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn	4264	6883
T_7 T_1 + 0.5 t FYM ha^{-1} En. with 1.5 kg Fe	4516	7140
T_8 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe	4790	7833
S.Em.±	94	153
C.D. at 5 %	266	431
C.V. %	8.75	8.77
Y x T	NS	NS

Table.3 Effect of iron and zinc enriched with FYM and without enriched FYM on nutrients content in wheat grain (Pooled data 4 years)

Treatments	Nutrients content in wheat grain (%)		
	Nitrogen	Phosphorus	Potassium
T_1 RDF (Based on STV)	2.14	0.27	0.61
T_2 T_1 + 1.0 t FYM ha^{-1}	2.20	0.33	0.67
T_3 T_1 + 1.5 kg Zn ha^{-1}	2.23	0.33	0.63
T_4 T_1 + 3.0 kg Fe ha^{-1}	2.32	0.32	0.63
T_5 T_1 + 1.5 kg Zn ha^{-1} + 3.0 kg Fe ha^{-1}	2.33	0.31	0.67
T_6 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn	2.32	0.32	0.61
T_7 T_1 + 0.5 t FYM ha^{-1} En. with 1.5 kg Fe	2.38	0.33	0.63
T_8 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe	2.41	0.33	0.66
S.Em.±	0.05	0.01	0.02
C.D. at 5 %	0.15	0.03	0.05
C.V. %	9.46	14.49	10.10
Y x T	NS	NS	NS

Table.4 Effect of iron and zinc enriched with FYM and without enriched FYM on micronutrients content in wheat grain (Pooled data 4 years)

Treatments	Fe (mg kg^{-1})	Zn (mg kg^{-1})
T_1 RDF (Based on STV)	45.57	13.91
T_2 T_1 + 1.0 t FYM ha^{-1}	48.94	15.35
T_3 T_1 + 1.5 kg Zn ha^{-1}	49.05	16.79
T_4 T_1 + 3.0 kg Fe ha^{-1}	54.07	15.02
T_5 T_1 + 1.5 kg Zn ha^{-1} + 3.0 kg Fe ha^{-1}	57.42	19.47
T_6 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn	47.95	17.63
T_7 T_1 + 0.5 t FYM ha^{-1} En. with 1.5 kg Fe	56.92	15.40
T_8 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe	59.07	18.33
S.Em.±	1.89	0.48
C.D. at 5 %	5.57	1.35
C.V. %	9.46	11.66
Y x T	NS	NS

Table.5 Effect of iron and zinc enriched with FYM and without enriched FYM on nutrients content in wheat straw (Pooled data 4 years)

Treatments	Nutrients content in wheat straw (%)		
	Nitrogen	Phosphorus	Potassium
T_1 RDF (Based on STV)	0.90	0.143	1.12
T_2 T_1 + 1.0 t FYM ha^{-1}	0.95	0.153	1.27
T_3 T_1 + 1.5 kg Zn ha^{-1}	0.97	0.153	1.15
T_4 T_1 + 3.0 kg Fe ha^{-1}	0.96	0.157	1.19
T_5 T_1 + 1.5 kg Zn ha^{-1} + 3.0 kg Fe ha^{-1}	1.03	0.150	1.28
T_6 T_{1+} 0.5 t FYM ha^{-1} En. with 0.75 kg Zn	0.99	0.152	1.25
T_7 T_{1+} 0.5 t FYM ha^{-1} En. with 1.5 kg Fe	1.04	0.166	1.27
T_8 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe	1.09	0.173	1.32
S.Em.±	0.04	0.006	0.03
C.D. at 5 %	0.11	0.018	0.09
C.V. %	10.86	16.22	10.89
Y x T	NS	NS	NS

Table.6 Effect of iron and zinc enriched with FYM and without enriched FYM on micronutrients content in wheat straw (Pooled data 4 years)

Treatments	Fe (mg kg^{-1})	Zn (mg kg^{-1})
T_1 RDF (Based on STV)	204.8	28.50
T_2 T_1 + 1.0 t FYM ha^{-1}	219.9	32.28
T_3 T_1 + 1.5 kg Zn ha^{-1}	230.4	34.04
T_4 T_1 + 3.0 kg Fe ha^{-1}	252.6	31.73
T_5 T_1 + 1.5 kg Zn ha^{-1} + 3.0 kg Fe ha^{-1}	260.3	40.27
T_6 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn	227.1	42.06
T_7 T_1 + 0.5 t FYM ha^{-1} En. with 1.5 kg Fe	259.3	37.92
T_8 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe	265.2	42.75
S.Em.±	5.9	1.19
C.D. at 5 %	16.6	3.35
C.V. %	9.81	13.13
Y x T	NS	NS

Table.7 Effect of iron and zinc enriched with FYM and without enriched FYM on nutrients uptake by wheat grain (Pooled data 4 years)

Treatments	Nutrients uptake by wheat grain ($kg\ ha^{-1}$)		
	Nitrogen	Phosphorus	Potassium
T_1 RDF (Based on STV)	81.15	10.34	23.92
T_2 T_1 + 1.0 t FYM ha^{-1}	93.20	14.24	28.77
T_3 T_1 + 1.5 kg Zn ha^{-1}	90.66	13.38	25.54
T_4 T_1 + 3.0 kg Fe ha^{-1}	97.52	13.78	25.31
T_5 T_1 + 1.5 kg Zn ha^{-1} + 3.0 kg Fe ha^{-1}	111.22	15.01	30.38
T_6 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn	99.62	13.67	25.65
T_7 T_1 + 0.5 t FYM ha^{-1} En. with 1.5 kg Fe	108.01	15.35	27.96
T_8 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe	119.82	16.25	31.54
S.Em.±	3.47	0.64	0.92
C.D. at 5 %	9.79	1.79	2.60
C.V. %	13.88	18.19	13.47
Y x T	NS	NS	NS

Table.8 Effect of iron and zinc enriched with FYM and without enriched FYM on micronutrients uptake by wheat grain (Pooled data 4 years)

Treatments	Fe ($g\ ha^{-1}$)	Zn ($g\ ha^{-1}$)
T_1 RDF (Based on STV)	179.2	52.65
T_2 T_1 + 1.0 t FYM ha^{-1}	212.7	65.15
T_3 T_1 + 1.5 kg Zn ha^{-1}	206.9	68.44
T_4 T_1 + 3.0 kg Fe ha^{-1}	242.7	62.46
T_5 T_1 + 1.5 kg Zn ha^{-1} + 3.0 kg Fe ha^{-1}	284.0	88.88
T_6 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn	218.1	74.85
T_7 T_1 + 0.5 t FYM ha^{-1} En. with 1.5 kg Fe	282.1	69.67
T_8 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe	305.8	88.54
S.Em.±	9.6	3.45
C.D. at 5 %	27.0	9.73
C.V. %	15.9	19.37
Y x T	NS	NS

Table.9 Effect of iron and zinc enriched with FYM and without enriched FYM on nutrients uptake by wheat straw (Pooled data 4 years)

Treatments	Nutrients uptake by wheat straw ($kg\ ha^{-1}$)		
	Nitrogen	Phosphorus	Potassium
T_1 RDF (Based on STV)	55.60	9.15	70.5
T_2 T_1 + 1.0 t FYM ha^{-1}	65.58	10.91	89.0
T_3 T_1 + 1.5 kg Zn ha^{-1}	62.85	10.30	75.5
T_4 T_1 + 3.0 kg Fe ha^{-1}	63.64	10.83	80.0
T_5 T_1 + 1.5 kg Zn ha^{-1} + 3.0 kg Fe ha^{-1}	76.56	11.42	95.7
T_6 T_{1+} 0.5 t FYM ha^{-1} En. with 0.75 kg Zn	67.65	10.80	86.7
T_7 T_{1+} 0.5 t FYM ha^{-1} En. with 1.5 kg Fe	74.33	12.33	90.8
T_8 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe	84.97	14.02	104.2
S.Em.±	3.60	0.55	2.9
C.D. at 5 %	10.58	1.54	8.3
C.V. %	14.11	19.46	13.54
Y x T	NS	NS	NS

Table.10 Effect of iron and zinc enriched with FYM and without enriched FYM on micronutrient uptake by wheat straw (Pooled data 4 years)

Treatments	Fe ($g\ ha^{-1}$)	Zn ($g\ ha^{-1}$)
T_1 RDF (Based on STV)	1280	177.4
T_2 T_1 + 1.0 t FYM ha^{-1}	1529	220.6
T_3 T_1 + 1.5 kg Zn ha^{-1}	1521	221.8
T_4 T_1 + 3.0 kg Fe ha^{-1}	1700	213.2
T_5 T_1 + 1.5 kg Zn ha^{-1} + 3.0 kg Fe ha^{-1}	1948	290.4
T_6 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn	1567	282.0
T_7 T_1 + 0.5 t FYM ha^{-1} En. with 1.5 kg Fe	1873	270.2
T_8 T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe	2098	332.7
S.Em.±	58	9.9
C.D. at 5 %	164	27.9
C.V. %	13.81	15.75
Y x T	NS	NS

A perusal of the data presented in Table 9 and Table 10 indicates that the nitrogen, phosphorus, potassium, iron and zinc uptake by wheat straw was significantly influenced by different combinations of iron and zinc enriched with FYM and without enriched FYM. From the perusal of the data, it was observed that significantly higher nitrogen (84.97 kg ha^{-1}), phosphorus (14.02 kg ha^{-1}), potassium (104.2 kg ha^{-1}), iron (2098 g ha^{-1}) and zinc (332.7 g ha^{-1}) uptake by wheat straw was recorded under treatment T_8 (T_1 + 0.5 t FYM ha^{-1} En. with 0.75 kg Zn and 1.5 kg Fe) on pooled basis. However, in case nitrogen and Fe uptake by wheat straw, T_8 was at par with treatments T_5 on pooled basis.

The maximum uptake of all these nutrients in the wheat grain and straw were recorded when nutrient were applied with the application of RDF along with + 0.5 t FYM ha^{-1} enriched with 0.75 kg Zn and 1.5 kg Fe. Increase in uptake in these nutrients may be due to the increased in fertility levels attributed to the better availability of nutrients and their transport to the plant from the soil. Similar results have been reported earlier (Gupta and Handore, 2009; Khan *et al.*, 2009). The beneficial effect of application of higher amounts of organic manure through FYM is not only favored the greater availability of throughout crop growth, fertilizer into different stages resulting in significant improvement in nutrient content and uptake. This result corroborates the finding of Zhang *et al.*, 2010. Since uptake of nutrient is a function of concentration of nutrient and yield/ha at higher fertility levels, nutrient absorption increased resulting in a luxuriant growth and accumulation of more nutrients in the grain and straw that might have increased the uptake of nitrogen, phosphorus, and potassium. This might be the main reason behind the higher production of grain and straw yield with maximum nutrient uptake in the crop.

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