Effect of Soil and Foliar Application of Zn and Fe on Nutrient Status of Maize (*Zea mays* L.) hybrid

ABSTRACT

The present experiment was carried out to study the effect of soil and foliar application of zinc and iron on nutrient status of maize at Sardar Vallabhbhai University, Meerut during Kharif season of 2017-18. The present study consists of soil application of eight nutrient treatments namely 100% NPK, NPK+ Zn and Fe each @ 5 kg/ha,@ 10 kg/ha,@ 20 kg/ha, NPK+ Zn and Fe each @10 kg/ha + vermicompost (1.5 t/ha), NPK+Vermicompost @ 1.5 t/ha, NPK+ Zn and Fe each @ 5 kg/ha + foliar spray each @ 0.1% at the tasselling stage and NPK+ Foliar spray Zn and Fe each @ 0.1% at 25 DAS and at tasselling stage. These treatments were tested in RBD with three replications, aiming to know the effect of micro-nutrients (Zinc and Iron) on performance nutrient content and uptake of the maize cultivar, ADV 755. The maximum nitrogen, phosphorus & potassium content and uptake were recorded in the treatment number T_5 (T_1 + soil applied Zn and Fe each @10 kg/ha + vermicompost), the maximum Zn and Fe content and uptake were recorded in the treatment number T_7 (T_1+Soil applied Zn and Fe each @ 5 kg/ha + foliar spray each @ 0.1% at tasseling stage) wherein N,P,K, Zn and Fe were applied with vermicompost. The application of N,P,K and vermicompost would have also helped in increasing N,P and K content and uptake in plants. The maximum Zn and Fe, content and uptake were recorded in Treatment T_7 which may have happened due to better soil and foliage application availability of nutrients in it.

Keywords: *Foliar spray, Iron, Maize, Soil Application, Zinc*

INTRODUCTION

Maize (*Zea mays* L.) is single of the chief cereal crops after wheat and rice in the world. Being a C_4 plant it has an extremely high yield perspective, there is no cereal in the world which has so huge potential and that is why it is called a miracle crop and queen of cereals. The average productivity of maize in India is about 2.43 t ha^{-1} and at the same time, it stands as the third mainly important food crop following rice and wheat. Biofortification is the method that aims to raise the concentration of nutrients in edible parts of crop plants through genetic biofortification and agronomic biofortification. Biofortified crops are also a possible means of reaching rural populations who may have limited access to varied diets or other micronutrients intervention. The aim of the micronutrients level for biofortified crops is placed to get together the exact dietary requirements of women and children based on obtainable consumption patterns. About half of the world's population suffers from micronutrient under nourishment including iron, zinc and iodine which are mostly linked to low dietary intake of micronutrients in diets with less miscellany of food (Kaur *et al.*, 2022). The daily diet should have Zn intake of (infants 5 mg/day, children 10 mg/day, pregnant women 15 mg/day, women 12 mg/day, lactating women 16 mg/day and men 15 mg/day) and Fe intake of (birth to 6 months 0.27 mg/day, 1-3 year 7.0 mg/day, 4-8 years 8 mg/day, 9-51 year 10 mg/day and pregnant women 27 mg/day). Intake of zinc and iron less than the amount specified by WHO may lead to slowing down the physiological processes because zinc insufficiency growth retarded, skeletal abnormalities, delays in injury healing, increased abortion hazard and diarrhea. Recent reports indicate that nearly five lakhs of children below 5 years of age pass away annually because of Zn and Fe deficiencies. Zinc is taken up by plants as a divalent Zn^{2+} cation. Among the micronutrients, commonly, zinc affects protein synthesis in plants, therefore, is considered to be the main critical micronutrient. Zn is also vital in taking piece in plant enlargement due to its catalytic action in metabolism for all plants, particularly maize. Amongst different methods, the foliar spray of micronutrients is capable one for improvement of crop productivity reasons the effectiveness of foliar spray is easy due to its direct application on the leaves. Never the less, micronutrients can also be applied honestly to the soil. The foliar application of zinc fertilizer improves zinc concentration in grain. In particular studies, soil and foliar application of Zn improve crop yield. Iron is a necessary micronutrient for approximately all living organisms because it plays a vital function in metabolic processes such as DNA synthesis, respiration and photosynthesis. Further, many metabolic pathways are activated through iron, and it is a prosthetic group ingredient of many enzymes. In plants, iron is concerned in the plant the synthesis of chlorophyll, and this is essential for the protection of chloroplast structure and function. Iron is an essential component of hemoglobin; oxygen is carried by red blood cells from the lungs throughout the body via hemoglobin.Hemoglobin represents around two-thirds of the body's iron. However, your body cannot gain enough prosperous oxygen-carrying red blood cells if you do not retain enough iron.

MATERIALS AND METHODS

The experiment was conducted in a pot at the meteorological observatory, the Department of Soil Science and Agricultural Chemistry at the Meerut campus of Sardar Vallabhbhai Patel University of Agriculture and Technology, (U.P) during the year 2017-18. The experiment was carried out by taking the hybrid maize variety (ADV755, Syngenta) as a test crop. The eight numbers of treatments (T_1 to T_8) each with three sets of replications in a Randomized block design. The treatments were designed with RDF and various doses of Zinc and Iron as Zinc Sulphate and Iron Sulphate, vermicompost and foliar application of the above mentioned micronutrients at the tasselling stage along with control having nitrogen (N), Phosphorus (P) and potassium (K) on 120, 60 and 60 kg ha^{-1} on a respective basis in the form of Urea, SSP and MOP respectively. Harvesting was done when the husk of the cobs turned yellow and grains become hard enough to have less than 30% moisture. The cobs were dehusked manually and then dried under the sun for a week. There after grains were separated with the help of maize beatting energized by an electric motor and plant samples were analyzed for concentration of total N, P, K, Zn and Fe. The N content of grain and straw sample was determined by the Kjeldahl method after sample digestion by extraction of ammonia (NH_3) gas in a Kel-plus auto analyzer and the distillate was titrated against a standard 0.02N H_2SO_4 for N estimation (Kumar *et al*, (2021). The P, K, Zn, and Fe analysis in plant samples were wet digested in a di-acid mixture. The P content of grain and straw was determined by Vanadomolybdo-phosphoric and yellow color method after di-acid digestion. The P estimation was done by spectrophotometer (Jackson, 1973). The K content of grain and straw was determined by filtration of di-acid digest and K concentration was estimated by a flame photometer (Jackson, 1967). The Zn, & Fe by DTPA extraction technique (Lindsay & Norvell, 1978) and estimated in atomic absorption spectrophotometer. N, P and K were expressed in % and Zn, and Fe in mg kg^{-1}. Here plant performance was expressed in terms of the total uptake of nutrients by the plant in terms of both grain and stover obtained from each treatment after harvest. The total uptake of N, P, K, Zn, and Fe by maize was calculated from dry matter obtained after harvesting (grains and stover). The data related to each character of the crop were analyzed statistically by using the standard method of Analysis of variance technique (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Nutrients content in grain and Stover

Macronutrient content

The data regarding nitrogen, phosphorus and potassium content of maize in percent are presented in Table 1. The nitrogen content in grain did not differ significantly with different treatments. Maximum nitrogen content (1.57 %) recorded in soil-applied Zn and Fe @10 kg/ha + vermicompost (T_5) was followed by T6 (1.56%) and minimum nitrogen content (1.500) in control (T_1). Application of vermicompost with NPK and micronutrients (T5) had registered higher N content over control. The nitrogen content of maize stover was significantly influenced by dissimilar treatments and varied from 0.40 to 0.49 %. Maximum nitrogen content (0.49 %) in stover recorded with the application of Zn and Fe @10 kg/ha + vermicompost (T_5) was significantly higher than all the treatments will the exception of T_6 where NPK was applied with vermicompost. Minimum N content (0.40 %) was analyzed in control (T_1). Phosphorus content at harvest was significantly affected by different micronutrient levels. Phosphorus content in the grain of maize differs from 0.30 to 0.38 %. Maximum phosphorus content (0.38 %) recorded with the application of soil-applied Zn and Fe @10 kg/ha + vermicompost (T_5) was found significantly higher than the treatments T_1, T_2, T_3, T_4, T_7, T_8 and statistically at par rest of the treatments. Application of vermicompost (T_5 and T_6) had registered improvement in P content (0.38 and 0.36 %) over control (T_1). The phosphorus content in stover of maize plant differs from 0.15 to 0.20 % and the maximum phosphorus content (0.20 %) recorded with the application of soil-applied Zn and Fe each @10 kg/ha + vermicompost (T_5) was found significantly higher than treatment T_1, T_2, T_3, T_4, T_7, T_8 and statistically at par T_6. Were significantly affected by different micronutrient levels, Potassium content in grain differs from 0.30 to 0.38 %. Maximum potassium content (0.38 %) recorded will soil application of Zn and Fe @10 kg/ha + vermicompost (T_5), was found significantly higher than treatment T_1, T_2, T_3, T_4, T_7, T_8 and statistically at par T_6. Potassium content in stover did not differ significantly under the influence of different treatments and varied from 1.40 to 1.44 %. Maximum potassium content (1.44 %) was recorded in soil-applied Zn and Fe @10 kg/ha + vermicompost (T_5) and minimum potassium content (1.400 %) in control (T_1). It is indicated from the results that the application of vermicompost with Zn and Fe as well as with NPK improved the NPK status of grain and stover over the application of NPK alone.

Application of N, P, K, Zn, Fe fertilizer and vermicompost brought a significant difference in nutrient content in the plant at harvest stages. Maximum nitrogen, phosphorus and potassium content were recorded with the application of N, P, K, Zn and Fe with vermicompost (T_5) due to higher supplementation of nitrogen and possibly better root development with the increased phosphorous application. The application of vermicompostis also helped in increasing N, P and K content in this treatment, by the application of vermicompost increases the number of micro-organisms which help in the conversion of immobile to mobile form and nutrients which are easily available to plants for superior root growth and development. The improved root system may have exploited the soil extensively for different nutrients and their higher nutrient content is obvious. A similar result was also reported by Sindhi *et al.*, (2016).

Micronutrient content

The data regarding zinc and iron content of plant (mg/kg) at the harvest stage as affected by different treatments (Table 2). The zinc content of the maize plant was significantly affected by different treatments and differed significantly from 21.23 to 35.50 mg/kg. The result showed that the Zn content of maize grain increased significantly withthe application of Zn in different treatments. The maximum Zn content of 35.50 mg/kg was recorded in treatment where basal and foliar Zn application was made and it was (T_7) followed by basal application of Zn and Fe @ 20 kg (T_4) and with vermicompost (T_5). The increment was noticed by 67% in T_7, 40 % in T_4 and 30 % in T_5 over T_1 (NPK alone). It is further verified that more Zn accumulation in grain was found where Zn was applied in combination with basal and foliar (T_7). Zinc content in stoverdiffers from 15.20 to 28.20 mg/kg. The maximum zinc content of 28.20 mg/kg recorded in soil applied Zn and Fe each @ 5 kg/ha + foliar spray each @ 0.1% at tasselling stage (T_7), was found significantly higher than all treatments. Application of graded doses of Zn and Fe with vermicompost had registered significantly higher Zn content in stover than the application of NPK alone (T_1). The iron content of the maize plant was affected significantly by different treatments and varied from 73.80 to 91.40 mg/kg. Maximum iron content in grain 91.40 mg/kgwas recorded in soil applied Zn and Fe @ 5 kg/ha + foliar spray @ 0.1% at tasselling stage (T_7), was significantly superior over control and statistically at par with the application of Zn and Fe @ 20 kg/ha (T_4) as well as Zn and Fe with vermicompost (T_5). The iron content in grain increased by 23.7, 19.7 and 14.9 %

over control in T_7, T_5 and T_4, respectively, an almost similar trend was noticed in Fe content in stover also. Maximum iron content in stover (186.80 mg/kg) was recorded in soil applied Zn and Fe @ 5 kg/ha + foliar spray @ 0.1% at the tasselling stage (T_7), followed by T_4 (182.58 mg/kg) and T_5 (181.09 mg/kg). Application of Zn and Fe with or without vermicompost had registered improvement in Fe content in stover.

The highest Zn and Fe, content were recorded in T_7 due to soil and foliage application of nutrients. The increase in the Zn and Fe content might be due to the existence of an increased amount of zinc and iron in soil solution by the application of $ZnSO_4$ and $FeSO_4$ which would have favored the absorption by the crop and translocated in the grains during the maturity phase. Zinc and Iron are two necessary elements for plant survival, and some deficiencies in these nutrients lead to growth retardation and crop yield decrease similar report was also reported by Salakinkop (2017).

Nutrient uptake in grain and Stover

Macronutrient uptake

The uptake of nitrogen, phosphorus and potassium (g/plant) of maize as affected by different micronutrients treatment is shown in Table 3. Nitrogen uptake by grain did not differ significantly by the application of different treatments and varied from 0.97 to 1.29 g/plant. Maximum (1.29 g/plant) and minimum (0.97 g/plant) nitrogen uptake were found in T_5 and T_1, respectively. Nitrogen uptakes by maize stover differ significantly from 0.37 to 0.52 g/plant. Maximum nitrogen uptake (0.52 g/plant) recorded with the application of soil-applied Zn and Fe each @10 kg/ha + vermicompost (T_5) was significantly higher than all the treatments except T_6. Application of Zn and Fe with vermicompost (T_5) had registered the highest total uptake of N (1.81 g/plant) by maize plant, which is 35% more than the treatment receiving NPK alone (T_1). Phosphorus uptake by grain and stover significantly varied among the treatments.Phosphorus uptake of maize grain varied from 0.19 to 0.31 g/plant. Maximum phosphorus uptake (0.31 g/plant) recorded with the application of Zn and Fe each @10 kg/ha + vermicompost (T_5) was significantly higher than all treatments except T6. The treatments receiving vermicompost (T_5 and T_6) registered higher P uptake by grain (0.31 and 0.28, respectively) over the rest of the treatments. Phosphorus uptakes of maize stover differ from 0.14 to 0.21 g/plant. Similarly, maximum phosphorus uptake

(0.21g/plant) recorded with the application of soil-applied Zn and Fe each @10 kg/ha + vermicompost (T_5) was significantly higher than all treatments except T6. There was no significant variation observed in P uptake by application of a graded dose of Zn and Fe. It is observed that the application of vermicompost (T_5 and T_6) increased the P uptake by maize. Potassium uptakes of grains differ significantly but stover did not among the treatments. Potassium uptake by maize grains varied from 0.19 to 0.31 g/plant. Maximum potassium uptake (0.31g/plant) recorded with the application of soil-applied Zn and Fe each @10 kg/ha + vermicompost (T_5) was significantly higher than other treatments except T_6. Potassium uptake by maize stover ranged from 1.31 to 1.55 g/plant. Maximum potassium uptake (1.55 g/plant) was recorded with the application of soil applied Zn and Fe each @10 kg/ha + vermicompost (T_5) while minimum potassium uptake (1.31 g/plant) in control (T_1). The treatments (T_5 and T_6) receiving vermicompost had registered higher total values for K uptake (1.86 and 1.80 g/plant respectively) by maize crop.

Application of N, P, K, Zn, Fe fertilizer and vermicompost brought a significant difference in nutrient uptake in the plant at harvest stages. Maximum nitrogen, phosphorus and potassium uptake were recorded with the application of N, P, K, Zn and Fe with vermicompost (T_5) due to higher supplementation of nitrogen and possibly better root development with the increased phosphorous application. The application of vermicompostis also helping in increasing N, P and K uptake in this treatment, by the application of vermicompost increase the number of micro-organisms which helps in the conversion of immobile to mobile form and nutrient which are easily available to plants for better root growth and development. A better root system may have exploitedthe soil extensively for different nutrients and thereby higher nutrient uptake is obvious. A similar result was also reported by Sindhi *et al.*, (2016). This improvement in the P range could have been due to extra P supply through the organic source of N linked with the release of fixed P owing to the production of organic acid during the mineralization of organic manure. The optimum K supply in different treatments had significantly higher K uptake, Pathania*et al.*, (2015) reported that K uptake in kernel increased with the increased K use.

Micronutrient uptake

The uptake of zinc at the harvest stage of maize as affected by different micronutrients level is shown in depicted Table 4. Zinc uptake at the harvest stage differed significantly under different treatments. At harvest grains, zinc uptakes differ from 1.37 to 2.50

mg/plant. Maximum zinc uptake (2.50 mg/plant) found with the application of soil-applied Zn and Fe each @ 5 kg/ha + foliar spray each @ 0.1% at tasselling stage (T_7) was significantly higher than $T_{1,}$ $T_{2,}$ $T_{3,}$ T_6 and T_8 and statistically at par with rest of the treatments. Soil applied Zn and Fe each @ 5 kg/ha + foliar spray each @ 0.1% at the tasseling stage (T_7) was found significantly better as compared to soil-applied Zn and Fe each @10 kg/ha + vermicompost (T_5). Application of graded dose of Zn and Fe (T_2, T_3, T_4) correspondingly increased the Zn uptake and a maximum (2.30 mg/plant) was recorded with the application of Zn and Fe @ 20 kg ha^{-1}. The treatment receiving NPK with vermicompost (T_6) had performed statistically equal for Zn uptake by grain with the application of NPK with Zn and Fe @ 10 kg ha^{-1} (T_3). The Zn uptake by grain was 1.95 and 1.85 in T_3 and T_6, respectively. Zinc uptake by stover varied from 1.42 to 2.82 mg/plant. Maximum zinc uptake (2.82 mg/plant) found with the application of soil-applied Zn and Fe each @ 5 kg/ha + foliar spray each @ 0.1% at tasselling stage (T_7) was significantly higher than $T_{1,}$ $T_{2,}$ $T_{3,}$ T_6 and T_8 and statistically at par rest of the treatments.

The uptake of iron at the harvest stage of maize as affected by different micronutrients level is shown in depicted (Table 4). Iron uptakes at the harvest stage differ significantly under different treatments and varied from 4.77 to 7.36 mg/plant. Maximum iron uptake by grain (7.36 mg/plant) recorded with the application of soil-applied Zn and Fe each @ 5 kg/ha + foliar spray each @ 0.1% at the tasselling stage (T_7) was significantly higher than $T_{1,}$ $T_{2,}$ $T_{3,}$ and T_8 and statistically at par rest of the treatments. It is also observed from the table the application of NPK with vermicompost (T_6) had registered a statistically similar uptake of grain Fe with the application of Zn and Fe @ 10 kg ha^{-1} (T_3). Iron uptakes by maize stover differ from 16.07 to 19.11 mg/plant. Maximum iron uptake of 19.11 mg/plant recorded with the application of soil-applied Zn and Fe each @ 5 kg/ha + foliar spray each @ 0.1% at tasselling stage (T_7) was significantly higher than T_1 and statistically at par with to rest of the treatments. Iron uptake by maize plant was maximum (26.48 mg/plant) in the treatment receiving the combined application of Zn and Fe on basal and foliar followed by application of Zn and Fe with vermicompost (T_5).

The highest Zn and Fe, uptake was recorded in T_7 due to soil and foliage application of nutrients. Increased uptake of Zn and Fe may be associated with increased amounts of zinc and iron in soil solution with the introduction of $ZnSO_4$ and $FeSO_4$ which would have favored the absorption by the crop and translocated in the grains during the maturity phase. The good response of maize to zinc fertilization is, Zinc and iron are two elements essential for plant durability, and severe deficiencies in these nutrients will stunt growth and reduce yield similar report was also reported by Salakinkop (2017). The growth of maize is intense from 35-75 DAS. Therefore, synchronizing the nutrient provides at these stages through fertilizer (Soil and Foliar application) and vermicompost application resulted in growth and consequently higher yields and nutrient uptake. Further, these periods coincide with the silking and cob development stages, where the crop requires a higher amount of nutrients. Different treatments significantly affected nutrient absorption in maize. The uptake of Nitrogen, Phosphorus, Zinc and Iron by plants increased significantly with successive increases in fertility levels, which led to maximum Nitrogen, Phosphorus, Zinc and Iron uptake. A significant increase in Nitrogen uptake in maize (grain + Stover) was noticed with the increase in the levels of N up to 181g plant^{-1}. Nutrient uptake of Nitrogen, Phosphorus, Zinc and Iron increased significantly with successive increases in nitrogen levels, which led to maximum Nitrogen, Phosphorus, Potash (Treatment No. 5), Zinc and Iron (Treatment No. 7) uptake at 181g/plant, 0.52 g/plant, 1.86 g/plant 5.32 mg/plant and 26.48 mg/plant. It can be attributed to the mobilization of a large proportion of nutrients from other parts of the plant to the grains during development. Improvement in Zinc and Iron uptake with an increased level of Nitrogen suggests a synergistic effect of Nitrogen on Zinc and Iron uptake. This could be owing to the adequate availability of nutrients for better growth and thereby resulting in increased uptake values. The application of Iron and Zinc along with a recommended dose of nutrients enhanced the total uptake of Nitrogen, Phosphorus, Potash, Zinc and Iron by maize crop compared to the rest of the other treatments. The synergistic effects of zinc and iron with essential nutrients can significantly increase the availability and uptake of zinc and iron by maize crops. This increase was mainly due to increased maize stover and grain yield and higher concentrations of respectively applied nutrients i.e., Nitrogen, Phosphorus and Zinc. Similar results have also been reported by Singh *et al.* (2010).

CONCLUSION

The soil and foliar application of Zn and Fe have increased the uptake and grain Zn and Fe contentin hybrid maize. The foliar application of Zn and Fe has been proven a better way to increase the uptake and nutrient content in maize grain. The yield was stable after Soil application of Zn and Fe each @ 5 kg/ha + foliar spray each @ 0.1% at the tasselling stage. The maximum accumulation of iron and zinc was in grains when the foliar application of Zn and Fe @ 0.1% was appliedtasselling stage. Hence, for the quality the basal as well as foliar application @ 5 kg/ha @ 0.1% at the tasselling stageand the quantity the basal application of zinc and iron @ 10 kg/ha along with NPK and vermicompost is useful for Zn and Fe improvement in maize grains.

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Table 1.Effect of foliar and soil application of Zinc and Iron on N, P, K content (%) in grains and stover of maize

Trea	**Composition**	**N content (%)**		**P content (%)**		**K content (%)**	
		Grains	**Stover**	**Grains**	**Stover**	**Grains**	**Stover**
T_1.	Control (NPK 120:60:60)	1.50	0.40	0.30	0.15	0.30	1.40
T_2.	T_1+Soil applied Zn and Feeach@ 5 kg/ha	1.51	0.41	0.31	0.16	0.31	1.41
T_3.	T_1+Soil applied Zn and Fe each@ 10 kg/ha	1.52	0.42	0.32	0.15	0.32	1.40
T_4.	T_1+Soil applied Zn and Feeach@ 20 kg/ha	1.51	0.43	0.32	0.16	0.32	1.41
T_5.	T_1+Soil applied Zn and Fe each @10 kg/ha + vermicompost (1.5 t/ha)	1.57	0.49	0.38	0.20	0.38	1.44

T_6.	T_1+Vermicompost @ 1.5 t/ha	1.56	0.48	0.36	0.19	0.37	1.43
T_7.	T_1+Soil applied Zn and Fe each @ 5 kg/ha + foliar spray each @ 0.1% at tasseling stage	1.52	0.41	0.32	0.15	0.31	1.41
T_8.	T_1+Foliar spray Zn and Fe each @ 0.1% at 25 DAS and at tasseling stage	1.51	0.42	0.30	0.16	0.32	1.40
	SEm±	**---**	**0.01**	**0.01**	**0.00**	**0.01**	**---**
	CD (P= 0.05)	**NS**	**0.04**	**0.03**	**0.01**	**0.03**	**NS**

Table 2.Effect of foliar and soil application of Zinc and Iron on Zn, Fe content (mg kg^{-1}) in grains and stover of maize

Treatments	**Treatments**	**Zn content (mg kg^{-1})**		**Fe content (mg kg^{1})**	
		Grains	**Stover**	**Grains**	**Stover**
T_1.	Control (NPK 120:60:60)	21.23	15.20	73.80	171.03
T_2.	T_1+Soil applied Zn and Fe each@ 5 kg/ha	26.46	19.10	76.26	176.93
T_3.	T_1+Soil applied Zn and Fe each@ 10 kg/ha	27.36	22.33	80.20	180.84
T_4.	T_1+Soil applied Zn and Fe each@ 20 kg/ha	29.90	24.73	84.80	182.58

T_5.	T_1+Soil applied Zn and Fe each @10 kg/ha + vermicompost (1.5 t/ha)	27.76	23.10	88.40	181.09
T_6.	T_1+Vermicompost @ 1.5 t/ha	23.13	18.46	81.13	177.38
T_7.	T_1+Soil applied Zn and Fe each @ 5 kg/ha + foliar spray each @ 0.1% at tasseling stage	35.50	28.20	91.40	186.80
T_8.	T_1+Foliar spray Zn and Fe each @ 0.1% at 25 DAS and at tasseling stage	26.20	21.50	79.60	170.83
	SEm±	**0.99**	**0.75**	**2.69**	**3.34**
	CD (P= 0.05)	**3.04**	**2.30**	**8.24**	**10.13**

Table 3. Effect of foliar and soil application of Zinc and Iron on nitrogen, phosphorus and potassium uptake (g/plant) by grains and stoverof maize

Treatments	**Treatments**	**Nitrogen uptake (g/plant)**			**Phosphorus uptake (g/plant)**			**Potassium uptake (g/plant)**		
		Grai	**Stov**	**Tot**	**Grai**	**Stov**	**Tot**	**Grai**	**Stov**	**Tot**
T_1.	Control (NPK 120:60 :60)	0.97	0.37	1.3	0.19	0.14	0.3	0.19	1.31	1.5
T_2.	T_1+Soil applied Zn and Fe each@ 5 kg/ha	0.99	0.39	1.3	0.20	0.15	0.3	0.20	1.35	1.5
T_3.	T_1+Soil applied Zn and Fe each@ 10 kg/ha	1.08	0.41	1.4	0.22	0.14	0.3	0.22	1.38	1.6
T_4.	T_1+Soil applied Zn and Fe each@ 20 kg/ha	1.16	0.43	1.5	0.24	0.16	0.4	0.24	1.43	1.6
T_5.	T_1+Soil applied Zn and Fe each	1.29	0.52	1.8	0.31	0.21	0.5	0.31	1.55	1.8

	@10 kg/ha + vermicompost (1.5 t/ha)									
T_6.	T_1+Vermicompost @ 1.5 t/ha	1.24	0.51	1.7	0.28	0.20	0.4	0.29	1.51	1.8
T_7.	T_1+Soil applied Zn and Fe each @ 5 kg/ha + foliar spray each @ 0.1% at tasseling stage	1.13	0.41	1.5	0.23	0.15	0.3	0.23	1.41	1.6
T_8.	T_1+Foliar spray Zn and Fe each @ 0.1% at 25 DAS and at tasseling stage	1.01	0.41	1.4	0.20	0.15	0.3	0.21	1.37	1.5
	SEm±	**---**	**0.02**	**---**	**0.01**	**0.01**	**---**	**0.01**	**0.00**	**---**

	CD (P= 0.05)	**NS**	**0.08**	**---**	**0.04**	**0.03**	**---**	**0.04**	**NS**	**---**

Table 4. Effect of foliar and soil application of Zinc and Iron on zinc & iron uptake (mg plant^{-1}) by grains and stover of maize

Treatments	**Treatments**	**Zinc uptake (mg plant^{-1})**			**Iron uptake (mg plant^{-1})**		
		Grains	**Stover**	**Total**	**Grains**	**Stover**	**Total**
T_1.	Control (NPK 120:60:60)	1.37	1.42	2.80	4.77	16.07	20.85
T_2.	T_1+Soil applied Zn and Fe each@ 5 kg/ha	1.61	1.83	3.44	5.05	16.97	22.02
T_3.	T_1+Soil applied Zn and Fe each@ 10 kg/ha	1.95	2.20	4.15	5.72	17.82	23.55

T_4.	T_1+Soil applied Zn and Fe each@ 20 kg/ha	2.30	2.50	4.80	6.55	18.46	25.01
T_5.	T_1+Soil applied Zn and Fe each @10 kg/ha + vermicompost (1.5 t/ha)	2.29	2.48	4.77	7.30	18.77	26.08
T_6.	T_1+Vermicompost @ 1.5 t/ha	1.85	1.96	3.81	6.49	18.84	25.33
T_7.	T_1+Soil applied Zn and Fe each @ 5 kg/ha + foliar spray each @ 0.1% at tasseling stage	2.50	2.82	5.32	7.36	19.11	26.48
T_8.	T_1+Foliar spray Zn and Fe each @ 0.1% at 25 DAS and at tasseling stage	1.75	2.10	3.86	5.34	17.62	22.97
	SEm±	**0.09**	**0.13**	**------**	**0.34**	**0.84**	....
	CD (P= 0.05)	**0.28**	**0.41**	**------**	**1.04**	**2.54**	....