Effect of iron and zinc enriched organics on nutrient content and uptake by wheat in loamy sand

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Abstract

A field experiment was carried at the Agronomy Instructional Farm, Department of Agronomy, Chimanhbai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the effect of iron and zinc enriched organics on nutrient content and uptake of wheat in loamy sand (Typic Ustisamments) during rabi season of 2017-18. The results revealed that the concentration of N in grain and straw was increased significantly due to an application of 5 t FYM ha\(^{-1}\) and 2 t VC ha\(^{-1}\) along with recommended dose of fertilizer (RDF) but remain at par with application of either 5t FYM ha\(^{-1}\) or 2 t VC ha\(^{-1}\) along with RDF. However, significantly higher content of Fe and Zn by grain and straw and uptake of N, P, Fe and Zn by grain and straw of wheat were obtained by application of vermicompost @ 0.2 t ha\(^{-1}\) enriched with 5.00 kg Fe and 2.50 kg Zn along with RDF as compared to control (RDF).

Keywords: Iron, zinc, FYM, vermicompost, wheat

Introduction

Micronutrient deficiencies in Indian soils and crops have been on the increase since the adoption of modern agricultural technology with increased use of NPK fertilizers generally free from micronutrients, intensive cultivation with fertilizer responsive improved varieties of crops with more irrigation facilities, limited use of organic manure and restricted recycling of crop residues (Prasad, 1999)\(^{[6]}\). The deficiencies of micronutrients have become major constraint for maintaining productivity of soil. Analysis of about 2.5 lakh soil samples in different states of India carried out under the All India Co-ordinated Research Project on Secondary and Micronutrients and Pollutant Elements in Soils and Plants has revealed that 48, 12, 5 and 3 per cent soils were deficient in cationic micronutrients such as Zn, Fe, Mn and Cu, respectively (Singh, 2006)\(^{[6]}\). Physical mixture of fertilizer with organic is supposed to be inferior compared to the addition of micronutrients to the soil in naturally chelated form with organics. The process of enrichment of organics with micronutrients has drawn attention of soil scientists as the enrichment not only improves the nutrient use efficiency, but also helps in reducing the load of inorganic chemicals as well as quantity of organics to considerable extents. The enrichment technique improves the quality of organics and therefore the addition of organics in lower quantities is expected to yield the similar effect on soil properties to that of use of FYM / vermicompost in higher quantities (without enrichment). It is very well known that when nutrients are chelated with organics, their use efficiency increases.

The information on Fe and Zn enriched organics (FYM/Vermicompost) in different crops are rare and scare, especially in wheat crop practiced on Fe and Zn deficient soil of Banaskantha of North Gujarat. Present study was aimed at assessing the effect of Fe and Zn enriched organics on nutrient content and uptake by wheat in loamy sand.

Material and Methods

A field experiment entitled “Effect of iron and zinc enriched organics on nutrient content and uptake by wheat (Triticum aestivum L.) in loamy sand” was conducted during rabi season of 2017-18 at the Agronomy Instructional Farm, Chimanhbai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. The soil of experimental field was loamy sand in texture and slightly alkaline in reaction. It was low in organic carbon, available N and DTPA-extractable Fe and Zn; medium in available P\(_2\)Os, K\(_2\)O. 

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and S whereas high in DTPA-extractable Mn and Cu content. Ten treatments viz., RDF (T1), RDF + 5 t FYM ha⁻¹ (T2), RDF + 2 t VC ha⁻¹ (T3), RDF + 5 t FYM ha⁻¹ + 2 t VC ha⁻¹ (T4), RDF + 0.5 t FYM ha⁻¹ + 5.00 kg Fe and 2.50 kg Zn ha⁻¹ (T5), RDF + 0.2 t VC ha⁻¹ + 5.00 kg Fe and 2.50 kg Zn ha⁻¹ (T6), RDF + 0.5 t FYM ha⁻¹ enriched with 5.00 kg Fe and 2.50 kg Zn(T7), RDF + 0.2 t VC ha⁻¹ enriched with 5.00 kg Fe and 2.50 kg Zn (T8), RDF + 0.2 t VC ha⁻¹ enriched with 2.50 kg Fe and 1.25 kg Zn (T9), RDF + 0.5 t FYM ha⁻¹ enriched with 2.50 kg Fe and 1.25 kg Zn (T10) were laid out under randomized block design with four replications. Wheat variety GW 451 was used as a test crop.

The enrichment process was started 45 days before their use in rabi experiment on wheat. The required quantity of FYM and vermicompost were filled in pre-dug pits of 1.5’ × 1.5’ × 1.5’ size. The FYM (0.5 t ha⁻¹) and vermicompost (0.2 t ha⁻¹) was thoroughly mixed with the solution of FeSO₄·7H₂O and ZnSO₄·7H₂O having required concentration as per the enrichment treatments viz., 5.00 kg Fe + 2.50 kg Zn and 2.50 kg Fe + 1.25 kg Zn. The moisture percentage of FYM and vermicompost after mixing with ZnSO₄·7H₂O and FeSO₄·7H₂O were kept at about 75 to 80. The starter inoculums of microorganisms in the form of cow dung slurry @ 1 per cent was applied to boost up the microbiological activities for enrichment of natural process of composting to fix the externally added inorganic Fe and Zn into organically bound and naturally chelated form of Fe and Zn; The pit was covered with polythene sheet and allowed for decomposition. The mixture was turned over periodically (weekly) and moisture level was maintained. The data for total Fe and Zn content of FYM and vermicompost before and after enrichment are given in Table 1. The Fe and Zn enriched organics were used in a field experiment.

| Organics               | Major nutrients (%) | Micro nutrients (mg kg⁻¹) |
|-----------------------|---------------------|--------------------------|
|                       | N       | P₂O₅   | K₂O   | Fe   | Zn   |
| FYM Before enrichment | 0.61    | 0.32   | 0.57  | 3710 | 80   |
| Vermicompost          | 1.41    | 1.07   | 0.61  | 4101 | 114  |
| FYM After enrichment  | 0.64    | 0.37   | 0.58  | 6054 | 160  |
| 0.5 t FYM ha⁻¹ enriched with 5.00 kg Fe and 2.50 kg Zn | 0.63 | 0.36 | 0.59 | 5340 | 125 |
| 0.5 t FYM ha⁻¹ enriched with 2.50 kg Fe and 1.25 kg Zn | 1.52 | 1.22 | 0.80 | 7040 | 210 |
| 0.2 t vermicompost ha⁻¹ enriched with 5.00 kg Fe and 2.50 kg Zn | 1.48 | 1.18 | 0.78 | 6110 | 185 |
| 0.2 t vermicompost ha⁻¹ enriched with 2.50 kg Fe and 1.25 kg Zn | 1.48 | 1.18 | 0.78 | 6110 | 185 |

The entire quantity of phosphorus (60 kg ha⁻¹) and half quantity nitrogen (60 kg ha⁻¹) were applied uniformly in opened furrow in the form of diammonium phosphate and urea, respectively. As per treatment the required quantity of Fe and Zn in the form of FeSO₄·7H₂O (19% Fe) and ZnSO₄·7H₂O (21% Zn) were applied in furrow, respectively. After that, application of Fe and Zn enriched FYM or vermicompost were applied in furrow as per the treatments. After fertilizer application, the furrows were covered with the soil in such a way that the furrow remained partly open for seed sowing. The remaining half dose of nitrogen (60 kg ha⁻¹) was top dressed in the form of urea at 23 days after sowing. Wheat showing was completed on 14th November, 2017, by keeping the inter raw spacing of 22.5 cm with the seed rate of 120 kg ha⁻¹. The treatment wise representative samples of grain and straw were drawn at the time of harvest. These samples were kept in brown paper bags for air drying. Thereafter, the samples were kept in oven at 60°C to 65°C for drying till the constant weight was obtained. The dried samples were powdered in a grinder having stainless steel blades to avoid contamination of micronutrients. Chemical analysis of grain and straw samples were done separately for N, P, Fe and Zn as per methods given in Table 2. The plant samples (grain and straw) were wet digested using di-acid mixture of HNO₃ and HClO₄ in 3:1 ratio (Johnson and Ulrich, 1959) [1]. The acid extract prepared after digestion was used for estimation of P, Fe and Zn. The concentration of the nutrients determined in plant samples (grain and straw) was expressed in per cent for major nutrients (N and P) and in mg kg⁻¹ for micronutrients (Fe and Zn) on dry weight basis.

| Reference |
|-----------|
| Waranke and Barber (1974) |
| Jackson (1973) |

Result and Discussion

Nutrients content in grain and straw

The data presented in Table 3 revealed that concentration of N in grain and straw was increased significantly due to combined application of 5 t FYM ha⁻¹ and 2 t VC ha⁻¹ along with RDF (T1) over rest of the treatments except treatments receiving either through 5 t FYM ha⁻¹) and or 2 t VC ha⁻¹ along with RDF. However, P content in grain and straw remained unchanged due to different treatments. Whereas, an application of vermicompost @ 0.2 t ha⁻¹ enriched with 5.00 kg Fe and 2.50 kg Zn in conjunction with RDF (T8) recorded significantly higher Fe and Zn content in grain and straw as compared to other treatments but remained at par with T7 and T10 treatments. The considerable increased in N content in both grain and straw due application of FYM (5 t ha⁻¹) + vermicompost (2 t ha⁻¹) along with RDF (T4) could be attributed to fact that FYM / vermicompost had favourable effect on soil properties and makes more N available during crop growing period. The observed significant increase in Fe and Zn concentration in grain and straw due to application of Fe and Zn enriched FYM / vermicompost might be due to fact that soil of experiment plot was deficient in available iron and zinc and its application after enrichment of FYM and VC had
beneficial effect on mobilizing native Fe and Zn nutrients to increase their availability in soil and also addition of Fe and Zn to the soil in naturally chelated form to provide better nutrition over longer time that caused higher utilization of Fe and Zn by grain and straw. Similar findings were also reported by Yadav et al. (2011) [7] in wheat, Rathod et al. (2012) [8] in wheat and Parmar (2016) [9] in fenugreek.

**Nutrients uptake by grain and straw**

The significantly higher removal of N by grain and straw were obtained under the treatment of RDF along with 0.2 t vermicompost ha⁻¹ enriched with 5.00 kg Fe and 2.50 kg Zn (T₈) but was at par with treatments of T₀, T₁, T₃, T₅ and T₇. However, an application of RDF along with 0.2 t vermicompost ha⁻¹ enriched with 5.00 kg Fe and 2.50 kg Zn (T₈) registered significantly the higher P uptake by grain and straw over rest of the treatments except T₁₀ and T₇ treatments by both grain and straw. Same treatment also recorded significantly the higher Fe uptake by grain and straw over rest of the treatments except T₁₀ and T₇ treatments. Though the significantly higher removal of Zn by grain and straw were recorded under treatment of RDF + 0.2 t vermicompost ha⁻¹ enriched with 5.00 kg Fe and 2.50 kg Zn (T₈), it was at par with T₁₀ and T₇ by both grain and straw.

The higher uptake of P by grain and straw might be due attributed to the favorable influence of organic acid in mobilization of native soil to P that make readily available to roots during crop growing period. The Fe and Zn enriched FYM / vermicompost (T₈, T₁₀ and T₇) caused higher utilization of Fe and Zn mainly due to its beneficial effects in mobilizing the native nutrients to increase their availability besides addition of Fe and Zn to soil in naturally chelated form. This might have provided better nutrition over longer time to cause better crop growth and higher yields. The higher removal of Fe and Zn by grain and straw also be attributed to the priming effect of externally added Fe and Zn to improve crop growth and yield hence higher content of Fe and Zn in grain and straw and also higher grain and straw yields under Fe and Zn enriched FYM / vermicompost along with RDF application might have contributed towards higher uptake of Fe and Zn by grain and straw. These findings are in agreement with the results of Yadav et al. (2011) [7], Patel et al. (2016) [10] in grain amaranth in wheat and Parmar (2016) [11] in fenugreek.

### Table 3: Effect of Fe and Zn enriched organics on N, P, Fe and Zn content by wheat

| Treatments | N content (%) | P content (%) | Fe content (mg kg⁻¹) | Zn content (mg kg⁻¹) |
|------------|--------------|---------------|---------------------|---------------------|
|            | Grain        | Straw         | Grain              | Straw              |
| T₁: RDF (120:60:00 kg N: P₂O₅: K₂O ha⁻¹) | 1.80         | 0.52          | 0.247              | 0.232              |
| T₂: RDF + 5 t FYM ha⁻¹ | 2.15         | 0.589         | 0.286              | 0.238              |
| T₃: RDF + 2 t VC ha⁻¹ | 2.13         | 0.583         | 0.284              | 0.237              |
| T₄: RDF + 5 t FYM ha⁻¹ + 2 t VC ha⁻¹ | 2.16         | 0.602         | 0.289              | 0.239              |
| T₅: RDF + 0.5 t FYM ha⁻¹ + 5.00 kg Fe and 2.50 kg Zn ha⁻¹ | 1.92         | 0.530         | 0.279              | 0.233              |
| T₆: RDF + 0.2 t VC ha⁻¹ + 5.00 kg Fe and 2.50 kg Zn ha⁻¹ | 1.92         | 0.538         | 0.279              | 0.233              |
| T₇: RDF + 0.5 t FYM ha⁻¹ + 5.00 kg Fe and 2.50 kg Zn ha⁻¹ | 1.93         | 0.548         | 0.280              | 0.235              |
| T₈: RDF + 2 t VC ha⁻¹ | 2.03         | 0.566         | 0.283              | 0.236              |
| T₉: RDF + 0.5 t FYM ha⁻¹ + 2.50 kg Fe and 1.25 kg Zn | 2.01         | 0.558         | 0.282              | 0.236              |
| T₁₀: RDF + 0.2 t VC ha⁻¹ | 1.96         | 0.553         | 0.281              | 0.235              |

**S. Em±**

| CD (P = 0.05) | 0.10         | 0.027         | NS                 | 3.08                |

**CV%**

| 3.30         | 3.31         | 5.61         | 2.24                |

### Table 4: Effect of Fe and Zn enriched organics on N, P, Fe and Zn uptake by wheat

| Treatments | N uptake (kg ha⁻¹) | P uptake (kg ha⁻¹) | Fe uptake (g ha⁻¹) | Zn uptake (g ha⁻¹) |
|------------|--------------------|--------------------|--------------------|--------------------|
|            | Grain              | Straw              | Grain              | Straw              |
| T₁: RDF (120:60:00 kg N: P₂O₅: K₂O ha⁻¹) | 75.19         | 25.61             | 10.35              | 11.82              |
| T₂: RDF + 5 t FYM ha⁻¹ | 94.33         | 31.07             | 12.56              | 12.54              |
| T₃: RDF + 2 t VC ha⁻¹ | 96.73         | 31.77             | 12.90              | 12.88              |
| T₄: RDF + 5 t FYM ha⁻¹ + 2 t VC ha⁻¹ | 99.85         | 33.28             | 13.32              | 13.25              |
| T₅: RDF + 0.5 t FYM ha⁻¹ + 5.00 kg Fe and 2.50 kg Zn ha⁻¹ | 88.80         | 29.47             | 12.95              | 12.96              |
| T₆: RDF + 0.2 t VC ha⁻¹ + 5.00 kg Fe and 2.50 kg Zn ha⁻¹ | 89.38         | 30.00             | 12.99              | 13.01              |
| T₇: RDF + 0.5 t FYM ha⁻¹ + En. with 5.00 kg Fe and 2.50 kg Zn | 95.99         | 32.63             | 13.93              | 14.02              |
| Tₑ: RDF + 0.2 t VC ha⁻¹ + En. with 5.00 kg Fe and 2.50 kg Zn | 109.96        | 36.62             | 15.29              | 15.30              |
| Tₑ: RDF + 0.5 t FYM ha⁻¹ + En. with 2.50 kg Fe and 1.25 kg Zn | 96.31         | 32.02             | 13.47              | 13.54              |
| Tₑ: RDF + 0.2 t VC ha⁻¹ + En. with 2.50 kg Fe and 1.25 kg Zn | 101.44        | 34.31             | 14.55              | 14.63              |

**S. Em±**

| CD (P = 0.05) | 14.13         | 4.11             | 1.78                | 1.69                |

**CV%**

| 10.27         | 8.94          | 10.83            | 8.69                | 9.96                | 10.02            | 9.3                | 9.8                |

### Conclusion

Based on the results of present study, the higher content and uptake of nutrients by wheat crop can be obtained by an application of 5.00 kg Fe and 2.50 kg Zn after enrichment of either vermicompost @ 200 kg ha⁻¹ or FYM @ 500 kg ha⁻¹ or application of 2.50 kg Fe and 1.25 kg Zn after enrichment of vermicompost @ 200 kg ha⁻¹ in conjunction with RDF (120 : 60 : 00 kg N : P₂O₅ : K₂O ha⁻¹) compared to only RDF in loamy sand soil deficient in available N, Fe and Zn whereas medium in available P status.

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