**Effect of Iron and Zinc Enriched Organics on Growth, Yield and Yield Attributes of Cowpea in Loamy Sand**

**ABSTRACT**

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| The present study was aimed at assessing the effect of Fe and Zn enriched organics on growth, yield attributes and yield of cowpea crop. A field experiment was carried at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the effect of iron and zinc enriched organics on growth, yield and yield attributes of cowpea (*Vigna unguiculata* L.) in loamy sand during *kharif* season of 2019. The field trial was laid out with three replications and the treatments comprised of T1 (Control), T2 (5.0 t FYM ha-1), T3 (2.0 t vermicompost ha-1), T4 (2.0 kg Zn ha-1), T5 (3.0 kg Fe ha-1 ), T6 (2.5 t FYM ha-1 + 1.0 t vermicompost ha-1 ), T7 (2.5 t FYM ha-1 + 2.0 kg Zn and 3.0 kg Fe ha-1), T8 (1.0 t vermicompost ha-1 + 2.0 kg Zn and 3.0 kg Fe ha-1), T9 (0.5 t FYM ha-1 enriched with 2.0 kg Zn and 3.0 kg Fe ha-1), T10 (0.2 t vermicompost ha-1 enriched with 2.0 kg Zn and 3.0 kg Fe ha-1), T11 (0.5 t FYM ha-1 enriched with 1.0 kg Zn and 1.5 kg Fe ha-1), T12 (0.2 t vermicompost ha-1 enriched with 1.0 kg Zn and 1.5 kg Fe ha-1). The results revealed that an application of vermicompost @ 0.2 t ha-1 enriched with 2.00 kg Zn and 3.00 kg Fe in conjunction with recommended dose of fertilizer (RDF) significantly improved growth and yield attributes *viz.* plant height, number of branches per plant, number of nodules per plant, fresh and dry weight of nodules per plant, number of pods per plant, number of seed per pods, seed and stover yield of cowpea as compared to control (RDF). |

**Keywords:** *Cowpea, enriched organics, iron, zinc,* Yield Attributes

**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). “On the basis of 7587 soil samples collected from different districts of Gujarat, it was found that 25.9 and 25.6 per cent samples were deficient in Fe and Zn, respectively” (Patel *et al.,* 2018). Desai *et al.,* (2018) “collected 556 soil samples from different *talukas* of Banaskantha district and found that 34.8 and 37.6 per cent samples were deficient in Fe and Zn, respectively. Iron and zinc deficiencies are common micronutrient deficiency in light textured soils of North Gujarat limiting both crop production and nutrition quality” (Yadav et al., 2019).

“The deficiencies of micronutrients have become major constraint for maintaining productivity of soil” (Hossain & Sarkar, 2021). “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” (Adegbite et al., 2021). “The process of enrichment of organics with micronutrients 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 extent” (Meena *et al.,* 2006).

“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. The present study was aimed at assessing the effect of Fe and Zn enriched organics on growth, yield attributes and yield of cowpea crop”. (Dharmesh et al.2020)

# MATERIALS AND METHODS

**2.1 Location of the Experimental Site**

The field experiment was conducted on plot number B-6 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, District: Banaskantha (Gujarat). The experimental site is geographically located in the North Gujarat at 72o 19' East longitude and 24o 19' North latitude at an altitude of 154.52 metres above the mean sea level.

**2.2 Season and Crop Varieties**

The study was conducted during the season of *kharif* from June 2019 to September 2019. The rainfall ranged between 0.0 to 150.2 mm and mean maximum temperature ranged between 30.3 to 43.3oC, while mean minimum temperature ranged between 23.9 to 26.6oC during the period of experimentation. The mean relative humidity recorded at morning and evening ranged from 61 to 83.0 and 52 to 81.0 per cent, respectively and the mean bright sunshine hours ranged between 0.0 to 11.4 hours during crop period. The overall climatologically data indicated that the weather conditions were observed normal and favorable for the satisfactory growth and development of the cowpea crop during *kharif*, 2019. The variety selected as cowpea was Gujarat Cowpea 4 with a duration of 70-80 days. The variety was sown in rows at 45 X 10 cm apart with 20 kg seed ha-1.

**2.3 Plot size and Irrigation**

The experiment was conducted on a gross plot size of 5.0 m × 4.5 m, comprising an area of 18.36 m² and accommodating 10 rows. The net plot area measured 4.0 m × 2.7 m, totaling 12.15 m² with 6 effective rows used for data recording. Two irrigations were scheduled during the crop growth period: the first on 27th June 2019 and the second on 12th July 2019.

**2.4 Experimental Design**

The field trial was laid out in randomized block design with three replications and twelve treatments (table 1)

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| **Table 1: Treatments details** |
| **Treatments** |
|  **T1:** |  Control |
|  **T2:** |  5.0 t FYM ha-1 |
|  **T3:** |  2.0 t vermicompost ha-1 |
|  **T4:**  |  2.0 kg Zn ha-1 |
|  **T5:** |  3.0 kg Fe ha-1 |
|  **T6:**  |  2.5 t FYM ha-1 + 1.0 t vermicompost ha-1 |
|  **T7:**  |  2.5 t FYM ha-1 + 2.0 kg Zn and 3.0 kg Fe ha-1 |
|  **T8:**  |  1.0 t VC ha-1 + 2.0 kg Zn and 3.0 kg Fe ha-1 |
|  **T9:**  |  0.5 t FYM ha-1 enriched with 2.0 kg Zn and 3.0 kg Fe ha-1 |
|  **T10:**  |  0.2 t VC ha-1 enriched with 2.0 kg Zn and 3.0 kg Fe ha-1 |
|  **T11:**  |  0.5 t FYM ha-1 enriched with 1.0 kg Zn and 1.5 kg Fe ha-1 |
|  **T12:**  |  0.2 t VC ha-1 enriched with 1.0 kg Zn and 1.5 kg Fe ha-1 |

**2.5 Soil Characteristics**

The soil of the experimental area was loamy sand in texture having pH value 7.2, which was low organic carbon and DTPA-extractable Fe and Zn; medium in available P2O5, and K2O.

The enrichment process was started 45 days before their use in *kharif* experiment on cowpea. The quantity of FYM (0.5 t ha-1) and vermicompost (0.2 t ha-1) were thoroughly mixed with 1% cow dung slurry and the solution of FeSO4.7H2O and ZnSO4.7H2O having required concentration as per the enrichment treatments *viz*., 2.00 kg Zn + 3.00 kg Fe and 1.00 kg Zn + 1.50 kg Fe. The moisture percentage of FYM and vermicompost after mixing with FeSO4 .7H2O and ZnSO4.7H2O were kept at about 60 to 70. The mixtures were filled in pre-dug pit and pit was covered with polythene sheet and allowed for decomposition. The mixture was turned over periodically (weekly) and moisture level was maintained. The Fe and Zn enriched organics were used in a field experiment. Farm yard manure (0.5, 2.5 and 5.0 t ha-1) and vermicompost (0.2, 1.0 and 2.0 t ha-1) were applied as per treatment in experiment. The recommended dose of entire quantity of nitrogen (20 kg ha-1) and phosphorus (40 kg ha-1) were applied commonly to all the treatments as a basal dose in the form of urea and diammonium phosphate 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.

**RESULTS AND DISCUSSION**

**Growth and yield attributes**

“The data presented in table 2 & 3 revealed that among different treatment tested, the treatment receiving recommended dose of fertilizer along with 0.2 t vermicompost ha-1 enriched with 2.00 kg Zn and 3.00 kg Fe in conjunction with RDF recorded significantly higher plant height than the other treatments but it was found at par with treatment receiving RDF + 0.5 t FYM ha-1 enriched with 2.0 kg Zn and 3.0 kg Fe ha-1 (T9), RDF + 0.2 t vermicompost ha-1 enriched with 1.0 kg Zn and 1.5 kg Fe ha-1 (T12), RDF + 0.5 t FYM ha-1 enriched with 1.0 kg Zn and 1.5 kg Fe ha-1 (T11), RDF + 1.0 t vermicompost ha-1 + 2.0 kg Zn and 3.0 kg Fe ha-1 (T8) and RDF + 2.5 t FYM ha-1 + 2.0 kg Zn and 3.0 kg Fe ha-1 (T7). The minimum plant height was recorded under treatment receiving RDF (T1)”. (Dharmesh et al.2020)

The observed significant increase in growth and yield attributes such as plant height (65.92 cm), number of branches per plant (8.46), number of nodules per plant (93.86), fresh (1.80 g) and dry weight of nodules per plant (0.46 g), number of pods per plant (16), number of seed per pods (13.01), under treatments of 0.2 t vermicompost or 0.5 t FYM enriched with either 2.00 kg Zn and 3.00 kg Fe or 1.00 kg Zn and 1.50 kg Fe could be due to fact that enrichment technique caused mobilization the native nutrients to increase their availability besides addition of Fe and Zn in naturally chelated form which are expected to become slowly available to growing crop over longer time. This might help to balance nutrition of Fe and Zn besides supplementing other essential plant nutrients and made them available to crop for longer time that causes better crop growth and yielding attributes characters. These findings are in agreement with those of Yadav *et al.,* (2011) in wheat, Meena and Jat (2015) in mungbean, Parmar (2016) in fenugreek, Yadav (2018) in cowpea and Italiya *et al.,* (2019) in green gram.

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| **Table 2: Effect of Fe and Zn enriched organics on growth attributes of cowpea** |
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| **Treatments** | **Plant height (cm)** | **Number of branches plant-1** | **Number of nodules plant-1** | **Fresh weight (g)** |
|  T1: Control | 54.23 | 5.52 | 78.37 | 1.213 |
|  T2: 5.0 t FYM ha-1 | 56.96 | 6.26 | 83.12 | 1.631 |
|  T3: 2.0 t vermicompost ha-1 | 57.03 | 7.00 | 83.34 | 1.643 |
|  T4: 2.0 kg Zn ha-1 | 56.35 | 5.93 | 81.13 | 1.498 |
|  T5: 3.0 kg Fe ha-1 | 56.28 | 6.23 | 81.67 | 1.599 |
|  T6: 2.5 t FYM ha-1 + 1.0 t vermicompost ha-1 | 58.31 | 7.13 | 84.78 | 1.664 |
|  T7: 2.5 t FYM ha-1 + 2.0 kg Zn and 3.0 kg Fe ha-1 | 60.52 | 6.46 | 85.33 | 1.652 |
|  T8: 1.0 t VC ha-1 + 2.0 kg Zn and 3.0 kg Fe ha-1 | 61.63 | 7.68 | 86.00 | 1.708 |
|  T9: 0.5 t FYM ha-1 enriched with 2.0 kg Zn and 3.0 kg Fe ha-1 | 64.87 | 7.72 | 90.80 | 1.787 |
|  T10: 0.2 t VC ha-1 enriched with 2.0 kg Zn and 3.0 kg Fe ha-1 | 65.92 | 8.46 | 93.86 | 1.802 |
|  T11: 0.5 t FYM ha-1 enriched with 1.0 kg Zn and 1.5 kg Fe ha-1 | 62.97 | 7.66 | 88.40 | 1.732 |
|  T12: 0.2 t VC ha-1 enriched with 1.0 kg Zn and 1.5 kg Fe ha-1 | 63.55 | 7.86 | 90.93 | 1.791 |
| S.Em± | 2.56 | 0.27 | 3.03 | 0.062 |
| CD *(P = 0.05)* | 7.50 | 0.80 | 8.95 | 0.182 |
| CV (%) | 7.40 | 6.77 | 6.13 | 6.52 |

**Seed and stover yield**

“Application of RDF along with 0.2 t vermicompost ha-1 enriched with 2.00 kg Zn and 3.00 kg Fe produced significantly the highest seed and stover yields of cowpea over rest of the treatments except treatment receiving RDF + 0.5 t FYM ha-1 enriched with 2.0 kg Zn and 3.0 kg Fe ha-1 (T9), RDF + 0.2 t vermicompost ha-1 enriched with 1.0 kg Zn and 1.5 kg Fe ha-1 (T12), RDF + 0.5 t FYM ha-1 enriched with 1.0 kg Zn and 1.5 kg Fe ha-1 (T11) and RDF + 1.0 t vermicompost ha-1 + 2.0 kg Zn and 3.0 kg Fe ha-1 (T8). The minimum seed as well as stover yield was obtained under treatment of RDF (control). The magnitude of increase in seed and stover yields due to application of RDF along with 0.2 t vermicompost ha-1 enriched with 2.00 kg Zn and 3.00 kg Fe (T10) was to the tune of 30.96 and 25.96 per cent, respectively over RDF (control)”. (Dharmesh et al.2020)

The observed significant increase in seed and stover yield of cowpea due to application of FYM/vermicompost enriched with either 2.00 kg Zn and 3.00 kg Fe or 1.00 kg Zn and 1.50 kg Fe might be due to fact that the soils of experimental plot was deficient in available Fe and Zn (Fe 4.43 mg kg-1 and Zn 0.39 mg kg-1) and its application after enrichment of FYM/vermicompost improve its availability in soil which might have enhance the yield attributes such seed and stover yield of cowpea. These results are in the line of those reported by Gurjar (2012) in mustard, Rathod *et al.,* (2012) in wheat, Meena and Jat (2015) in mungbean, Patel *et al,* (2016) in cumin, Yadav (2018) in cowpea.

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| **Table 3: Effect of Fe and Zn enriched organics on yield and economics of cowpea** |
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| **Treatments** | **Dry weight (g)** | **Number of pods plant-1** | **Number of seeds pod-1** | **Yield (kg ha-1)** |
| **Seed** | **Stover** |
| T1: Control | 0.295 | 9.24 | 10.21 | 1069 | 1779 |
| T2: 5.0 t FYM ha-1 | 0.397 | 10.00 | 11.25 | 1110 | 1989 |
| T3: 2.0 t vermicompost ha-1 | 0.423 | 11.32 | 11.42 | 1170 | 2004 |
| T4: 2.0 kg Zn ha-1 | 0.369 | 10.06 | 10.26 | 1159 | 1975 |
| T5: 3.0 kg Fe ha-1 | 0.392 | 10.23 | 10.40 | 1148 | 1964 |
| T6: 2.5 t FYM ha-1 + 1.0 t vermicompost ha-1 | 0.428 | 12.40 | 12.01 | 1205 | 2012 |
| T7: 2.5 t FYM ha-1 + 2.0 kg Zn and 3.0 kg Fe ha-1 | 0.426 | 12.53 | 12.46 | 1206 | 2047 |
| T8: 1.0 t VC ha-1 + 2.0 kg Zn and 3.0 kg Fe ha-1 | 0.431 | 14.17 | 12.60 | 1240 | 2072 |
| T9: 0.5 t FYM ha-1 enriched with 2.0 kg Zn and 3.0 kg Fe ha-1 | 0.448 | 14.73 | 12.66 | 1349 | 2165 |
| T10: 0.2 t VC ha-1 enriched with 2.0 kg Zn and 3.0 kg Fe ha-1 | 0.460 | 16.00 | 13.01 | 1400 | 2241 |
| T11: 0.5 t FYM ha-1 enriched with 1.0 kg Zn and 1.5 kg Fe ha-1 | 0.434 | 15.53 | 12.53 | 1306 | 2106 |
| T12: 0.2 t VC ha-1 enriched with 1.0 kg Zn and 1.5 kg Fe ha-1 | 0.451 | 14.53 | 12.73 | 1316 | 2137 |
| S.Em± | 0.015 | 0.65 | 0.63 | 65 77 | 65 77 |
| CD *(P = 0.05)* | 0.046 | 1.91 | 1.86 | 191 | 227 |
| CV (%) | 6.67 | 8.99 | 9.32 | 9.24 | 6.59 |

# CONCLUSION

# Based on the results of present study, the higher growth, yield attributes and seed & stover yield from cowpea crop can be obtained by the application of 2.0 kg Zn and 3.0 kg Fe ha-1 after enrichment of either vermicompost @ 200 kg ha-1 or FYM @ 500 kg ha-1 or application of 1.0 kg Zn and 1.5 kg Fe ha-1 after enrichment of vermicompost @ 200 kg ha-1 or FYM @ 500 kg ha-1 in conjunction with RDF (20: 40: 00 kg N: P2O5: K2O ha-1) in loamy sand soil deficient in available Fe and Zn.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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