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Effect of iron and zinc enriched organics on quality of potato in loamy sand Soil (Typic *Ustipsamments*) of Sardarkrushinagar

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Abstract
A field experiment was conducted at the Agronomy Instructional Farm, Department of Agronomy, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the effect of Fe and Zn enriched organics on quality of potato in loamy sand (Typic *Ustipsamments*) during the *rabi* seasons of 2016-17 and 2017-18. An application of 5 t vermicompost ha^{-1} significantly enhanced quality parameters *viz.*, total chlorophyll content in fresh leaf at 60 DAP, volume of tuber, total soluble sugar and starch content in tuber on fresh weight basis over 20 t FYM ha^{-1}. An application of organics 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn registered significantly higher total chlorophyll content in fresh leaf at 60 DAP, volume of tuber, protein content in tuber on dry weight basis and starch content in tuber on fresh weight basis as compared to no application of Fe and Zn (control).

Keywords: Iron, zinc, vermicompost, FYM, potato, quality

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) [10]. 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 (Ramani *et al.*, 2018) [11]. Desai *et al.* (2018) [3] 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 nutritional quality. The productivity could be sustained through integration use of organics with inorganic fertilizers. Reports in literature indicate that combination of organics with inorganic fertilizers is helpful in decreasing the use of chemical fertilizers under integrated plant nutritional system (IPNS). Supplementation of deficient nutrients is necessary for higher crop yields. The process of enrichment of organics with micronutrients not only increase crop yield but also helps in reducing the load of inorganic chemicals as well as quantity of organics to a considerable extent (Meena *et al.* 2006) [7]. The information on Fe and Zn enriched organics (FYM/Vermicompost) is lacking on Fe and Zn deficient soils of Banaskantha of North Gujarat where potato crop is grown. Present study was aimed at assessing the effect of Fe and Zn enriched organics on growth, yield attributes and yield of potato crop.

Materials and Methods
A field experiment was conducted on a Fe and Zn deficient loamy sand (Typic *Ustipsamments*) soil during *rabi* seasons of 2016-17 and 2017-18 at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. The soil of the experimental plot was low in organic carbon, available N and DTPA-extractable Fe and Zn; medium in available P_2O_5, K_2O and S whereas high in DTPA-extractable Mn and Cu content. Twelve treatment combinations comprising of two organics *viz.*, 20 t FYM ha^{-1} (M_1) and 5 t vermicompost ha^{-1} (M_2) and six treatments of Fe and Zn supplementation *viz.*, No Fe and Zn (N_1), 6 kg Fe and 4 kg Zn ha^{-1} through inorganic (N_2), organics 2 t ha^{-1} enriched with 3 kg Fe (N_3), organics 2 t ha^{-1} enriched with 2 kg Zn (N_4), organics 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn (N_5) and organics 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn (N_6) were laid out under factorial randomized block

design with four replications. The enrichment process was started 45 days before their use in *rabi season* experiments (2016-17 and 2017-18) on potato. The quantities of organics (FYM and vermicompost) were thoroughly mixed with 1% cow dung slurry and the solution of $FeSO_4.7H_2O$ and $ZnSO_4.7H_2O$ having required concentration as per treatments *viz.*, 3 kg Fe, 2 kg Zn, 6 kg Fe and 4 kg Zn and 3 kg Fe and 2 kg Zn through 2 tonnes of organics (FYM and vermicompost) per hectare. The moisture percentage of organics after mixing with $FeSO_4$ 7 H_2O and $ZnSO_4$ $7H_2O$ was kept at about 70-80 percent. The mixture were filled in pre-dug pit and the pit was covered with polythene sheet in natural chelation during the process of composting. The mixture was turned over periodically (weekly) and moisture loss was maintained. The data for total N, P_2O_5, K_2O, Fe and Zn content of FYM and vermicompost before and after enrichment are given in Table 1, 2 and 3.

Farm yard manure @ 20 t ha^{-1} and vermicompost @ 5 t ha^{-1} were manually applied in previously opened furrows as per treatment in both the years. The entire quantity of phosphorus (137.5 kg ha^{-1}) and potassium (275 kg ha^{-1}) whereas, half quantity of nitrogen (137.5 kg ha^{-1}) were applied uniformly in opened furrows (50 cm) in the form of diammonium phosphate, muriate of potash and ammonium sulphate, respectively. As per treatment the required quantity of Fe and Zn in the form of $FeSO_4.7H_2O$ (19 % Fe) and $ZnSO_4.7H_2O$ (21 % Zn) were applied in furrow. After that application of Fe, Zn and Fe + Zn enriched FYM or vermicompost @ 2 t ha^{-1} were applied in furrows as per the treatments. Light planking was done. Cut pieces of potato tubers variety Kufri pukhraj were planted 20 cm apart in furrows with seed rate of 3000 kg tubers ha^{-1}. The remaining half dose of nitrogen (137.5 kg ha^{-1}) was top dressed in the form of urea at 45 days after planting. The treatment-wise representative samples of tubers and haulm were drawn at the time of harvest. For estimation of chlorophyll, middle portion of fourth leaf of potato plant was collected at 60 DAP. Then, it was properly cleaned with distilled water and removed the water with blotting paper. The chlorophyll content in fresh leaves was determined by the method as described by Bruuinsma (1963) [1]. Volumes of average five plant tubers samples were measured by water displacement method. Volume (cc) of potato tubers was calculated and average value was taken for each treatment (Tabatabaeefar, 2002) [12]. Nitrogen estimation in powder sample of tuber was done by micro-Kjeldahl's method (Jackson, 1973) [5]. The protein content of tuber was calculated by multiplying the nitrogen content of tuber with the factor of 6.25 and was expressed as per cent on dry weight basis for each treatment. Starch content (%) in tuber on fresh weight basis was determined by adopting anthrone sulphuric acid method as described by Hofreiter and Hodge (1962) [4]. Total soluble sugar of raw tubers was determined by phenol-sulphuric acid method (Dubois *et al.*, 1956) [2].

Table 1: Nutrient content of FYM and vermicompost (*Before enrichment*)

Sr. No.	Parameters	FYM		Vermicompost	
		2016-17	2017-18	2016-17	2017-18
1	Nitrogen (%)	0.61	0.58	1.55	1.52
2	Phosphorus (%)	0.32	0.31	1.09	1.01
3	Potassium (%)	0.56	0.53	0.67	0.59
4	Iron (mg kg^{-1})	3825	3510	4354	4120
5	Zinc (mg kg^{-1})	90	85	120	108

Table 2: Nutrient content of FYM and vermicompost after enrichment (2016-17)

Sr. No.	Treatment combination code	Treatment combinations	Chemical parameters				
			N (%)	P_2O_5 (%)	K_2O (%)	Fe (mg kg^{-1})	Zn (mg kg^{-1})
1	M_1N_3	FYM 2 t ha^{-1} enriched with 3 kg Fe	0.62	0.36	0.58	5696	110
2	M_1N_4	FYM 2 t ha^{-1} enriched with 2 kg Zn	0.63	0.35	0.55	4040	191
3	M_1N_5	FYM 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn	0.64	0.37	0.57	8151	270
4	M_1N_6	FYM 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn	0.63	0.36	0.56	5848	204
5	M_2N_3	Vermicompost 2 t ha^{-1} enriched with 3 kg Fe	1.66	1.27	0.85	6350	150
6	M_2N_4	Vermicompost 2 t ha^{-1} enriched with 2 kg Zn	1.64	1.15	0.76	4580	225
7	M_2N_5	Vermicompost 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn	1.69	1.30	0.82	8810	395
8	M_2N_6	Vermicompost 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn	1.62	1.25	0.79	6480	230

Table 3: Nutrient content of FYM and vermicompost after enrichment (2017-18)

Sr. No.	Treatment combination code	Treatment combinations	Chemical parameters				
			N (%)	P_2O_5 (%)	K_2O (%)	Fe (mg kg^{-1})	Zn (mg kg^{-1})
1	M_1N_3	FYM 2 t ha^{-1} enriched with 3 kg Fe	0.61	0.35	0.57	5580	97
2	M_1N_4	FYM 2 t ha^{-1} enriched with 2 kg Zn	0.60	0.34	0.58	3990	178
3	M_1N_5	FYM 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn	0.61	0.36	0.59	8016	248
4	M_1N_6	FYM 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn	0.62	0.35	0.59	5710	210
5	M_2N_3	Vermicompost 2 t ha^{-1} enriched with 3 kg Fe	1.62	1.13	0.63	6260	144
6	M_2N_4	Vermicompost 2 t ha^{-1} enriched with 2 kg Zn	1.61	1.18	0.64	4470	212
7	M_2N_5	Vermicompost 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn	1.65	1.26	0.69	8780	381
8	M_2N_6	Vermicompost 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn	1.62	1.23	0.68	6315	223

Result and Discussion

Total chlorophyll content in fresh leaf (mg g^{-1} fresh leaf) at 60 DAP

The data presented in Table 4 indicated that different organics had significant effect on total chlorophyll content in fresh leaf at 60 DAP during both the years as well as in pooled data. An application of 5 t vermicompost ha^{-1} recorded significantly higher total chlorophyll content in fresh leaf than that of 20 t FYM ha^{-1}. The significant increase in total chlorophyll content in fresh leaf at 60 DAP on application of vermicompost seems to be due to increased availability of nitrogen to the plant from vermicompost resulting in increased nitrogen content in plant which has significant role in chlorophyll content in leaves. Plant available form of nitrogen is grater in vermicompost due to higher microbial activity which might have enhanced the total chlorophyll content in fresh leaf at 60 DAP of potato. These results corroborative the findings of Koodi *et al.* (2014) [6] in sweet potato.

Among different treatments of Fe and Zn supplementation, an application of 2 t organics ha^{-1} enriched with 6 kg Fe and 4 kg Zn being on par with organics 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn registered significantly higher total chlorophyll content in fresh leaf at 60 DAP over rest of the treatments during individual year and also in pooled analysis. Significantly the lowest chlorophyll content in fresh leaf at 60 DAP was recorded under control (No Fe and Zn).

Significant increase in total chlorophyll content in fresh leaf due to iron and zinc enriched organics might be due to fact that addition of Fe and Zn enriched organics to the soil helps in mobilizing the native nutrients to increase their availability besides addition of Fe and Zn in naturally chelated form which are slowly available to growing crop over a longer time. This might helped to provide better nutrition of Fe and Zn besides supplementing of other essential nutrients. Thus, increasing the availability of Fe and Zn in soil that increased the total chlorophyll content in fresh leaf as Fe helps in metabolism of chlorophyll and Zn act as a metal activator and is an essential component of enzymes such as proteinase and peptidase which are responsible for assimilation of nitrogen. It also helps in chlorophyll formation.

Volume of potato tuber (CC)

Effect of organics on volume of potato tuber was significant during both the years and in pooled analysis, wherein an application of 5 t vermicompost ha^{-1} recorded significantly higher volume of potato tuber as compared to application of 20 t FYM ha^{-1} (Table 4).

The data given in Table 4 revealed that the different treatment of Fe and Zn supplementation had significant effect on volume of potato tuber. Though the highest volume of potato tuber was recorded with the application of 2 organics ha^{-1} enriched with 6 kg Fe and 4 kg Zn, it was at par with treatment receiving 2 t organics ha^{-1} enriched with 3 kg Fe and 2 kg Zn during individual year as well as in pooled analysis. Significantly the lowest volume of potato tuber was recorded under control (No Fe and Zn).

The positive effect of Fe and Zn enriched organics may be due to fact that Fe and Zn availability in soil was expected to be enhanced through complexation or chelation and thereby prevented fixation in soil. This might have helped to provide balance nutrition of Fe and Zn to potato besides supplementing other essential nutrients in potato crop. Increase in volume of tuber with Fe and Zn enriched organics also may be due to improved the physiological activity like photosynthesis and translocation of food materials and it also helped in increasing the average weight of individual tuber thereby transpiring the tuber from small to medium grade and medium to large grade. These results are in accordance with those reported by Mousavi *et al.* (2007) [8] and Koodi *et al.* (2017) [6].

Total soluble sugar (%) in tuber on fresh weight basis

The data presented in Table 4 indicated that an application of 5 t vermicompost ha^{-1} significantly enhanced total soluble sugar content in tuber as compared to 20 t FYM ha^{-1} in both the years of study as well as in pooled analysis. However, different treatments of Fe and Zn supplementation failed to show its significant effect on total soluble sugar content in tuber on fresh weight basis during both the years as well as in pooled analysis.

Protein content (%) in tuber (on dry weight basis)

Different organics did not excert any significant influence on protein content in tuber on dry weight basis during individual year as well as in pooled data (Table 5). Among different treatments of Fe and Zn supplementation, an application of 2 t organics ha^{-1} enriched with 6 kg Fe and 4 kg Zn registered maximum value of protein content in tuber as compared to other treatments but it was at par with treatment receiving 2 t organics ha^{-1} enriched with either 3 kg Fe and 2 kg Zn or 2 kg Zn in pooled data (Table 5). Significantly the lowest value of protein content in tuber was noted under control (No Fe and Zn). On pooled data basis, the treatment of 2 t organics ha^{-1} enriched with 6 kg Fe and 4 kg Zn registered 9.7 per cent higher protein content in tuber over no application of Fe and Zn (control) treatment.

The significant increase in protein content in tuber due to Fe and Zn enriched organics may be attributed to increase the availability of nitrogen in the soil which enhance the N content in tuber that resulted in increase protein content of tuber as N being a basic constitute of amino acids which are building block of protein. Another reason is due to addition of Fe and Zn through Fe and Zn enriched organics which helps to increase the availability of Zn and Fe in soil. Fe and Zn act as a metal activator and is an essential component of enzymes such as a proteinase and peptidase which are responsible for assimilation of N in the form of amino acid and protein. The results are in agreement with those reported by Mousavi *et al.* (2007) [8] and Parmar *et al.* (2016) [9].

Starch content (%) in tuber (on fresh weight basis)

The data given in Table 5 indicated that organic treatments exhibited their significant influence on starch content in tuber on fresh weight basis in individual year and in pooled analysis. An application of vermicompost @ 5 t ha^{-1} registered significantly higher starch content in tuber than that of application of 20 t FYM ha^{-1}. The beneficial effect of vermicompost on starch content in tuber as observed in present study could be attributed to the fact that vermicompost supply of almost all the essential plant nutrients and also increasing the availability of native soil nutrients due to increased microbial activity. Thus, it provides balance nutrients in general and potassium plays an important role in the activation of starch synthetase and also helps in translocation of starch from leaves to tubers. These results are in line with the findings of Koodi *et al.* (2017) [6] in sweet potato.

Among different treatments of Fe and Zn supplementation, an application of organics 2 t ha^{-1} enriched with 6 kg Fe and 4 kg

Zn registered significantly the highest starch content in tuber over rest of the treatments during both the years of study as well as in pooled analysis. An application of 2 t organics ha^{-1} enriched with 6 kg Fe and 4 kg Zn registred 9.3 per cent higher starch content in tuber than no application of Fe and Zn (control) on pooled basis. Significantly the lowest starch content in tuber was noted under control (No Fe and Zn). The beneficial effect of Fe and Zn enriched organics on starch content in tuber was mainly due to its application caused higher utilization of micronutrients mainly due to its beneficial effect in mobilizing the native nutrients to increase their availability besides addition of Fe and Zn to the soil in naturally chelated form. Increased in Fe and Zn content in soil which was activates enzymes like aldolase and carbonic anhydrase that helps in translocation of carbohydrates from leaves to tubers.

References

1. Bruuinsma J. The quantitative analysis of chlorophylls a and b in plant extracts. Photochemistry and Photobiology. 1963; 2:241-249.
2. Dubois M, Gilles KA, Hamilton JK, Rebers PA, Smith F. Colorimetric method for determination of sugars and related substances. Analytical Chemistry. 1956; 28:350-356.
3. Desai D, Patel BT, Chaudhary N, Thakur P. Status of available sulphur and cationic micronutrients in cultivated soils of Banaskantha district of Gujarat. Indian Journal of Agriculture Research. 2018; 52(2):203-206.
4. Hofreiter BT, Hodge JE. In: Methods in carbohydrate chemistry (Eds. Whistler, R.L. and Be Miller, J.N.). Academic Press, New York, 1962.
5. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, 1973.
6. Koodi S, Singh SP, Rolaniya MK, Gathala S, Choudhary R. Effect of NPK, FYM and Vermicompost on growth, yield and quality of sweet potato (*Ipomoea batatas* Lam.). Chemical Science Review and Letters. 2017; 6(21):495-499.
7. Meena MC, Patel KP, Rathod DD. Effect of Zn and Fe enriched FYM on mustard yield and micronutrient availability in loamy sand soil (Typic Haplustert) of Anand. Journal of Indian Society of Soil Science. 2006; 54 (4):495-499.
8. Mousavi SR, Galavi M, Ahmadvand G. Effect of zinc and manganese foliar application on yield, quality and enrichment on potato (*Solanum tuberosum* L.). Asian Journal of Plant Science. 2007; 6:1256-1260.
9. Parmar M, Nandre BM, Pawar Y. Influence of foliar supplementation of zinc and manganese on yield and quality of potato (*Solanum tuberosum* L.). International Journal Farm Science. 2016; 6(1):69-73.
10. Prasad B. Conjoint use of fertilizers with organics, crop residues and green manuring for their efficient use in sustainable crop production. Fertilizer News. 1999; 44(5):67-73.
11. Ramani VP, Dileep Kumar, Patel RA, Pandya CB, Patel KP, Shukla AK. Recent Development on Micro and Secondary Nutrients Research in Gujarat. In Souvenir, 83rd Annual Convention of Indian Society of Soil Science & National Seminar on Developments in Soil Science, 2018, 75-90.
12. Tabatabaeefar A. Size and shape of potato tubers. International Agro Physics. 2002; 10:301-305.