REVIEW ARTICLE

EVALUATION OF MICRONUTRIENT AVAILABILITY AS INFLUENCED BY MANURE AND FERTILIZER APPLICATION: A REVIEW

Pankaj Singroha, Manu Rani*, Rajni Yadav and Vikas Kumar

Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana
Email: manusagwal@gmail.com

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Abstract: Under various cropping systems, the combined application of manures and fertilizers played a critical role in improving soil physico-chemical characteristics and micronutrient distribution. Micronutrients in the soil are just as significant as macronutrients, and hence have an impact on soil fertility. Intensive cropping practices cause shortages in Zn, Cu, Fe, and Mn in surface and subsurface soil, which can be remedied by applying manures and fertilizers together. The goal was to look at how organic manures and inorganic fertilizers could be used to boost micronutrient availability. When organic manures are used in conjunction with chemical fertilizers, the biological activity increases, and the availability of micronutrients improves as well. Organic matter also acts as a chelating agent, making micronutrients more soluble.

Keywords: Micronutrients, Soil fertility, Manures and fertilizers, Availability

INTRODUCTION

Micronutrient deficiencies in soil and crops are one of the most serious issues affecting soil fertility and affecting the lives of over two billion people (Pirzadeh *et al.* (2010). Micronutrient deficiencies are dangerous to one's health, especially in youngsters and pregnant women (Detterbeck *et al.*, 2016). Food grain production is expanding year after year as a result of intense land cultivation, depleting a large number of macronutrients as well as micronutrients. Wheat, after rice, is the most essential crop for human nourishment, with production exceeding 740 Mt in 2016 and continuing to rise. Micronutrient deficiency is therefore more common in those whose diets are dominated by cereal grains, notably rice, which has a low micronutrient bioavailability (Ahmed *et al.*, 2015). In the Indo Gangetic Plains, overuse of macronutrient fertilizers, decreased use of organic manures, limited recycling of agricultural residues, and bumper harvests have resulted in secondary and micronutrient shortages over the last three decades. Zinc (Zn) insufficiency first developed in various places where intense cropping was practised, followed by iron (Fe) and manganese (Mn) deficits. Organic matter has an impact on the activity and quantity of soil microorganisms such as arbuscular mycorrhizal fungus, which can help plants absorb Zn (Lehmann *et al.*, 2014). Available micronutrient status in soil changes to a large extent with changes in fundamental soil chemical characteristics like as pH, cation exchange capacity, and soil organic C under various nutrient management strategies (Moharana *et al*,. 2017). Although chemical fertiliser application of important microelements in the soil is gaining popularity, it is a costly nutrient management technique whose performance is typically limited to certain soil conditions (White and Broadley, 2009). In terms of crop yield, integrated nutrient management (INM) is one of the best solutions for maintaining soil health (Bajpai *et al.*, 2006). Despite the fact that there is significant evidence supporting the effect of micronutrients in soil on crop performance, micronutrients are still not included in nutrient management plans. Therefore, in order to nourish intensive cropping without irrevocably hurting the process, persistent efforts are necessary to be made through judicious and integrated use of mineral fertilisers, organic as well as green manuring, and absorption of crop residues into soil. Furthermore, because to the high cost and restricted supply of artificial fertilisers, our farmers are frequently forced to fully exploit potential alternative sources of plant nutrition. In this context, renewable bionutrient sources such as vermicompost, neem seed cake, FYM, and others are critical. These animal-derived products, which are readily available in the area, can be exploited to great advantage. Organic manures, when used in conjunction with mineral fertilisers, aid to increase soil aeration, permeability, aggregation, water holding capacity, nutrient holding capacity, biological characteristics, and nutrient usage efficiency, in addition to providing plant nutrients to crops. So, in order to increase output, farmers can apply organic, inorganic, and biofertilizer in appropriate proportions while keeping soil fertility and productivity in mind. A well-balanced fertilization programme also helps to keep the environment clean. Farmers must be adequately educated about the need of integrated nutrition for agriculture in order to provide greater soil health, a pollution-free environment, clean water, and higher crop yields with yield stabilization (Rana and Badiyala, 2014).

Effect of Inm on soil micronutrient availability

Inorganic fertilizers alone are insufficient to maintain production. Under varied cropping systems when nutrient depletion and turnover in the soil plant system are substantial, neither organic manure nor

*Corresponding Author

chemical fertilizers alone can achieve yield sustainability. Organic manure has the dual benefits of improving soil health and fertility while also supplying a portion of crop nutrition requirements (Choudhary *et al*., 2011). Saha *et al*. (2019) studied the effect of long-term INM involving chemical fertilizers and organic amendments on the availability of micronutrients in soil under rice-wheat cropping system on an inceptisols of West Bengal. The results revealed that availability of Zn, Cu, Fe, Mn and B were significantly increased by 2.45,1.54, 1.26, 1.29 and 3.30 times under the treatment applied with 50% RDF + 50% N through FYM to rice and 100% RDF to wheat as compared to the treatment under 100% RDF to both rice and wheat, respectively (Table 1). The higher available Zn content in organically amended treatments may be due to the supply of Zn in the form of organic manures and straw (Khaliq *et al*., 2017), and additional organic inputs promote biological and chemical reactions that result in the dissolution of relatively unavailable Zn in soil (Moharana *et al*., 2017). When FYM, green manure, and paddy straw are added to the soil, the redox potential of the soil is reduced, resulting in more micronutrients being released in an available form in the soil than when inorganic fertilisers are used alone. This could be the reason for the increase in available Cu contents (Walia *et al*., 2010). Furthermore, organic chemicals generated during the decomposition of the organic inputs utilised in the current experiment, namely FYM and green manuring, have chelating properties, which may boost Cu availability by inhibiting fixation, oxidation, precipitation, and leaching (Nikoli and Matsi, 2011). The induced submerged circumstances and lowering of pH of the soil throughout the rice-growing season, which results in an increase in the soluble Fe^{2+} ions in the soil, could be attributed to the higher accessible Fe status in the soil over its starting values. Increased organic C content under organically amended treatments led to greater chelation of B by organic matter, mainly due to formation of B-diol complexes with the breakdown products of soil organic matter (Yermiyahu *et al*., 2001), and organic acids produced during decomposition of organic matter might have solubilized some of the sparingly soluble, fixed, or adsorbed B on clay (Niaz et al., 2013). Dey *et al*. (2017) observed 49.3 and 58.0% higher available (hot $CaCl_2$-extractable) B content under NPK+FYM treatment over control and 100% NPK treatment, respectively, in 13-year long-term groundnut–wheat system involving chemical fertilizers and organic manures. Kharche *et al*. (2013) also reported that the use of FYM, wheat straw and green manure along with chemical fertilizers was found useful in maintaining available micronutrient status of soil over a long-term cropping period. This could be attributed due to integrated nutrient supply system and secretions of different organic acids, the release of micronutrients as a result of decomposition of organic sources and subsequently forming stable complexes with organic ligands (chelates) which decrease its susceptibility to desorption, fixation or precipitation reactions in soil (Khandare *et al*., 2019). In legume based cropping system, Wei *et al*. (2006) studied the effect of fertilization of micronutrients availability and they observed that available Zn, Cu, Mn and Fe was significantly higher under treatment where FYM was applied along with nitrogen and phosphorus as compared to control and find a positive correlation between available Zn, Mn, and Fe with soil organic matter and available phosphorus.

Effect of Inm on micronutrient uptake

Integrated nutrient management practices not only affects the availability of soil nutrients but also considered as most effective nutrient management practice, allowing plant roots to absorb the nutrients efficiently and resulting in better plant growth. In the Eastern Himalayas region, Harish *et al*. (2018) studied the impact of nutrient-management practices (organic, INM, inorganic and control) on micronutrient uptake and grain yield of rice. They observed that Fe, Mn, Zn and Cu uptake was higher under INM practices (83.86, 23.88, 18.22 and 9.39 ppm) as compared the application of only inorganic fertilizers (80.25, 23.41, 17.13 and 9.16), respectively (Table 2). Whereas, grain yield under INM was 11.76, 3.98 and 84.95% higher than organic, inorganic and control practices, respectively. Higher soil micronutrient (Fe, Mn, Zn, and Cu) addition under organic and INM methods may have resulted in significant heterogeneity in nutrient accumulation in rice grains from nutritional sources as well as enhanced root parameter acquisition (Choudhary and Suri, 2009). As a result, it can be concluded that INM is the ideal nutrient-management strategy for harnessing the maximum grain yield with better biofortified grains with micronutrients as compared to other nutrient-management approaches. In a field experiment, Billore and Joshi (2005) investigated the direct and residual effects of an integrated micronutrient application on the soybean–wheat system in alkaline soil. They noticed an increase in production when using FYM at a rate of 10 t ha^{-1}. Under a pearl millet–wheat cropping system, Chaudhary and Narwal (2005) observed that the dose and mode of application of FYM had a substantial impact on DTPA extractable and total Zn, Fe, Mn, and Cu concentrations in soil, with the 45Mg ha^{-1} FYM dose being the most effective. According to Kulandaivel *et al*. (2004), the application of 30 kg $ZnSO_4$ and 5 kg $FeSO_4$ ha^{-1} chelating with FYM in sandy clay loam soil with low Zn and Fe content was determined to be the optimal combination for micronutrient uptake by rice in the rice-wheat cropping system. Prasad and Sinha (2000) studied the impact of fertilisers and organic manures on micronutrient uptake by rice and wheat crops in a rice-wheat cropping system in Bihar over a long period of time. They found that Zn, Cu, Fe, and Mn uptake was increased up to 100% N, P, and K uptake, but that beyond that, it slightly decreased. Wheat and rice uptake of Zn, Cu, Fe, and Mn was in the order FYM+crop residue>FYM>crop residue>no organic manure or crop residue in plots treated with organic manure and crop residues. Behera and Singh (2009) reported similar findings. In a study of rice-wheat cropping system treated with different fertilizers Khan *et al.* (2002) found higher micronutrient uptake under N, P, K, S, and Zn treatments which indicates the effective influence of balanced fertilization can on the micronutrient uptake.

Table 1. Influence of long-term addition of different organic amendments (FYM, PS, and GM) and chemical fertilizers on availability of micronutrients (mg kg^{-1}) in rice–wheat system(Saha *et al*., 2019)

Treatments	Avail Zn	Avail Cu	Avail Fe	Avail Mn	Avail B
T1	0.46G	0.72E	44.2F	9.13F	0.11C
T2	0.45G	0.86CBD	54.7E	12.7E	0.14C
T3	0.43G	0.86CBD	57.0ED	17.4D	0.14C
T4	0.58F	0.80ED	53.5E	18.4CD	0.15C
T5	0.60F	0.78ED	56.8ED	21.5CB	0.10C
T6	1.48A	1.20A	71.5A	27.8A	0.33A
T7	1.32B	1.15A	67.3BA	23.9B	0.27B
T8	0.98DE	0.91CBD	61.8BCD	22.8B	0.23B
T9	0.90E	0.83CED	59.0ECD	21.9CB	0.24B
T10	1.11C	0.98B	64.8BC	24.2B	0.27B
T11	1.01DC	0.91CBD	58.3ED	21.7CB	0.22B
T12	0.53GF	0.97CB	53.3E	21.3CB	0.14C
CV	7.17	8.31	5.95	9.90	14.08
LSD (0.05)	0.10	0.13	5.90	3.39	0.05
Initial status	0.80	0.76	36.7	13.2	0.16

(T1-control, T2-50% RDF to both rice and wheat, T3-50% RDF to rice and 100% RDF to wheat, T4-75% RDF to both rice and wheat, T5-100% RDF to both rice and wheat, T6-50% RDF + 50% N through FYM to rice and 100% RDF to wheat, T7-75% RDF + 25% N through FYM to rice and 75% RDF to wheat, T8-50% RDF + 50% N through PS to rice and 100% RDF to wheat, T9-75% RDF + 25% N through PS to rice and 75% RDF to wheat, T10-50% RDF + 50% N through GM to rice and 100% RDF to wheat, T11-75% RDF + 25% N GM to rice and 75% RDF to wheat, T12-conventional farmer's practice. Numbers followed by different uppercase letters are significantly different at P ≤ 005 by Duncan's multiple-range test).

Table 2. Effect of nutrient-management practices on crop productivity, nutrient acquisition of micro-nutrients in rice grains. (Harish *et al*., 2018)

Treatment	**Grain yield (t/ha)**	**Micronutrient content in grains (ppm)**			
		Fe	**Mn**	**Zn**	**Cu**
Organic	3.74	82.20	23.24	18.58	9.36
INM	4.18	83.86	23.88	18.22	9.39
Inorganic	4.02	80.25	23.41	17.13	9.16
Control	2.26	77.25	22.55	15.97	9.10
SEm±	0.06	0.26	0.24	0.13	0.04
CD (P=0.05)	0.21	0.89	0.83	0.44	0.14

CONCLUSION

The application of various combinations of chemical and organic fertilisers had a substantial impact on micronutrient availability and uptake, according to the literature reviewed. When compared to control and chemical fertilisers, INM techniques had considerably higher micronutrient availability and uptake. In comparison to the control, nitrogen and phosphorus fertilisers, together with or without FYM, improved the availability of micronutrients. As a result, combining chemical fertilisers with organic manures helps in maintaining balanced nutrition and enhances micronutrient availability.

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