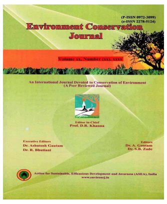
Environment Conservation Journal 24 (4): 192-196, 2023

Journal homepage: https://www.environcj.in/

Environment Conservation Journal

ISSN 0972-3099 (Print) 2278-5124 (Online)



Agronomic biofortification with zinc and iron to enhance nutrient concentrations in mango

Archana Mahida ✉

Department of Fruit Science, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsai, India

Tandel, Y. N

Department of Fruit Science, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsai, India

Patel, D. P

Department of Fruit Science, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsai, India

Manish Kumar

Department of Horticulture, School of Life Sciences, Central University of Tamil Nadu, Thiruvarur, India

ARTICLE INFO

Received : 18 January 2023

Revised : 18 June 2023

Accepted : 04 July 2023

Available online: 12 November 2023

Key Words:

Agronomical fortification

$ZnSO_4$

$FeSO_4$

foliar spray

N, P and K

ABSTRACT

Biofortification is a global-scale agricultural approach that can improve human nutrition. Agronomic biofortification is viewed as a quick-fix and supplemental approach. Agronomic biofortification, especially foliar application, is highly effective for zinc and iron. A field experiment on agronomic biofortification of zinc and iron micronutrients in mango cv. Kesar was carried out in 2016-2017 at the Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat). The experiment was arranged in a completely randomized design (CRD) with three replications containing 9 treatments. The results show that foliar application of $ZnSO_4$ and $FeSO_4$ (0.5% each) resulted in higher N (48.73 mg/100 g) and K (94.17 mg/100 g) in the pulp and P (0.056%) in the peel of mango. The iron (Fe) and zinc (Zn) contents in pulp and peel were highest in treatment T_9 (0.50% $FeSO_4$ + 0.50% $ZnSO_4$), which was on par with those in treatment T_8 (0.50% $FeSO_4$ + 0.25% $ZnSO_4$).

Introduction

Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae. It is a significant fruit crop in Asia and has gained recognition on a global scale. It has long been associated with culture and religion as a helpful and delectable fruit. Mango is known as "The King of Fruits" due to its great nutritional content. Micronutrients are crucial for plant metabolism and have negative consequences when they are lacking, which makes them important for crop development. Micronutrients have a significant impact on plant development in addition to disease resistance in farmed crop species. Due to the widespread prevalence of micronutrient imbalance throughout India, the situation has taken a troublesome turn. Due to the significance of micronutrients in the diet of humans, it is anticipated that biofortification of horticulture crops will play an important and decisive role in addressing the nation's nutritional security in the years to come (Cakmak,2008). Iron is a crucial mineral and part of several proteins involved in metabolism and oxygen transport. The body typically regulates the amount of iron absorbed from the diet to keep its levels of iron regular. The greatest global nutritional problem, according to the WHO, is iron deficiency. Iron deficiency is responsible for approximately 50% of anemia worldwide. Globally, more than 2 billion people suffer from iron deficiency (Mehansho, 2006). In addition to being a vital component of many enzymes, zinc also plays a crucial role in cellular development and differentiation in tissues with a high rate of differentiation and turnover, such as the immune system and the digestive tract. The skin, brain, central nervous system, and immunological, skeletal, and reproductive systems are all impacted by zinc deficiency. Over 2 billion individuals, according to the World Health Organization

Corresponding author E-mail: *mahidaarchana24@gmail.com*

Doi: https://doi.org/10.36953/ECJ.17432548

(WHO), are believed to be zinc deficient. Approximately 20% of the world's population may be at danger of zinc insufficiency, according to estimates of zinc consumption and bioavailability obtained from FAO food balance statistics. Iron and zinc deficits were listed as two of the world's most significant health risks in the World Health Report from 2000.Increasing the content of vitamins in fruit while concurrently enhancing their bioavailability is the dual goal of biofortification, which aims to reduce human micronutrient deficiencies. It is a possible sustainable and cost-effective agronomic method to increase the micronutrient content of food. A future plan is to address micronutrient deficiencies globally. Conferring to estimates from the World Health Organization (Anon., 2000), biofortification of iron might help treat two billion individuals with anemia caused by iron deficiency. Maintaining enough zinc and iron delivery to the fruit throughout the reproductive stage and maintaining a sufficient amount of readily accessible zinc and iron in foliar solution appear to be key agronomic fortification strategies. It is a highly appealing and practical technique for efficiently addressing global health issues connected to iron and zinc deficiencies.

Material and Methods

Study Area: The experiment was carried out on a 20-year-old mango orchard planted at a 10 m×5 m distance, and the site was located at the Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat) from October 2016 to June 2017. The experimental site was situated at 20°57' north latitude, 72° 54' east longitude and has an altitude of 10 meters above the mean sea level. The analytical procedures employed for determining nutrients are presented in Table 1. The climate of this area is characterized by three well-defined seasons: monsoon, mild winter and summer. The monsoon commences from the second week of June and lasts up to the end of September. The intensity of rainfall is high during July and August. The details of the meteorological data with respect to maximum and minimum temperature, relative humidity, rainfall, etc., during the period of experimentation were obtained from the Agricultural Meteorological Observatory, College Farm, N. M College of Agriculture, NAU, Navsari.

Treatment details: The trial was directed in a completely randomized design (C.R.D.) with 9 treatments and replicated three times. The details of the experimental treatment plan employed in the present investigation are as follows: Control (T_1), 0.25% $FeSO_4$ (T_2), 0.50% $FeSO_4$ (T_3), 0.25% $ZnSO_4$ (T_4), 0.50% $ZnSO_4$ (T_5), 0.25% $FeSO_4$ + 0.25% $ZnSO_4$ (T_6), 0.25% $FeSO_4$ + 0.50% $ZnSO_4$ (T_7), 0.50% $FeSO_4$ + 0.25% $ZnSO_4$ (T_8), and 0.50% $FeSO_4$ + 0.50% $ZnSO_4$ (T_9) (Table 2). The foliar spray of these nutrients was performed at the time of flowering (21/12/2016), pea stage (17/02/2017) and egg stage (20/03/2017). For the preparation of Zn and Fe foliar solutions, commercial grade $ZnSO_4.7H_2O$ and $FeSO_4.7H_2O$ fertilizers were used, respectively. The mandatory quantities of ferrous sulfate and zinc sulfate were weighed and dissolved in water, and then the pH of the solution was adjusted to 6.0 by using saturated $CaCO_3$ solution.

Table 1:- Analytical procedures employed for determining nutrients from pulp and peel of mango

Nutrient	Method employed	Reference
N	Wet digestion (Chromic acid)	Trivedi *et al.* (1999)
P and K	Wet digestion (diacid) followed by P: Spectrophotometric (Vanadomolybdophosphoric yellow color method) K: Flame photometric	Jackson (1973)
Fe, Mn, Zn and Cu	Atomic Absorption Spectrophotometer (AAS)	Elwell and Gridley (1967)

Table 2: Micronutrient fertilizers and water required for foliar spraying

S N	Treatments	Fertilizers required (g/20 Lit)	
		$FeSO_4.7H_2O$	$ZnSO_4.7H_2O$
1.	Control	-	-
2.	0.25% $FeSO_4$	91.4	-
3.	0.50% $FeSO_4$	182.8	-
4.	0.25% $ZnSO_4$	-	89
5.	0.50% $ZnSO_4$	-	178
6.	0.25% $FeSO_4$ + 0.25% $ZnSO_4$	91.4	89
7.	0.25% $FeSO_4$ + 0.50% $ZnSO_4$	91.4	178
8.	0.50% $FeSO_4$ + 0.25% $ZnSO_4$	182.8	89
9.	0.50% $FeSO_4$ + 0.50% $ZnSO_4$	182.8	178

Statistical analysis

The acquired data were statistically evaluated in accordance with the method (Panse and Sukhatme, 1967) suitable for a completely randomized design, and the treatment means were compared using critical differences at a 5% level of probability.

Results and Discussion

The N and K contents in the mango pulp were 48.73 mg/100 g and 94.17 mg/100 g, respectively, which were highest in the combined application of 0.50% FeSO4 + 0.50% ZnSO4 (T9) compared to the other treatments and controls. However, the P content did not show any significant response to foliar spraying on the Fe and Zn contents in the pulp of mango. Furthermore, the N and K contents in the peel of mango did not demonstrate significant variation by the foliar spray treatments applied. However, a significantly increased P content in the peel (0.056 ppm) was found in the foliar spray of 0.50% $FeSO_4$ and 0.50% $ZnSO_4$. Increased nutrient content in pulp and peel may be the result of foliar micronutrient spray, which reduced nutritional deficits and enhanced fruit quality due to absorption of macro- and micronutrients in tissues and organs of mango plants. Singh *et al.* (2020) found a similar effect with mango. The maximum zinc (Zn) content and iron (Fe) content in the pulp and peel of mango cv.

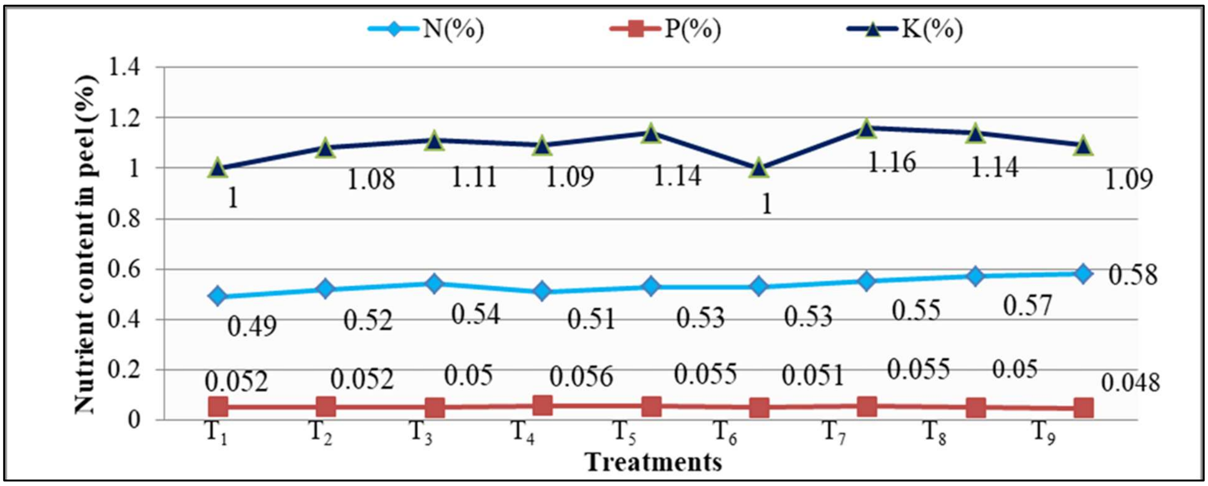


Figure 1: Effect of foliar spray of Zn and Fe on major nutrient content in peel of mango cv. Kesar

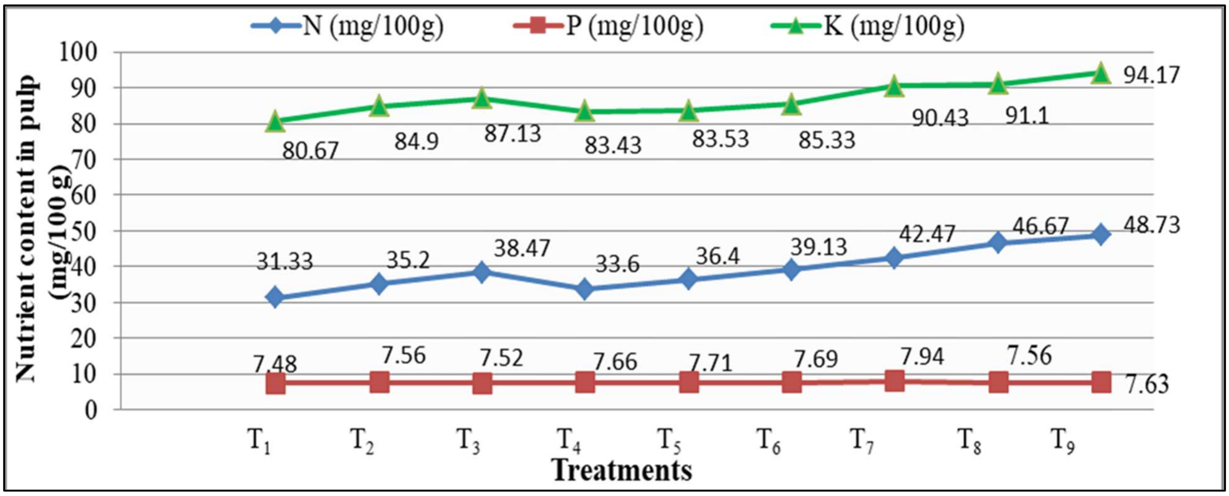


Figure 2: Effect of foliar spray of Zn and Fe on micro nutrient content in pulp of mango cv. Kesar

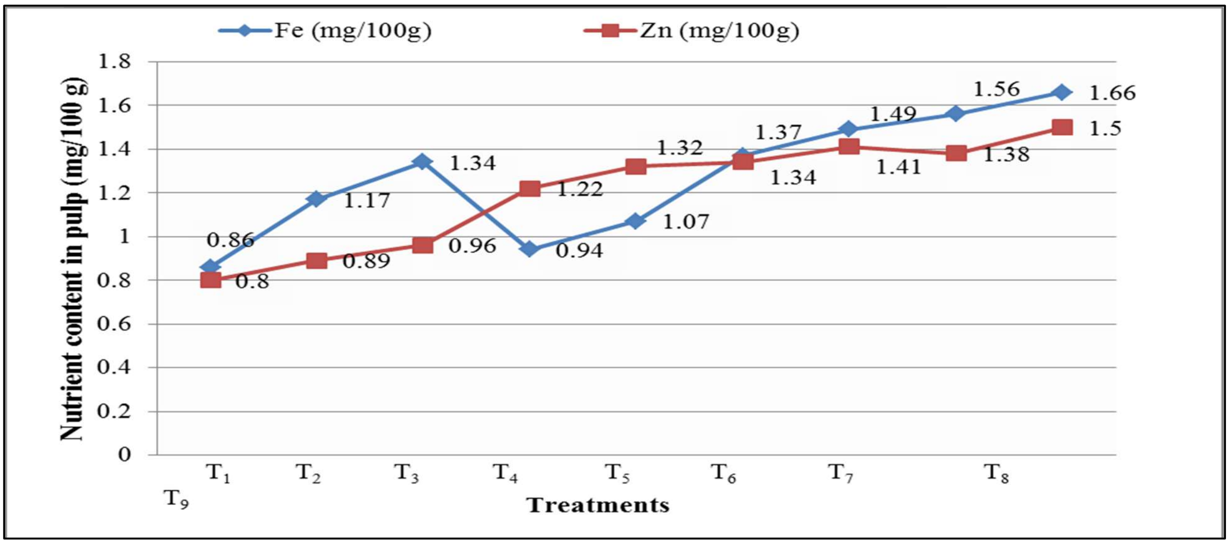


Figure 3: Effect of foliar spray of Zn and Fe on micro nutrient content in pulp of mango cv. Kesar.

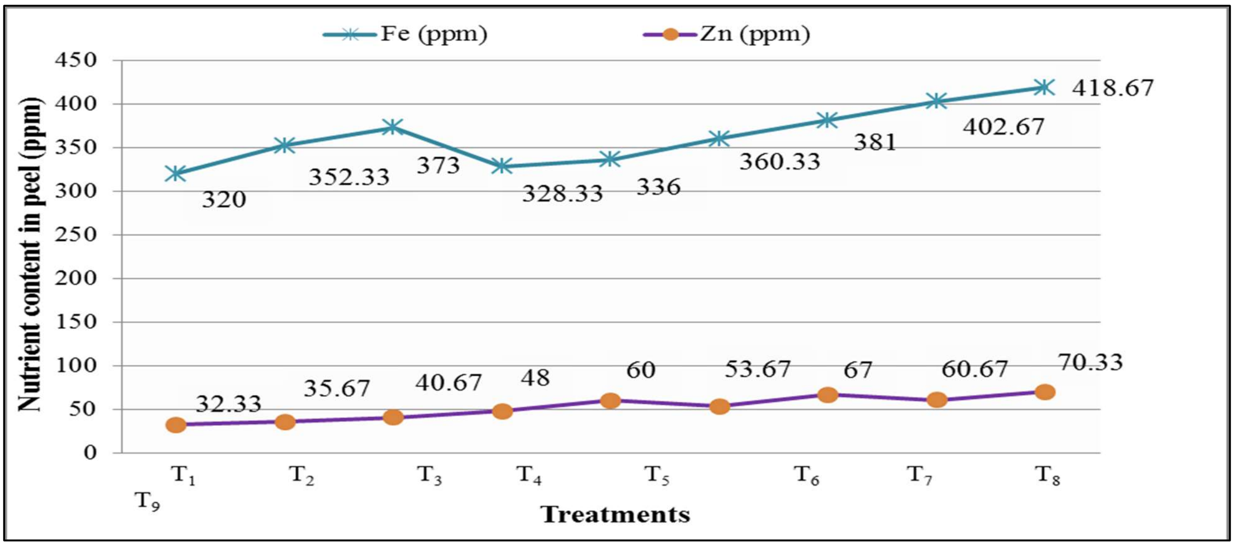


Figure 4: Effect of foliar spray of Zn and Fe on micro nutrient content in peel of mango cv. Kesar.

Kesar were recorded in the treatment combination of 0.50% $FeSO_4$ and 0.50% $ZnSO_4$ (T_9). In 2020, Li Li and his coworkers reported that the pulp may have been a greater sink for zinc than the other mango components. Fruits and leaves quickly absorb iron, increasing their capacity for concentration and uptake. Auxin and protein synthesis, seed development, and the activation of several enzymes are all impacted by zinc. All of these activities promote zinc absorption. The results of nutrient absorption closely support the findings of Sultana *et al.* (2018) in wheat, Chhetri *et al.* (2017) in mandarin orange, and Dhaliwal *et al.* (2021) in lentil.

Conclusion

The results of the study indicate that the foliar application of 0.50% FeSO4 and 0.50% ZnSO4 nearly quadrupled the content of N, K, and P in pulp and peel, as well as Fe and Zn in pulp and peel. The quality of harvested crops pre- and postharvest is one advantage of foliar treatments. For even better results, this experiment can be improved by applying nanotechnology to the leaves. However, this study will contribute to reducing malnutrition.

Acknowledgement
The beatitude and euphoria that accompanies successful completion of any task would be incomplete without expression of appreciation of simple certitude to the people who made it possible to achieve the goal by encouraging guidance and proper steering. It is still great at this juncture to recall all the faces and spirit in the form of teachers, parents, friends and dear ones. I consider myself lucky to have worked under the guidance of

excellence pursuing and ever helpful personality Dr. Y. N. Tandel, Assistant Professor (Fruit Science), ACHF, NAU, Navsari. I am immensely grateful to him for his genuine guidance.

Conflict of interest
The authors declare that they have no conflict of interest.

References
Anonymous, (2000). World Health Organization, Geneva, Switzerland.

Cakmak, I. (2008). Enrichment or cereal grains with zinc agronomic or genetic biofortification. *Pl. Soil.,* 302:1-17.

Chhetri, L.B.; Puspa Raj Poude, P.R.; Dhruba Bijaya G.C.; Gautam, D and Jyoti Bhandari.(2017). Foliar Spray of Micronutrients in Mandarin Orange (Citrus reticulata Blanco); An Efficient Technique of Nutrient Management. *North American Academic Res.* 3(11):11-20.

Dhaliwal, S.S.; Sharma, V.; Shukla, A.K.; Kaur, J.; Verma, V.; Singh, P.; Singh, H.; Abdel-Hafez, S.H.; Sayed, S.; Gaber, A.; *et al.*(2021). Enrichment of Zinc and Iron Micronutrients in Lentil (*Lens culinaris* Medik.) through Biofortification. *Molecules*. 26: 7671

Elwell, W. T. and Gridlely, J. A. F. (1967). In: Atomic absorption spectophotometery, pergamon press Ltd., London, pp. 221.

Jackson, M. L. (1973). "Soil Chemical Analysis"., Prentice-Hall of India Pvt. Ltd., New Delhi, India, pp. 39- 415.

Li, L.; Wu, H. X.; Ma, X. W.; Xu, W. T.; Liang, Q. Z.; Zhan, R. L.; and Wang, S. B. (2020). Transcriptional mechanism of differential sugar accumulation in pulp of two contrasting mango (*Mangifera indica* L.) cultivars. *Genomics*, 112(6):4505-4515.

Mehansho, H. (2006). Iron Fortification Technology Development: New Approaches. *J. Nutrition.,* 136:1059-1063

Panse, V. G. and Sukhatme, P. V. (1967). Statistical Methods for Agricultural Workers . ICAR, New Delhi.

Sultana, S.; Naser, H. M.; Quddus, M. A.; Shil, N.C. and Hossain, M.A.(2018).Effect Of Foliar Application Of Iron And Zinc On Nutrient Uptake And Grain Yield Of Wheat Under Different Irrigation Regimes. *Bangladesh J. Agril. Res.* 43(3): 395-406.

Singh, T. K.; Singh, D.; Kumar, A.: Patel, A. and Bose, U. S. (2020). Effect of micronutrients on growth, yield and fruit quality of mango (Mangifera indica L.) cv. Dashehari. *International J. Chemical Studies*. 8(6):2055-2058.

Trivedi, B. S.; Patel, G. G.; Desai, R. M. and Padhiyar, G. M. (1999). Comparision of Kjeldahl’s and Chromic Acid Methods of Nitrogen Determination. *Gujarat Agric. University Res. J.*, 25(1): 9-14.