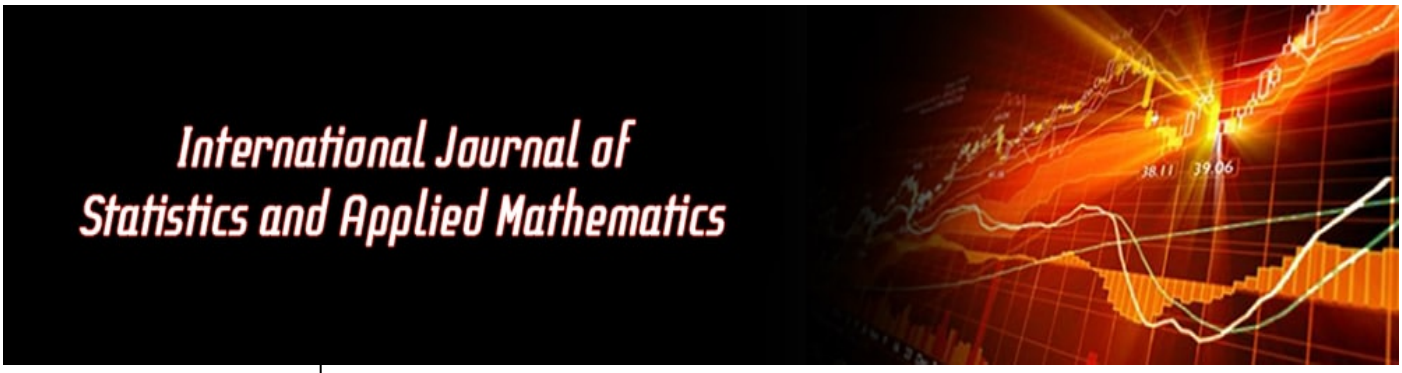

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Impact of integrated nutrient management on leaf nutrient content in Nagpur mandarin

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Abstract
The experiment was conducted in the orchard, at Regional Fruit Research Station, Katol, Dr. Panjabrao Deshmukh Krishi Vidyapeeth during 2021-22. The study was initiated in an eleven-year-old Nagpur mandarin orchard under normal planting density (6 m x 6 m). The experiment was laid out in Randomized Block Design (RBD) with nine treatments comprising various combinations of FYM, biofertilizers, RDF and foliar spray of micronutrients with three replications. The treatments comprise T_1- Only FYM @ 50 kg tree^{-1} + Biofertilizers, T_2- 100 % Recommended dose of NPK, T_3-100 % Recommended dose of N only + FYM @ 50 kg tree^{-1} + Biofertilizers, T_4-100 % Recommended dose of N and P + FYM @ 50 kg tree^{-1} + Biofertilizers, T_5- 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers, T_6- 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers + S, T_7- 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn, T_8- 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn + Fe, T_9- 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn + Fe + B. The results of the present study revealed that, the leaf nutrients content increased with the combined application of different treatments as compared to their individual application. The integrated nutrient management recorded the maximum leaf macronutrient content like total nitrogen (2.52 %), phosphorus (0.15 %), potassium (1.49 %) and sulphur (0.19 %).

Keywords: INM, Nagpur mandarin, leaf nutrient, nitrogen, phosphorus, potassium, sulphur

Introduction
Integrated nutrient management is a practice that combines organic and inorganic fertilizers with biofertilizers to maintain soil fertility and productivity while reducing the reliance on chemical fertilizers, resulting in cost-effectiveness (Bodkhe, 2017) [4]. Nagpur mandarin (*Citrus reticulata* Blanco) is a significant citrus crop in India, with an annual production of 100.9 lakh tonnes, covering 310.42 lakh ha (12.4 % of the total fruit crop area). However, it has an average yield of 9.7 t ha^{-1}, which is lower compared to other citrus varieties (Shirgure *et al.*, 2012) [10]. In Maharashtra, the area dedicated to this crop is 1.48 lakh ha, with a production of 8.75 lakh tonnes and the average yield varies between 10-14 tonnes ha^{-1}. In the Vidarbha region of Maharashtra, Nagpur mandarin covers an area of 1,46,040 ha and produces 5,97,758 million tonnes (Anonymous, 2018) [1]. For fruit crops like Nagpur mandarin, the integrated use of organic and inorganic fertilizers provides an excellent opportunity to enhance nutrient uptake. Therefore, this study aims to investigate the impact of integrated nutrient management on leaf nutrient content in Nagpur mandarin.

Materials and Methods
The research was conducted in the orchard at Regional Fruit Research Station, Katol, Dr. Panjabrao Deshmukh Krishi Vidyapeeth during the year 2021-22. Eleven-year-old Nagpur mandarin trees, spaced at 6 m x 6 m intervals, were employed for this experiment. The experiment was designed following the principles of a Randomized Block Design, with nine treatments, each replicated three times. The treatments comprise T_1- Only FYM @ 50 kg tree^{-1} + Biofertilizers, T_2- 100 % Recommended dose of NPK, T_3-100 % Recommended dose of N only + FYM @ 50 kg tree^{-1} + Biofertilizers, T_4-100 % Recommended dose of N and P + FYM

@ 50 kg tree^{-1} + Biofertilizers, T_5- 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers, T_6- 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers + S, T_7- 100 % NPK + FYM @ 50 kg tree^{-1} +Biofertilizers + S + Zn, T_8- 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn + Fe, T_9- 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn + Fe + B. The recommended dose of fertilizers for Nagpur mandarin is N 800 g, P_2O_5 300 g, K_2O 600 g, S100 g tree^{-1}. Biofertilizers 500 g VAM (*Glomus mosseae*) + 100g PSB (*Bacillus megaterium*) +100 g Azospirillum (*Azospirillum lipoferum*) + 100 g Trichoderma *(Trichoderma viride*) tree^{-1} mixed with FYM @ 50 kg tree^{-1} were applied 15 days before all treatments. Micronutrients (Zn 0.5 %, Fe 0.5 % and B 0.1 %) tree^{-1} had two foliar sprays in each month of July, August and September. The observations recorded during the investigation were tabulated and subjected to statistical analysis. The results were analyzed and interpreted in accordance with the methods outlined in "Statistical Methods for Agricultural Workers" by Gomez and Gomez (1984) [5]. Appropriate standard errors (S.E.) and critical differences (C.D.) at a 5 % significance level were determined as needed.

Result and Discussion

Data regarding the impact of integrated nutrient management on leaf nutrient content in Nagpur mandarin are presented in Table 1. Increased nutrient concentration was observed not only with the application of the recommended dose of fertilizers but also when combining it with organic manure, biofertilizers and foliar micronutrient sprays. The maximum nitrogen content in the leaves of Nagpur mandarin was found in the treatment with 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn + Fe + B (T_9) (2.52 %), whereas, the highest phosphorus content in the leaves of Nagpur mandarin was observed in treatments receiving 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn + Fe + B (T_9) and 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn (T_7) (0.15 %). The highest potassium concentration in the leaves was recorded in the treatment supplied with 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn + Fe (T_8) (1.49) and 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers (1.49 %) after the harvest of Nagpur mandarin. The lowest leaf N, P and K content was observed in the treatment with only FYM @ 50 kg tree^{-1} + Biofertilizers (T_1) (2.28 %, 0.10 % and 1.33 %). After the harvest of Nagpur mandarin, sulphur content in the leaves was noticed to be the highest in the treatment with 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn + Fe + B (T_9) (0.19 %), while the lowest was observed in 100 % NPK (T_2) (0.12 %). Balanced fertilization, including the use of chemicals, organic manures, biofertilizers and foliar sprays, can lead to increased leaf macronutrient content through various mechanisms. Biological nitrogen fixation and enzyme production help solubilize and make nutrient elements available for plant uptake, contributing to increased nutrient content. Similar results were made by, Patekar *et al.* (2020) [8]. Baviskar *et al.* (2014) [3] noted that, the application of a combination consisting of application of (1125:750:375 g NPK + 15 kg vermicompost + 250 g *Azotobacter* tree^{-1} + 250 g PSB tree^{-1}) resulted in improved levels of macronutrients (nitrogen, phosphorus, potassium and sulphur) in the leaves. The leaf nutrient status in sapota showed significant enhancement when inorganic fertilizers were combined with organic manures and biofertilizers, compared to the control group. A similar reference was also made by Srivastava *et al.* (2015) [11], they reported a significant increase in N, P, K and S content in mandarin leaves with the combination of 75 % RDF + 25 % Vm + MC, which significantly improved leaf nutrient content over 25 % Vm + MC or 100 % RDF alone. Further, Bakshi *et al.* (2017) [2] also found that, integrated nutrient management in Kinnow mandarin using the combined application of *Azotobacter* + 25 % nitrogen as vermicompost and 75 % nitrogen as urea resulted in the highest concentrations of leaf N (2.57 %), P (0.19 %) and K (1.56 %). Similar findings were also reported by Kamalakannan *et al.* (2019) [6] that, the leaf nutrient content increased with the application of treatment RDF (1000: 1000: 1500 g NPK tree^{-1}) + vermicompost @ 12.5 kg tree^{-1} + EM (effective microorganisms).

The results demonstrated that, leaf nutrient content slightly improved with the foliar application of zinc, iron and boron. Specifically, in treatment 100 % NPK + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn + Fe + B (T_9), compared to treatment 100 % NPK (T_2) and FYM @ 50 kg tree^{-1} + Biofertilizers (T_1). These results were also similar to the findings of Walli *et al.* (2022) [12], they observed that, foliar application of Zn and B (alone or in combination) has significantly improved nutrient content in the leaves of treated trees. When zinc and boron are foliarly applied, they may facilitate the enhanced uptake and retention of nutrients in the leaf tissues, as these micronutrients can be more readily absorbed and retained in the leaves. This rise in macronutrient levels is attributed to a synergistic relationship between N, P, K, S, Zn, Fe and B. Earlier, foliar application of B and Zn was reported to have a positive effect on the leaf nutrient contents of 'Kinnow' mandarin by Razzaq *et al.* (2013) [9]. Similarly, Khan *et al.* (2015) [7] also reported that, the highest increase in N contents (2.34 %) was recorded in the trees subjected to the combined application of boric acid and zinc sulphate at the fruit set stage.

Table 1: Impact of integrated nutrient management on leaf nutrient content in Nagpur mandarin

Treatments		Leaf nutrient (%)			
		Total nitrogen (%)	Total Phosphorus %)	Total potassium (%)	Total sulphur (%)
T_1	Only FYM @ 50 kg tree^{-1} + Biofertilizers	2.28	0.10	1.33	0.12
T_2	100 % Recommended dose of NPK	2.33	0.11	1.38	0.12
T_3	100 % Recommended dose of N only + FYM @ 50 kg tree^{-1} + Biofertilizers	2.36	0.10	1.36	0.13
T_4	100 % Recommended dose of N and P + FYM @ 50 kg tree^{-1} + Biofertilizers	2.40	0.12	1.38	0.13
T_5	T_2 + FYM @ 50 kg tree^{-1} + Biofertilizers	2.44	0.14	1.45	0.14
T_6	T_2 + FYM @ 50 kg tree^{-1} + Biofertilizers + S	2.44	0.14	1.46	0.16
T_7	T_2 + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn	2.44	0.15	1.49	0.17
T_8	T_2 + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn + Fe	2.49	0.14	1.49	0.18
T_9	T_2 + FYM @ 50 kg tree^{-1} + Biofertilizers + S + Zn + Fe + B	2.52	0.15	1.46	0.19
SE m (±)		0.03	0.01	0.02	0.01
CD at 5 %		0.09	0.03	0.07	0.04

Conclusion

Based on the above finding, it is concluded that the Nagpur mandarin trees treated with a combination of organic manure, biofertilizers and inorganic fertilizers, along with foliar micronutrient spray, exhibited significant improvements in terms of the leaf nutrient content compared to the sole use of either organic or inorganic fertilization.

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