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Research Article

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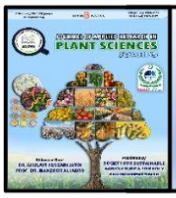

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Yield and Fruit Quality of Kinnow Mandarin Influenced by Foliar Spray of Different Nutrients.

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Abstract

Citrus (*Citrus sinensis* L.) is one of the world's most significant fruit crops, 3rd among subtropical fruits. Kinnow is considered as the trademark of Pakistan's citriculture industry, dominates the major citrus growing areas of the country. Macro and micronutrients have the capacity to regulate and manipulate the growth and fruit quality of Kinnow mandarin. The present study was initiated to evaluate the influence of foliar sprays of nutrients on yield and fruit quality of Kinnow mandarin. For this purpose, foliar sprays of nitrogen (1 and 1.5 %), iron (0.25 and 0.5 %) and zinc (0.25 and 0.5 %) were applied at pre flowering stage. The trial was carried out using a randomized complete block design (RCBD). The parameters such as reducing sugars (%), acidity (pH), TSS (brix)^0, total sugars (%), total fruits per plant, fruit set (%), yield per tree (Kg), length of fruit (cm), fruit width (mm), total number of seeds per fruit and peel thickness (mm) were studied. The collected data was analyzed statistically by Using STATISTIX 8.1 According to results, T_6 (Nitrogen @1.5%) gave best results in terms of reducing sugars, TSS/Brix (^{0}), total sugars (%), fruit set (%), yield per tree (Kg), fruit length (cm), fruit width (mm), number of seeds per fruit and peel thickness (mm). The minimum acidity (pH) was recorded in T_5 (Nitrogen @1%) and T_4 ($FeSO_4$ @0.5%). While the maximum number of fruits per plant were recorded in T_4 ($FeSO_4$ @0.5%) then in T_2 ($ZnSO_4$ @0.5%). All the treatments gave good result as compare to T_0 (control / no treatment) while T_6 (Nitrogen @1.5%) gave best results in maximum parameters observation. From the results it was concluded that foliar spray Nitrogen @1.5% can be used for enhancing the yield and fruit quality of Kinnow mandarin.

Key words: *Micronutrients, yield, growth, foliar spray, quality*

Introduction

Citrus (Citrus sinensis L.) holds the key position in horticulture industry of Pakistan. Citrus is being significantly grown in many areas of Punjab i.e. Sargodha, Faisalabad and Toba Teksingh. These regions of central and upper Punjab contributes the maximum share in total citrus production of Pakistan. The share of lower Punjab and other provinces is minor in overall production. In citrus global scenario (Qureshi *et al*., 2021). Pakistan ranks 7th according to area and 13th according to production. However, as compared to top citrus producing countries like Brazil, USA, China and Spain, citrus production of Pakistan is still far behind and increasing at an average annual rate of only 5%. Brazil holds the 35% share in total citrus production of world while share of Pakistan is only 1.46% (GOP, 2021). Total citrus production in Pakistan is 2.39 million tonnes and total area under citrus is about 192832 hectares (FAO, 2021). Kinnow mandarin is considered as trademark product of all citrus cultivars being commonly known as "King of all mandarins". This distinction of kinnow is due to its magnificent aroma, premium taste, high juice contents and nutritional profile of kinnow i.e. high Vitamin C contents, rich in sugars and antioxidants (Memon, 2014). Pakistan contributes 2.5 % to world's mandarin production by producing better quality of kinnow (Divya, 2014). Fruit vendors in foreign countries such as, Indonesia, Philippine, Hong Kong, Europe, Canada, Sri Lanka and Bangladesh prefer Kinnow mandarin from orchards of Pakistan (Siddiqui, 2015). Foliar application of nutrients has emerged as an effective approach to supplement nutrient uptake in Kinnow Mandarin. By directly applying nutrients to the leaves, foliar spray improves nutrient availability and absorption (Barooah *et al*., 2022). This method offers several advantages, including targeted nutrient delivery, rapid response, and reduced losses compared to soil application. Studies have shown that foliar spray of macronutrients positively influences the growth and development of Kinnow Mandarin.

Nitrogen sprays, for example, enhance leaf area, chlorophyll content, and overall plant vigor (Razzaq *et al*., 2013). Similarly, phosphorus and potassium foliar applications improve fruit quality attributes such as size, color, and juice content (Rahman *et al*., 2020). Foliar application of micronutrients plays a crucial role in addressing deficiencies and improving yield in Kinnow Mandarin. Iron sprays alleviate iron chlorosis symptoms and enhance photosynthetic efficiency (Sharma *et al*., 2019). Zinc and manganese foliar applications promote enzyme activity related to carbohydrate metabolism, leading to improved fruit set and yield. Boron foliar sprays positively influence flower formation and fruit set, contributing to increased crop productivity (Singh *et al*., 2021). Micronutrients are essential for maintaining fruit crop development, productivity and yield accrediting characteristics. Though their economic and industrial usage limits their relevance, they are critical for industrial output and factors of production as well as the qualitative attributes of fruit harvests. Although the bulk of plant metabolic responses and biological activities are dependent on macronutrients, the contribution of micronutrients may be compared to dusting or spraying on the cake. Micronutrients improve the general appeal and attractiveness of fruit harvests by reducing fruit desirable properties. Though acute micronutrient shortages may be undetectable. Crops have been proven to have a secret appetite for micronutrients that, when satisfied, allows for excellent output (Singh *et al*. 2019). Internal quality parameters of fruits such as juice content, color of flesh and peel, TSS, acid content and granulation are also influenced by different nutrients (Aboutalebi and Hassanzadeh, 2013). Micronutrients can significantly influence many aspects of citrus tree such as tree vegetative performance, over all yield and fruit quality. Additionally, many fruit quality parameters i.e. total soluble solids, titrable acidity, juice pH are also effected by macro and micronutrients (Gurjar and Rana, 2014). In Pakistan, the prevalence of nutrient deficiencies, especially micro-nutrient deficiencies, is high. This is primarily attributed to factors such as low soil organic matter, alkaline soil pH, and the calcareous nature of the soil (Marschner, 2003; Zekri & Obreza, 2003; Zaman & Schumann, 2006). Consequently, there is a significant opportunity to develop a cost-effective technology that can be applied to a wide range of citrus crops, regardless of diverse climatic conditions. The development of such a breakthrough in the field of fertilizers is widely acknowledged to address the long-standing issue of low yields in agriculture, which has severely impacted both the farming community and the overall economy for many years (Yaseen *et al*., 2004). Keeping in view the importance of different nutrients in regulating the growth and quality of kinnow mandarin, present study was directed to evaluate the best performance of nutrients for commercial growth of citrus and to recommend the appropriate nutrition for commercial production of citrus in Sargodha.

Materials and Methods

Experimental site and Plant material: Experiment was conducted in the research area of Department of Horticulture, College of Agriculture, University of Sargodha during 2021-22. Fifteen years old Kinnow trees were selected for this experiments. Foliar spray of various nutrients was applied at pre flowering stage and their effect on yield and quality of Kinnow was recorded.

Treatments of the experiment: Following concentrations of different nutrients were devised for present study

Treatment	Detail
T_0	Control
T_1	$ZnSO_4$ (0.25%)
T_2	$ZnSO_4$ (0.5%)
T_3	$FeSO_4$ (0.25%)
T_4	$FeSO_4$ (0.5%)
T_5	Nitrogen (1 %)
T_6	Nitrogen (1.5%)

Data collection: Performance of kinnow mandarin was evaluated on the basis of reproductive traits and fruit quality characteristics. Random branches were tagged on all the four sides of the selected trees and data were collected from those tagged branches.

Fruit set: After the completion of blooming phase, fruit set percentage of kinnow trees on different rootstocks was recorded from mid of April to end of April. Number of fruits on tagged branches was counted and fruit set percentage was calculated by using following formula.

$$Fruit\ set\ percentage = \frac{Total\ fruit\ set\ on\ tagged\ branches}{Total\ no.of\ flowers\ tagged} \times 100$$

Number of fruits per plant: Total number of fruits per tree was recorded at the time of final harvest in the month of January.

Yield per tree (Kg): Yield per tree was calculated by multiplying the average weight and number of fruits and expressed in kilograms.

TSS (Brix^0): The fruits from each treatment was chosen at randomized for to analyze the amount of reducing sugars by using the refractometer.

Acidity (pH): Total acidity was measured Acidity by titration againft 0.1 N NaoH as outlined by Qureshi *et al*., (2021).

Reducing sugars: The fruits from each treatment were randomly selected to analyze the amount of reducing sugars by using the method described by Qureshi *et al.*, (2021).

Total sugars (%age): The fruits from each treatment were randomly selected to analyze the amount of total sugars by using the method described by Qureshi *et al.*, (2021).

Statistical analysis: Experiment was laid out according to Randomized Complete Block Design with nine treatments. Each treatment was replicated thrice. Collected data was analyzed statistically by analysis of variance (ANOVA) techniques. Average of significant treatment was compared in accordance with Least Significant Difference test at 5% level of significance (Steel *et al*., 1997).

Results

Number of fruits per plant: Nutrient treatment increased the number of fruits per plant substantially. When compared to the control (no nutrient treatment), the application of nitrogen, iron and zinc performed better. The number of fruits per plant, as shown in Fig. 1, was influenced by different plant nutrients. As shown by the P-value of the F-test, the difference in number of fruits per plant from one treatment to another is significant at a 5% ($P \leq 0.05$) level of significance. It was found that as the plants treated with T_4 (1325) showed best results in terms of fruit set (%). The plants treated with T_4, had the highest average fruit set (1325). The results were in line with El-Otmani *et al*. (2002), they reported that foliar application of micronutrients and nitrogen enhance the blooming intensity of mandarins which ultimately enhance the fruiting capacity.

Fruit set percentage: Nutrient treatment increased the fruit set percentage. When compared to the control (no nutrient treatment), the application of nitrogen, iron and zinc performed better. The fruit set (%), as shown in Fig.2, was manipulated by different plant nutrients. As shown by the P-value of the F-test, the difference in fruit set (%) per plant from one treatment to another is significant at a 5% ($P \leq 0.05$) level of significance.It was observed that the plants treated with T_6 (8.9%). The results are in line with El-Otmani *et al*. (2000), they found that application of urea at pre flowering stage and during flowering initiation results in enhanced fruit set percentage. Razzaq *et al*., (2013) who found that foliar spray of micronutrients enhanced the fruit set percentage of kinnow mandarin

Yield per tree (Kg): Nutrient treatment increased the yield per tree (Kg). When compared to the control (no nutrient treatment), the application of nitrogen, iron and zinc performed better. The yield per tree (Kg), as shown in in Fig.3, was manipulated by different plant nutrients. As shown by the P-value of the F-test, the difference in yield per tree (Kg) from one treatment to another is significant at a 5% ($P \leq 0.05$) level of significance. It was discovered that as the plants treated with T6 (171kg) showed best results in terms of yield per tree (Kg). Increase in fruit yield by the application of foliar spray of micronutrients were also reported by Meena *et al*. (2021). Similar results were also reported by Shawky *et al*. (1990) and Ismail (1994), who concluded that yield of oranges can be enhanced by the foliar spray of Zn. Noor *et al*. (2019) reported that at pre flowering stage foliar spray of micronutrients enhanced that flowering, fruit setting and yield of citrus. Yaseen *et al*., (2004) also reported that same results that application of micronutrients enchancd that fruit production of kinnow mandarin by improving the nutrient use efficiency and overall plant health

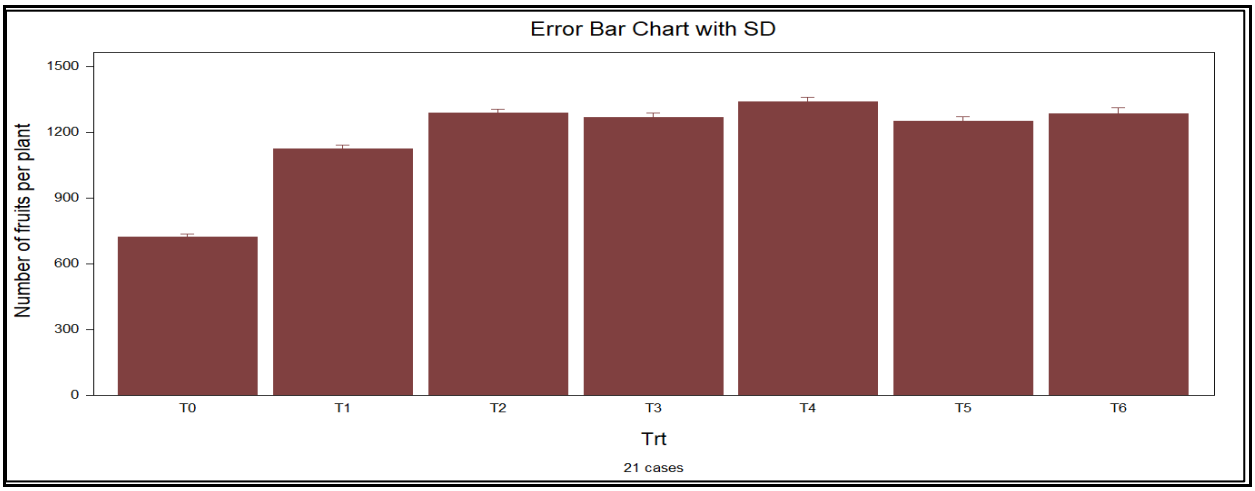

Fig. 1: Effect of foliar sprays of nutrients on number of fruits per plant in citrus

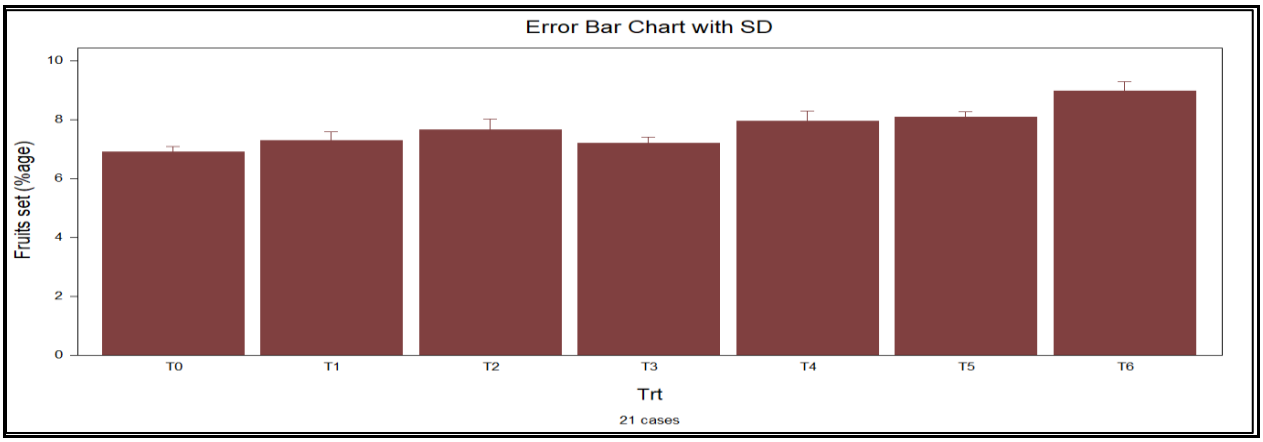

Fig. 2: Effect of foliar sprays of nutrients on fruit set (%) in citrus

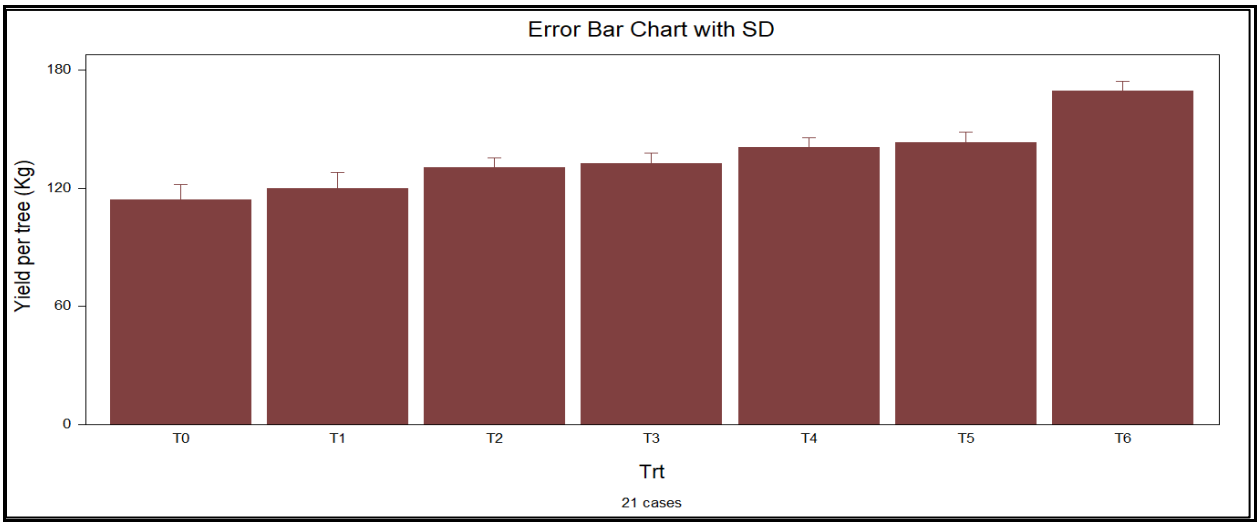

Fig. 3: Effect of foliar sprays of nutrients on yield per tree (kg) in citrus

TSS/Brix (^{0}) and Acidity (%): Nutrient treatment significantly increased the TSS/Brix in fruit juice substantially. When compared to the control (no nutrient treatment), the application of nitrogen, iron and zinc performed better. The TSS/Brix in fruit juice, as shown in in Fig.4, was effected by different plant

nutrients. As shown by the P-value of the F-test, the difference in TSS/Brix from one treatment to another is significant at a 5% ($P \leq 0.05$) level of significance. It was found that maximum TSS (6^0) was recorded when plants were treated with with T_6. Nutrient treatment increased the acidity (%) in fruit juice substantially. When compared to the control (no nutrient treatment), the application of nitrogen, iron and zinc performed better. The acidity in fruit juice, as shown in in Fig.5, was manipulated by different plant nutrients. As shown by the P-value of the F-test, the difference in acidity from one treatment to another is significant at a 5% ($P \leq 0.05$) level of significance. It was discovered that as the plants treated with T5 (2.4) showed best results in terms of acidity in fruit juice.

The influence on total soluble solids (TSS) and total acidity (TA) resulting from the micronutrient sprays can be attributed to their impact on various enzymes involved in the synthesis of proteins, acids, and sugars (Srivastava and Gupta, 1996). Dawood *et al*. (2001) have confirmed that the foliar application of Zn to 'Balady' mandarin can effectively raise the SSC and TA levels. Similarly, Sahota and Arora (1981) reported that Zn, whether applied alone or in combination with nitrogen (N), did not significantly affect the SSC:TA ratio in 'Hamlin' sweet orange.

Reducing sugars (%): Nutrient treatment increased the value of reducing sugar in fruit juice substantially. When compared to the control (no nutrient treatment), the application of nitrogen, iron and zinc performed better. The reducing sugars, as shown in in Fig.6, was manipulated by different plant nutrients. As shown by the P-value of the F-test, the difference in reducing sugars from one treatment to another is significant at a 5% ($P \leq 0.05$) level of significance. It was discovered that as the plants treated with T_6 (6.4%) showed best results in terms of reducing sugars. The plants treated with T_6 (6.2%) had the highest average reducing sugars (6.4%), followed by T_5, T_4, T_3, T_2 and T_1 respectively.

Total Sugars (%): Nutrient treatment increased the total sugars in fruit juice substantially. When compared to the control (no nutrient treatment), the application of nitrogen, iron and zinc performed better. The total sugars in fruit juice, as shown in in Fig.7, was manipulated by different plant nutrients. As shown by the P-value of the F-test, the difference in total sugars from one treatment to another is significant at a 5% ($P \leq 0.05$) level of significance. It was discovered that as the plants treated with T_6 (14%) showed best results in terms of total sugars in fruit juice. The plants treated with T6, had the minimum average total sugars (14%), followed by T_5, T_4, T_3, T_2, T_1 and T_0 respectively.

The observed increase in sugar levels in treatments incorporating zinc (Zn), Iron (Fe) and nitrogen (N) can be attributed to their impact on the activity of the aldolase enzyme, which is involved in sugar formation in fruits (Alloway, 2008). Previous studies by Babu and Yadav (2005) have also reported an improvement in the total sugar percentage of 'Khasi' mandarin fruit through the foliar application of Zn. Similar results were also reported by Razzaq *et al*., (2013) who found that foliar spray of micronutrients enhanced the biochemical quality parameters of kinnow mandarin.

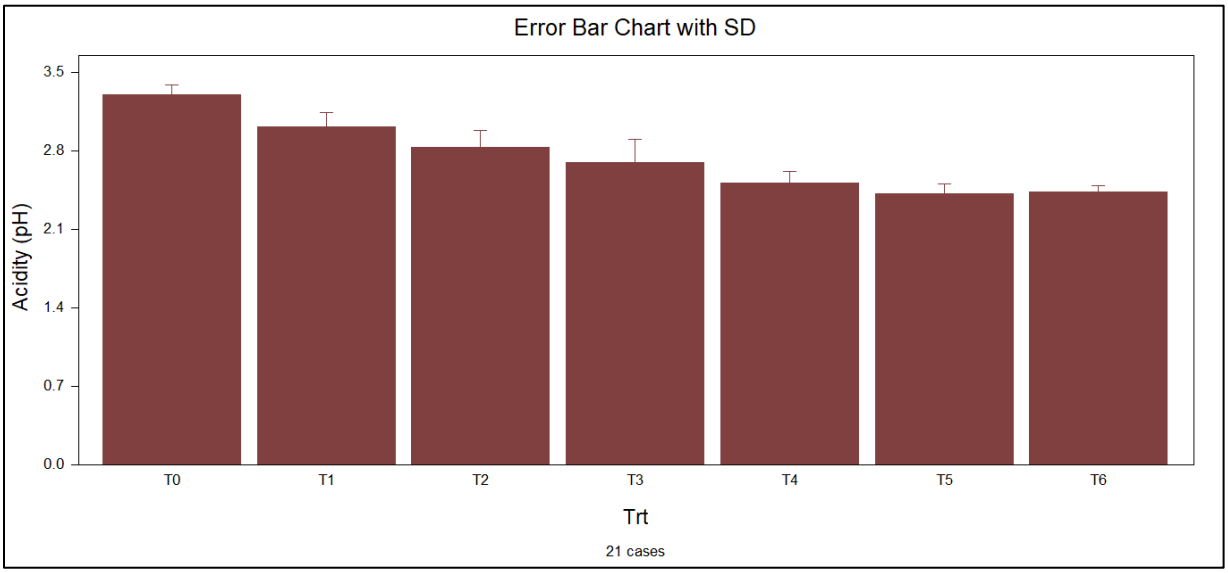

Fig. 4: Effect of foliar sprays of nutrients on TSS/Brix (^{0}) in citrus

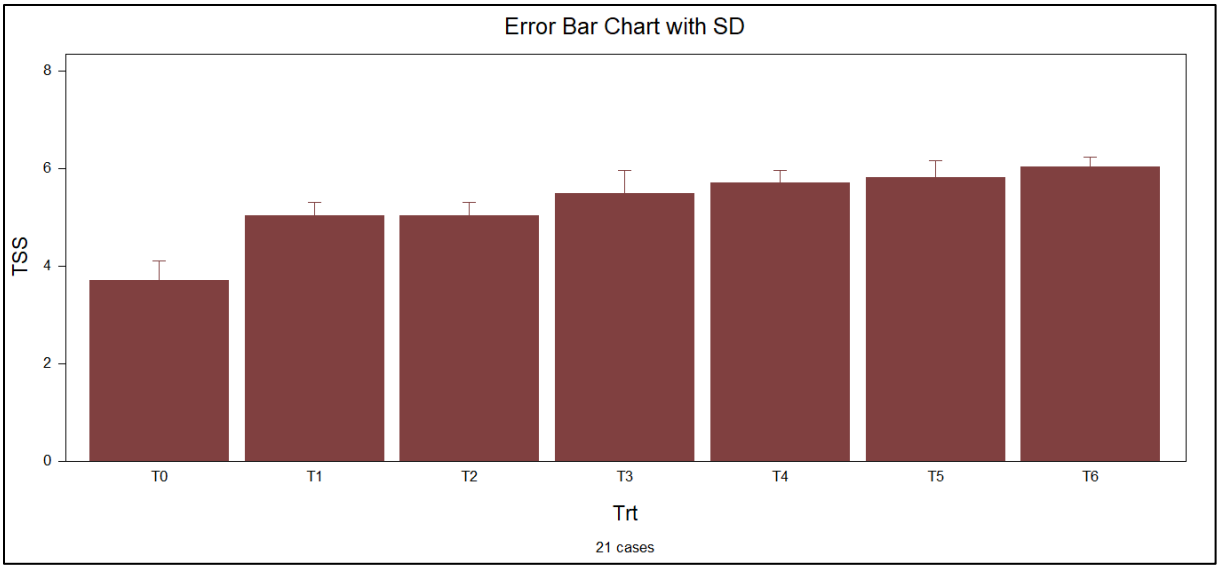

Fig. 5: Effect of foliar sprays of nutrients on acidity (pH) in citrus

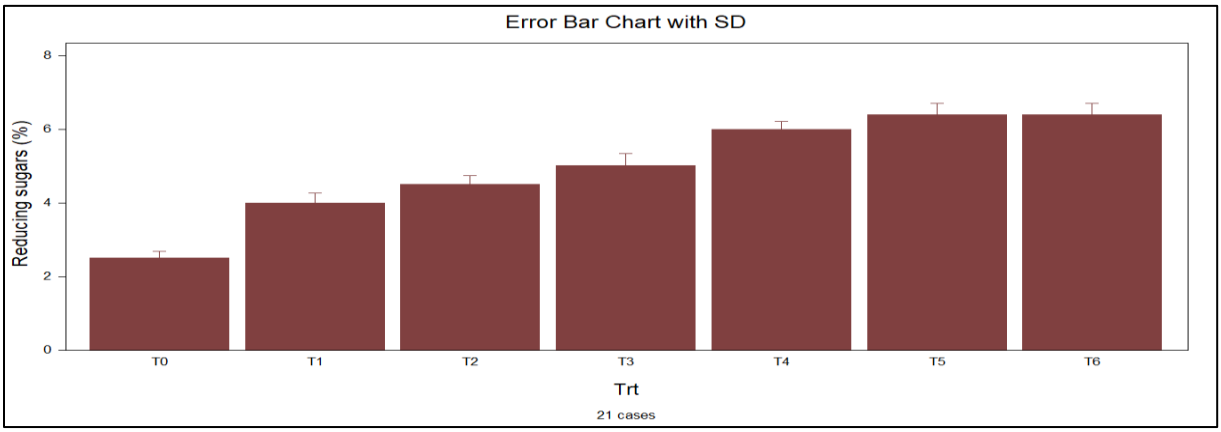

Fig. 6: Effect of foliar sprays of nutrients on reducing sugars (%) in citrus

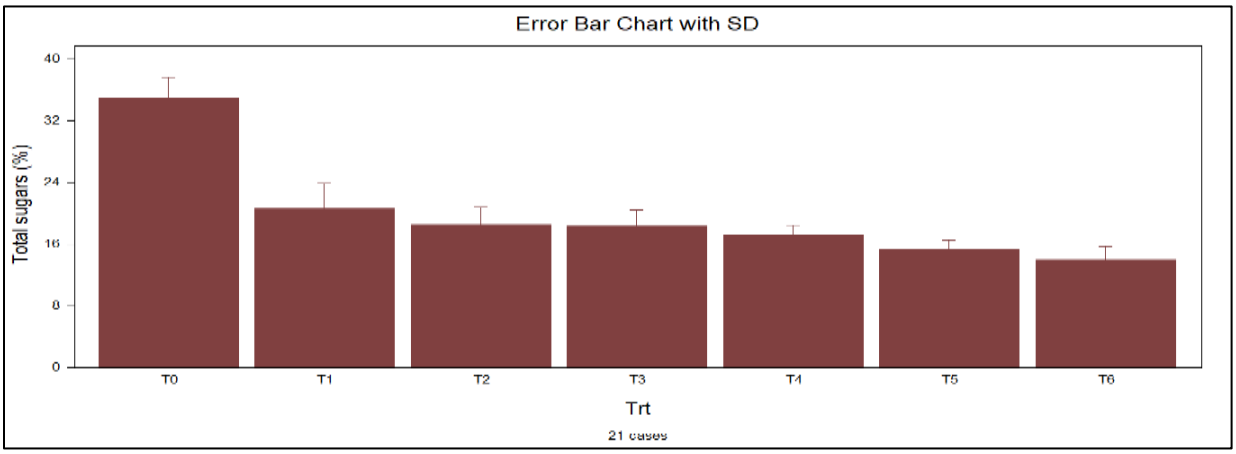

Fig. 7: Effect of foliar sprays of nutrients on Total Sugars (%) in citrus

Conclusion

It was concluded that foliar spray of nitrogen, iron and zinc at pre flowering stage is useful for improving the yield and fruit quality of Kinnow mandarin. Nitrogen @1.5% can be used for enhancing the yield and fruit quality of Kinnow mandarin.

References

Aboutalebi, A., & Hassanzadeh, H. (2013). Effects of iron and zinc on Sweet lime (Citrus limmetta) fruit quantity and quality in calcareous soils. International Journal of Farming and Allied Sciences, **2**(18), 675-7.

Alloway, B. J. (2008). Zinc in Soils and Crop Nutrition. Brussels: The International Zinc Association.

Babu, K. D., & Yadav, D. S. (2005). Foliar spray of micronutrients for yield and quality improvement in Khasi mandarin (Citrus reticulata Blanco.). Indian Journal of Horticulture, **62(**3), 280-281.

Barooah, A., Chakravarty, M., & Hazarika, B. (2022). Response of nutrient management on growth, yield and quality of citrus crop: A review. Journal of Pharmacognosy and Phytochemistry, **11**(5), 291-297.

Dal, B., & Gübbük, H. (2018). Research on the effects of foliar urea applications on fruit set and yield in 'Washington Navel' oranges. In XXX International Horticultural Congress IHC2018: VII International Symposium on Tropical and Subtropical Fruits, Avocado, II 1299 (pp. 261-268).

Dawood, S. A., Meligy, M. S., & El-Hamady, M. M. (2001). Influence of zinc sulfate application on tree leaf and fruit characters of three young citrus varieties grown on slightly alkaline soil. Annals of Agriculture Science, **39**, 433-447.

Divya, G. (2014). India is 3rd country to come up with 'seedless' kinnows. The Indian Express, 1st September.

El-Otmani, M., Ait-Oubahou, A., Zahra, F., & Lovatt, C. J. (2002). Efficacy of foliar urea as an N source in sustainable citrus production systems. Acta Horticulturae, (594), 611-617.

GOP. (2021). Agriculture Statistics of Pakistan. Ministry of Food, Agriculture and Livestock, Islamabad, Pakistan.

Gurjar, P. S., & Rana, G. S. (2014). Influence of foliar application of nutrients and growth regulator on fruit drop, yield and fruit size and quality in Kinnow mandarin. Indian Journal of Horticulture, **71**(1), 109-111.

Khurshid, F., Sarwar, S., & Khattak, R. A. (2008). Effect of foliar applied (Zn, Fe, Cu, and Mn) in citrus production. Science Technology and Development, **27(**1-2), 34-42.

Marschner, H. (2003). Mineral Nutrition of Higher Plants. 2nd edition (6th printing). Academic Press 525 B Street, Suite 1900, San Diego, California 92101-4495, USA. http://www.academicpress.com

Meena, D., Bhatnagar, P., Kumar, N., & Meena, L. (2021). Effect of foliar spray of nutrients on yield and quality of Nagpur mandarin (Citrus reticulata Blanco.). Pharma Innov. J, **10**, 1122-1127.

Memon, N.A. (2014). Market potential for pakistani citrus fruit (kinnow) in world. Exclusive on Kinnow.

Razzaq, K., Khan, A. S., Malik, A. U., Shahid, M., & Ullah, S. (2013). Foliar application of zinc influences the leaf mineral status, vegetative and reproductive growth, yield and fruit quality of 'Kinnow' mandarin. Journal of Plant Nutrition, **36**(10), 1479-1495.

Sahota, G. S., & Arora, J. S. (1981). Effect of N and Zn on 'Hamlin' Sweet orange. Journal of the Japanese Society for Horticultural Science, **50**, 281-286.

Sajid, M., Rab, A., Ali, N., Arif, M., Ferguson, L., & Ahmed, M. (2010). Effect of foliar application of Zn and B on fruit production and physiological disorders in sweet orange cv. Blood orange. Sarhad Journal of Agriculture, **26**(3), 355-360.

Siddiqui, S. (2015). Kinnow not exported to EU for quality checks. 10 March, The News Intl.

Singh, A., Bakshi, M., Brar, A. S., & Singh, S. K. (2019). Effect of micro-nutrients in Kinnow mandarin production: A review. International Journal of Chemical Studies, **7**(3), 5161-5164.

Singh, Y., Bhatnagar, P., Meena, N. K., & Gurjar, S. C. (2018). The effect of foliar spray of Zn, Cu and B on physico-chemical parameters of sweet orange (Citrus sinensis L.) cv. Mosambi. Journal of Pharmacognosy and Phytochemistry, **7**(6), 1606-1610.

Srivastava, P. C., & Gupta, U. C. (1996). Trace Elements in Crop Production. Lebanon, NH: Science Publishers.

Yaseen, M., Nadeem, M., & Hussain, S. (2004). Investigating the effectiveness of Micropower foliar spray on growth and yield of different crops. Pak. J. Life Soc. Sci., **2**(2), 156-158.

Zaman, Q., & Schumann, A. W. (2006). Nutrient management zones for citrus based on variation in soil properties and tree performance. Precision Agriculture, **7**, 45-63.

Zekri, M., & Obereza, T. A. (2003). Micronutrient deficiencies in citrus: Iron, zinc, and manganese. Document SL 204, a fact sheet of the Soil and Water Science Department, Florida, Cooperative Extension Service, Institute of Food and Agricultural Services, University of Florida. http://edis.ifas.ufl.edu

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