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EFFECT OF FOLIAR SPRAYS OF KNO_3 ON THE YIELD AND FRUIT QUALITY OF KINNOW

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A B S T R A C T

Citrus is a huge important fruit crop for its unique flavorful taste and dietary value. High yield and better quality of citrus fruit is directly dependent on the best fertilizer ratios. The present study was aimed to check the effect of liquid KNO_3 on growth and yield of citrus, alone and in combination with conventional fertilizers (N: P: K 800: 400: 400 g/plant). The experiment was done according to randomized complete block design (RCBD), with eight treatments and four replications. Data of growth parameters such as number of fruits per plant, Weight of Fruit (g), length of fruit (mm), width of fruit (mm), peel thickness (mm), peel weight (g), Juice weight (g), juice percentage (%), Rag weight (g), TSS and Yield per plant (Kg) to evaluate the effect of different KNO_3 doses on plant growth and produce. Data showed that the maximum fruit weight in T_3 (155 g) and comparatively higher results of fruit yield per plant were obtained in T_5 (42 kg). It was concluded that liquid KNO_3 along with the conventional fertilizers played an important role to enhance the fruit quality and yield in the climatic conditions of Sahiwal.

Keywords: Citrus, Fertilizer ratios, KNO_3, Growth parameters.

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INTRODUCTION

Citrus is the predominant fruit crop throughout the world, covers a pivotal position in the fruit crops. For its cultivation and production Mediterranean regions are considered more suitable. In Pakistan it is cultivated on 156211 ha and annual citrus production is 2229529 tonnes, from previous some years due to its day by day increasing demand its production has raised along with cultivation area (MINFALL, 2022-2023). Pakistan produces better quality kinnow and contributes about 2.5 % of world's production of mandarin (Divya, 2014). It is the most important fruit among trade and the consumer's demand on the citrus has been increasing throughout the world mainly because of the scientifically accepted health benefits such as rich source of vitamin c, high antioxidant and ascorbic acid contents. The fruit is used for confectionaries and cosmetics commodities along with edible usage. Citrus fruit gets affected from various production and postharvest problems including pest, diseases, fruit cracking, granulation, yield problems, alternate bearing and post-harvest quality loss and most of these issues are somehow deemed to nutrition and cultivation practices (Kahramanoglu et al., 2020).

Deficiency of micronutrients in many areas, causing limited ratios of yields or can also be an element to low quality produce. As many of the elements in the soils get vanished by leeching down in the deep layers. In some other many

cases they make some kind of complexes in reaction with the soil elements due to which in many situations they get unavailable or a very lesser in amount to get accessible to the plants for their growth and development procedures. In other words plants cannot use them for their growth and development due to their inaccessibility. Foliar applications of micronutrient can be very helpful in such cases to enhance the element availability to the plants for their different growth processes (Khalifa et al., 2009). Foliar sprays are simple and effective method, which involves active and passive processes for the translocation of nutrients from leaves to the other organs of plants when the nutrient uptake from the soil is disturbed and cannot, achieved successfully (Rahman et al., 2012). The application of nutrients through foliar spray improves nutrients absorption and availability (Barooah et al., 2022). The application of phosphorous and potassium as foliar treatments improves the fruit quality attributes like color, size and juice content (Nazir et al., 2020). The doses and time of potassium application depends on citrus cultivars as well as agro climatic conditions (Erner et al., 1993 and Sangwan et al., 2008).

Some of the essential elements such as Potassium (K), Boron (B), Magnesium (Mg) etc., which are highly determinate of the plant growth processes are very less available as most of them get leached in the soil complexes. There is no surety of how much availability of elements to plants applied in soil (Fernandez et al, 2020). In such cases it gets severely necessary to apply such essential elements in the form of readily available solutions in the form of sprays to the leaves, to get benefited by all ratios as in this they get directly available to plant for usage and translocation to the other parts (Obreza et al., 2010). In different studies the scientists reported a good enhanced fruit size and quality as well. Potassium Nitrate is overall a beneficial solution for the citrus and other crops also as large quantities of the elements in this compound are used.it is equally beneficial for the texture, flavour and volume of the fruit (Kahramanoglu et al., 2020).

The uncertain and erratic climatic conditions give rise to problems like fruit drop, poor fruit size and erratic bearing causing economical loss to farmers (Rana et al., 2020). Citrus is nutrient exhaustive crop and is quite receptive to fertilizers added as supplement (Wang et al., 2006). The present protocol was also aimed to emphasize the beneficiary aspects of Potassium Nitrate (KNO3) by directly application to the leaves in different ratios alone and in combination with common soil application of N:P:K. In future this study will help to induce the citrus fruit quality crieterias on sound basis and will promote the strategy on commercial footage to intricate the quality aspects of citrus.

METHODOLOGY

Plants of same age (10 years) of citrus variety Kinnow were selected in the orchard of Horticultural Research Station, Sahiwal. The experiment was done according to randomized complete block design (RCBD), with eight treatments and four replications. The fertilizer applications were done in the months of March and April. Data of growth parameters such as number of fruits per plant, Weight of Fruit (g), length of fruit (mm), width of fruit (mm), peel thickness (mm), peel weight (g), Juice weight (g), juice percentage (%), Rag weight (g), TSS and Yield per plant (Kg) to evaluate the effect of different KNO_3 doses on plant growth and produce.

Table 1: Different treatments of fertilizers used.

Treatments	Product	Dose	Application
T_1	Control	check	-
T_2	KNO_3	2 % solution	Foliar spray
T_3	KNO_3	4 % solution	Foliar spray
T_4	KNO_3	6 % solution	Foliar spray
T_5	KNO_3+ *Conventional Fertilizer	2 % solution + T8	Foliar application + Farmer practice
T_6	KNO_3+ *Conventional Fertilizer	4 % solution + T8	Foliar application + Farmer practice
T_7	KNO_3+ *Conventional Fertilizer	6 % solution + T8	Foliar application + Farmer practice
T_8	*Conventional Fertilizer	N: P: K	Farmer practice

*Conventional Fertilizer; N= 800gm/plant/year, P=400gm/plant/year, K=400gm/plant/year

RESULTS AND DISCUSSION

The use of KNO_3 treatments also had a profound impact on growth and fruit quality traits of Kinnow. The integrated application of 2% KNO_3 with T8 (T5) was the most influential, which gave the highest fruit number per plant (1325.3), significantly higher than the control (1023.5). T5 further resulted in heaviest fruit (186.50 g), fruit length (6.4 mm), and widest fruit width (7.0 mm) meaning enhanced

size and market worth. Juice weight was also enhanced maximally in T5 (87.1 g) implying improved internal quality and consumer attractiveness.

The 4% KNO_3 with T8 treatment (T6) also reported significant improvements, i.e., fruit weight (182.87 g) and juice weight (77.8 g) substantially greater than control, albeit slightly less than T5. Notably, fruit size properties (length and width) and peel traits were relatively high throughout T5–T7, reflecting uniform outcomes with integrated treatments.

Among the single KNO_3 applications, 4% KNO_3 (T3) produced better results in fruit weight (169.87 g), length (6.0 mm), and juice weight (78.0 g), indicating it as the most effective single dose. Control (T1) maintained the lowest values in most of the parameters. Generally, foliar KNO_3, particularly when used in combination with N:P:K (T8), highly promoted yield and quality of Kinnow fruit (Table 2).

The quality of plant and fruit are key coefficients to the nutrients available and cultivation strategies which cannot be neglected at any phase of plant growth. The innovation and ideas to improve the plant health is the need of hour along with passing time. Citrus likewise other crops also determinate of the strategies implied if the nutrition and cultural practices are good then the good produce can be fetch otherwise time to time different diseases, fruit cracking, granulation, alternate bearing, low yield and produce quality as well as some other symptoms showing on the plant and fruit with the passage of time (Sajid et al., 2010).

Nutrient uptake of the plants from soil is a huge complex process which is primarily considered. In short the nutrients applied to the soil wholly may not get available for the plant to uptake. Overall different elements play different roles for the plant growth and their absence for the plants in most of the cases get serious and show impacts on plant and on the produce later on (Khalifa et al., 2009). The nutrients get leeched to the lower debris of soil cannot be exactly utilized by the shallow rooted crops especially like citrus. Here all about is to strengthen the plant through application of essential elements in the form of foliar sprays to ensure their quick and complete availability to the plant to ensure the growth factors (Haider et al., 2019).

Potassium Nitrate (KNO3) is highly used by the plants. It is the solution in which both of the elements such as K and N are required by the plants the most and to a greater extent presence of nitrates inhibit the uptake of chlorides by the plant roots Rattanpal et al. (2005) concluded that KNO3 5.0% + 2, 4-D sprayed at 60 days after full bloom proved best with maximum increase in fruit size. Similarly Hamza et al. (2012) observed betterment in peel thickness and improved fruit quality of citrus by application of potassium.

The foliar application of potassium nitrate affects the different aspects especially it stop the premature fruit drop. In the less rainfall areas (of Punjab, Pakistan) like Sahiwal it the May and June months of the Year are much hectic and determinate of the citrus produce as most of the premature fruit get falls due to high temperature and low water availability from soil. In this the most of the citrus crop sheds as in form of premature fruit or burning of small fruit. There it goes a huge big reason to choose the foliar sprays. And most of the scientists quote that the foliar sprays like KNO3 are helpful to tolerate drought conditions and ensures the performance of the fruit plants to a greater extent (Sangwan et al., 2008, Rana *et al*., 2020).

Table 2: Effect of KNO3 treatments on growth and quality parameters of kinnow.

Treatments	Number of Fruits per plant	Fruit Weight (g)	Fruit length (mm)	Fruit width (mm)	Peel Thickness (mm)	Peel Weight (g)	Juice Weight (g)
T_1-Control	1023.5 d	156.1 c	5.1	5.0 c	3.0 b	49.2 b	55.9 c
T_2-2% KNO_3	1095.3 d	158.9 c	5.4 b	5.8 b	3.3 a	52.4 ab	61.5 b
T_3-4% KNO_3	1088.5 d	169.87 b	6.0 a	6.2 b	2.6 b	51.7 a	78.0 a
T_4-6% KNO_3	1195.2 c	164.11b	5.2 b	5.9b	2.9 b	54.6 ab	62 a
T_5 2 % KNO_3 + T8	1325.3 a	186.50 a	6.4 a	7.0 a	3.2 a	55.2 a	87.1a
T_6 4 % KNO_3 + T8	1247.3 b	182.87 a	5.9 ab	5.7 b	3.4 a	56.6 a	77.8 a
T_7 6 % KNO_3 + T8	1206.0 c	174.03 b	5.8 ab	5.5 b	3.1 a	54.9 a	81.1a
T_8 N: P: K	1132.8 d	163.47 b	5.5 ab	5.8 b	2.9 b	54.2 b	52.0 d

Moreover uptake of nitrates by the plants inhibits the excess uptake of chlorides (Rahman et al., 2012). For the citrus it plays an important role in reducing the granulation, alternate bearing and improvement of fruit set, prevention of fruit drop, enhancement of fruit quality etc. In various studies it also documented as to induce the disease and drought resistance. It impacts collectively overall plant health criteria's and fruit such as number of

fruits, fruit weight, peel, juice contents etc as explained by Turner and Burri, 2013).

The various treatments greatly affected juice percentage, rag weight, TSS, and yield per plant in Kinnow. The maximum juice percentage was obtained in T3 (4% KNO_3) and T5 (2% KNO_3 + T8), and T5 recorded 45.1%, followed by T7 (45.5%). T8 (N:P:K alone) and the control (T1) had the minimum juice contents. T5 had the highest rag weight (50.9 g), which reflected improved fruit development, while the lowest rag weight was observed in T7 (42.9 g). TTS was also maximum in T5 and T4 (12.1% and 12.0% respectively), which reflected improved fruit quality when these were treated with combined KNO_3 and N:P:K. Plant yield was remarkably increased by treatment with combined application, of which T5 was highest (247.16 kg) followed by T6 (228.09 kg). Generally, T5 (2% KNO_3 + N:P:K) was the most effective treatment and enhanced both the quantitative and qualitative characteristics, which were followed by T6 and T7 to validate the combined synergistic benefits of KNO_3 and balanced fertilization (Table 3).

Table 3: Effect of KNO_3 treatments on postharvest quality parameters of kinnow.

Treatments	Juice Percentage (%)	Rag Weight (g)	TSS (%)	Yield Per Plant (Kg)
T_1-Control	35.81 c	46.5 b	10.9 c	186.05 c
T_2-2% KNO_3	38.70	44.5 b	11.1 b	201.56 bc
T_3-4% KNO_3	45.91 a	49.2 a	11.4 b	208.53 b
T_4-6% KNO_3	37.77 c	45.0	12.0 a	194.39 c
T_5 2 % KNO_3 + T8	45.1 a	50.9 a	12.1 a	247.16 a
T_6 4 % KNO_3 + T8	41.4 b	49.1a	11.8 a	228.09 a
T_7 6 % KNO_3 + T8	45.5 a	42.9 b	11.8 a	209.88 b
T_8 N: P: K	31.81 c	46.3 b	10.5 c	201.56 bc

Sangwan et al. (2008) reported improved yield with three foliar sprays of 2 % KNO3 at 2/3rd leaf stage, 2 cm diameter of fruitlets and one month after spraying the second one respectively. The application of potassium nitrate in foliar form increased the yield of various species of citrus (Erner et al., 1993, Achilea, 2000 and Vijay, 2015). Similarly Mostafa and Saleh (2006) observed that spraying KNO_3 with girdling has a positive influence on fruit quality and yield of Balady mandarin. In addition to that Mostafa et al. (2005) and El-Fangary (1998) found spraying potassium by using various forms had a positive influence on yield of Balady mandarin.

CONCLUSION

On the basis of study conducted that foliar spray of KNO_3 has imparted positive impact on the yield and yield attributing parameters of kinnow mandarin in particular fruit drop, fruit number and yield per plant. Therefore in order to obtain the better fruit quality, minimizing the losses caused by fruit drop and attaining desired productivity levels foliar spray of KNO_3 can be used effectively in the low rain fall areas of Punjab in Pakistan such as Sahiwal, here the application of nutrient sprays not only improves the quality attributes of the citrus crop but also protect the plant to ensure maximum fruit set during harsh May June Months where a very low water availability can affect a lot.

AUTHOR CONTRIBUTIONS

All the authors contributed equally.

COMPETING OF INTEREST

No conflicts of interest have been disclosed by the authors.

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