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Effect of foliar application of micronutrients on persimmon fruit quality and yield

Haider Ali[1], Azhar Hussain Shah[1*], Muhammad Naeem[2], Junaid Khan[1], Abdul Majid[1], Zafar Iqbal[1] and Habib Ahmad[3]

[1]*Department of Botany, Hazara University, Mansehra Pakistan*

[2]*Research Officer, Agriculture Research Institute Swat Pakistan*

[3]*Department of Genetics, Hazara University, Mansehra Pakistan*

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Abstract

In the present research work forty five trees of persimmon having uniform height and canopy were evaluated against five treatments (T1, T2, T3, T4 and T5) to determine the efficiency of micronutrients foliar spray on the yield and yield attributes. The experiment was conducted at a farmer's field in Randomized Complete Block Design (RCBD) with three replications. Micronutrients concentration was measured before and after foliar spray. Mixed application of micronutrients i.e. T5 (30 $ZnSO_4$, Borax 20 and 40 g $FeSO_4$) gave the highest persimmon yield (148.9 kg $tree^{-1}$) with an increase of 7.73% over control followed by T4 with an increase of 6.15% over control. Micronutrients application in comparison with the control also improved number of fruits $tree^{-1}$, fruit weight and fruit diameter. The response of the lone application of micronutrients were in the order Zn >Fe > B. Moreover micronutrients spray also produced lush green shiny leaves and improved the fruit quality significantly by increasing Zinc, Iron and Boron contents. On the basis of our findings combined application of micronutrients (T5) along with other fertilizers are recommended as a most efficient and cost effective method to improve the quality and yields of persimmon.

* **Corresponding Author:** Azhar Hussain Shah ✉ drahshu@gmail.com

Introduction

Persimmon (*Diospyros kaki* L.) is an edible fruit of the genus *Diospyros* and belongs to the family *Ebenaceae*. In ancient Greek the word *Diospyros* means "the fruit of the gods". Persimmons contains high amount of glucose with a fair amount of protein (Lee, 1991). Hundred grams edible portion of persimmon contain 78.6g of moisture, 0.7g protein, 0.4g fat, 19.6g carbohydrates, 6mg calcium, 26 mg phosphorus, 0.3 mg iron, 6mg sodium, 177 mg potassium, 7 mg magnesium, 2,720 I.U carotene, 0.04 mg thiamine, 0.03 mg riboflavin, 0.1 mg niacin and 12 mg ascorbic acid (Morton, 1987). In Pakistan persimmon plantation on commercial scale has been undertaken in Khyber Pakhtunkhwa recently. Soil and crop surveys of the area revealed that deficiencies of micronutrients are quite widespread in the fruit orchards. Probably due to these deficiencies, persimmon orchards are now turning into unproductive plantation, producing poor quality fruit (Khattak and Parveen, 1988, Habib, 1990). These deficiencies can be removed either by i. soil application of micronutrients or ii. foliar spray. Although soil application can supply enough nutrients as well as improve plant production and yield but it has caused world-wild anxiety about environmental pollution and leaching of nutrients to ground water (Dinnes, *et al.* 2002). On the other hand foliar application has many advantages over soil application because i. application rates are significantly minor than soil application ii. an even application is easily obtained and iii the plant response to micronutrient is nearly instant, thus deficiencies of micronutrients can be corrected during the same season. As micronutrients are required in very small amount, so their foliar application can be the easiest and the most efficient method especially in the soil which is mostly calcareous with high pH values and deficient in micronutrients. On such soils, foliar application in the form of inorganic salts or chelates is a valuable tool in combating nutrient deficiencies (Dinnes, *et al.* 2002; Liew *et al.,* 2010). Moreover micronutrients are particularly required for deep rooted fruit trees because of lower quantities in the sub-soils and persimmon tree is deep rooted, so foliar application of micronutrients is advantageous over micronutrients applied on the soil surface (Khattak and Parveen, 1988, Habib, 1990). This is the context in which this project was under taken with the rationale to formulate recommendations for the farming community about micronutrients use on persimmon for improving both its quality and yield in short period of time.

Materials and methods

Experimental Layout and Fertilizers

The experiment was carried out at a farmer field in Randomized Complete Block Design (RCBD) with three replications and five treatments at village Takhtaband, District Swat, during 2010.

Treatments

T1 = Control, T2 = 30 gm Zinc Sulphate ($ZnSO_4$.$7H_2O$) per treatment, T3 = 20 gm Borax ($Na_2B_4O_7.10H_2O$) per treatment, T4 = 40 gm Iron Sulphate ($FeSO_4$.$7H_2O$) per treatment, T5 = 30 + 20 + 40 gm $ZnSO_4$ + Borax + $FeSO_4$ per treatment, Replications =3, Number of trees/ Treatment=3, Total number of trees=5×3×3= 45, Statistical design = RCBD.

Forty five trees of similar sizes and vigor and growing under similar conditions of soil fertility and irrigation were selected and each tree was tagged according to the treatment. The micronutrients treatments (Zn, B, and Fe) were applied as foliar sprays twice a year. The first dose of fertilizers was applied @ 1-2-1 kg N-P_2O_5-K_2O/ tree to persimmon (total 45 trees) in the month of February, while the second dose of fertilizers was applied @ 1-1 kg N-K_2O/tree (total 45 trees) in the month of April 2010.

Soil analysis of experimental soil

Before starting the experiment, three composite soil samples from a depth of 0-45cm were collected from three randomly selected spots at the experimental site and analyzed in the laboratory.

Preparation of foliar spray solution

Foliar sprays were prepared from commercially

available micronutrients in the market. The volume of water was kept six liters per tree to wet completely the canopy of a tree.

Micronutrients determination in persimmon leaves

Micronutrients concentration was measured before and after foliar spray from leaf samples. The leaves were washed, dried and ground with dry ashing technique and analyzed for elemental content of Zn and Fe by atomic absorption spectrophotometer following the methods of Jones and Case, (1990). Boron concentration was determined by spectrophotometer, after color development procedure with Azomethine-H (Porter *et al.*, 1981).

Statistical analysis

The data was analyzed statistically using MS Excel and statistical package MStatC. Treatments were compared using LSD test of significance at $p<0.05$ according to Gomez and Gomez (1984).

Results

Before starting the experiment, three composite soil samples from a depth of 0-45cm were collected from three randomly selected spots at the experimental site and analyzed in the laboratory. The details of the analyses are given in Table 1 and 2.

Table 1. Soil analysis of experimental site.

S. No.	Soil property	Laboratory result	
1	Soil depth (cm)	0-20	20-45
2	$pH_{(1:5)}$	7.38	7.27
3	$EC_{(1:5)}$ (dS m^{-1})	0.85	0.89
4	Lime (g kg^{-1})	68.3	60
5	O.M (g kg^{-1})	11.98	11.10
6	ABDTPA Extractable P (mg kg^{-1} soil)	2.59	1.82
7	ABDTPA Extractable K (mg kg^{-1} soil)	68.6	61.17

As shown in Table-2 the amount of AB-DTPA Extractable Cu and Mn is the highest, i.e., 4.556-4.904 mg kg-1 and 2.504-9.604 mg kg-1 which are considered to be adequate while rest of the micronutrients determined i.e., Zn, Fe and B were either low or marginal.

Effect of micronutrient foliar spray on persimmon

Number of fruits per tree

Data in Table 3 reveals a statistically significant difference among different micronutrients foliar spray. Maximum number of fruits per tree was recorded for T5 (1182) and increase was 5.16% over the control (T1). T4 had the second highest number of fruits per tree that was 1166 and increase of 3.86% which was also statistically significant. T3 and T2 had produced 1145 and 1129 number of fruits per tree with increase of 2.09 and 0.73% respectively. T1 had the lowest number of fruits per tree (1121).

Table 2. Micronutrient status of the experimental site.

S. No.	Soil Nutrient (AB-DTPA Extractable)	Concentration (mg kg^{-1})	Status
1	Zn	0.928 - 1.12	Low/ Marginal
2	Cu	4.556 - 4.904	Adequate
3	Fe	1.272 - 3.652	Low/ Marginal
4	Mn	2.504 - 9.604	Adequate
5	B	0.45 - 0.5	Low/ Marginal

Fruit diameter (cm)

Effect of different treatments of micronutrients foliar spray on persimmon fruit diameter was also significant ($p<0.05$). Data in Table 3 shows that micronutrients application in comparison with the control increased the average persimmon fruit diameter. T5 had the highest fruit diameter of 6 cm with an increase of 11.67% over control. T3 fruit diameter was 5.9 cm with increase of 10.17 % followed by T4 which was 5.7 cm with increase of 7.01 % over control. T2 produce 5.6 cm fruit with increase of 1.85 % in diameter over control one. Control had the lowest fruit diameter of 5.3 cm (Table 3).

Table 3. Effect of different treatments of micronutrients foliar spray on persimmon Yield (kg tree^{-1}), fruit weight (g), fruit diameter and number of fruits tree^{-1} .

Treatment	T1	T2	T3	T4	T5	$LSD_{(0.05)}$
Yield (kg tree^{-1})	137.4 e	140.4 d	143.8 c	146.4 b	148.9 a	1.009
Increase in yield (%)		2.2	4.45	6.15	7.73	
Fruit Weight (g)	122.3 d	124.3 c	126.3 b	124.9 c	129.1 a	1.483
Increase in weight (%)		1.55	3.13	2.08	5.26	
Fruit diameter (cm)	5.3 c	5.4 c	5.9 a	5.7 b	6.0 a	0.298
Increase in diameter (%)		1.85	10.17	7.01	11.67	
Number of fruits tree^{-1}	1121 e	1129 d	1145 c	1166 b	1182 a	2.997
Increase in fruits number (%)		0.70	2.09	3.86	5.16	

Fruit Weight (g)

Effect of different treatments of micronutrients foliar spray on persimmon fruit weight was significant ($p<0.05$). T5 had the highest fruit weight (129.1 g) with an increase of 5.26 % over control followed by T3 which gave average fruit weight of 126.3 g and increase of 3.13 %. T4 gave 124.9 g of fruits with increase of 2.08 % over the control one. T2 increase in term of fruit weight was less significant which gave the fruit weight of 124.3 g and increase of 1.55%. Control had the lowest fruit weight (122.3 g) (Table 3).

Table 4. Concentration of micronutrients in persimmon leaves before foliar spray.

S. No.	Micronutrients	Concentration in leaves (µg g^{-1})	Optimum value* (µg g^{-1})	Status
1	Zn	9.6	20-50	Low
2	Cu	14.3	6-16	Adequate
3	Fe	22.5	100-250	Low
4	Mn	145.8	40-160	Adequate
5	B	23.7	25-60	Low

*Source: (Reuter and Robinson, 1986 and Zia *et al.*, 2004).

Persimmon yield (kg tree^{-1})

Data in Table 3 shows effect of different treatments of micronutrients foliar spray on persimmon yield which was statistically significant ($p<0.05$). T5 gave the highest persimmon yield (148.9 kg tree^{-1}) with an increase of 7.73% in yield over control followed by T4 which gave 146.4 kg tree^{-1} with an increase of 6.15% over control. T3 produced 143.8 kg tree^{-1} and increased persimmon yield over control by 4.45%. T2 has given the lowest yield among the other treatments and gave 140.4 kg tree^{-1} with increase of 2.2 % over the control T1. T1 had the lowest persimmon yield (137.4 kg tree^{-1}).

Micronutrients concentration in persimmon leaves before foliar spray

Average native concentration of micronutrients (Zn, Cu, Fe, Mn and B) before foliar spray is given in Table

4 which shows that concentration of Zn, Fe and B were low while Cu and Mn were adequate.

Micronutrients concentration in persimmon leaves after foliar spray

Zinc

Results showed that foliar spray of Zn significantly increased the Zn concentration in persimmon leaves in those treatments where Zn was sprayed alone or with other micronutrients (T2 and T5). Highest Zn concentration of 28.7 µg g^{-1} was obtained when Zn was sprayed with other nutrients (T5). T2 gave the second highest Zn foliar concentration of 28.0 µg g^{-1}. Results further indicated that foliar spray of Zn alone or with combination of other micronutrients completely eliminated the Zn deficiency and produced a lush green color in leaves and eliminated yellow intervienal blotches. Results also showed that optimum level of Zn was obtained in treatments where Zn was sprayed as compared to control where Zn was not applied (Table 5).

Table 5. Concentration of micronutrients in persimmon leaves after foliar spray .

	Treatments	Zn	B	Fe
S. No.		---------- (µg g^{-1}) ----------		
1	T1	10.0 b	24.5 b	23.2 b
2	T2	28.0 a	25.5 b	24.1 b
3	T3	10.7 b	30.0 a	23.2 b
4	T4	10.8 b	24.8 b	45.5 a
5	T5	28.7 a	30.9 a	45.2 a
6	$LSD_{(0.05)}$	2.125	1.005	1.246

Iron

Similarly foliar spray of iron significantly increased Fe concentration in persimmon leaves. Results showed that maximum Fe concentration was found in T4 to be 45.5 µg g^{-1} followed by T5 (45.2) which was statistically non-significant from each other (table 8). Other treatments had no apparent effect on foliar concentration of Fe. T1 (control) had the lowest Fe concentration (23.2 µg g^{-1}). Results further revealed that application of Fe gave dark green and shiny color to persimmon leaves and also eliminated yellow color of young leaves Table 5.

Boron

Foliar spray of boron had no significant effect on foliar concentration of B as compared to other micronutrients. However, a highest concentration of 30.9 µg g^{-1} was reported for T5 where B was sprayed with other nutrients. T3 gave 30 µg g^{-1} of foliar B. Other treatments have no apparent effect on foliar concentration of B. (table 8). Results further indicated that fruit size was significantly increased for those treatments where B was applied alone or in combination Table 5.

Discussion

Micronutrients are essential elements required by the plant in minute quantity and are vital for plant growth. As compare to primary nutrient (Nitrogen, Phosphorus and Potassium) micronutrients (Boron, Iron, Zinc, Copper, Manganese and Molybdenum) are required in minute quantity but their deficiency in plants causes yield reduction as well as deteriorate fruit quality (Rashid *et al.,* 1993).

The results showed that combined application of micronutrients have positive effect on number of fruits set per tree. Maximum number of fruits per tree was recorded for T5 (1182) with increase of 5.16% over the control (T1). T4 had the second highest number of fruits per tree that was 1166 and increase of 3.86% which was also statistically significant. T3 and T2 had produced 1145 and 1129 number of fruits per tree with increase of 2.09% and 0.70% respectively. T1 had the lowest number of fruits per

tree (1121). Similar result was also shown by Azza *et al.*, (2006).

Micronutrients application in comparison with the control increased the average persimmon fruit diameter. Considerably large fruit size was obtained when boron was sprayed alone (T3) or with other micronutrients (T5). T5 had the highest fruit diameter with an increase of 11.67% over control, T3 increased fruit size over control by 10.17%. Control had the lowest fruit diameter (5.3 cm). These results are in agreement with those of Saraswathi *et al.,* (1998). They stated that trees of Mandarin which were sprays with Zn, Mn and B had the highest fruit weight and diameter which was 0.5% higher than the control one.

Application of micronutrients improves plant quality and yield. Our results showed that micronutrients application in comparison with the control increased the average persimmon fruit weight. T5 had the highest fruit weight of 129.1 g with an increase of 5.26% over control followed by T3 which increase fruit weight by 3.13 %. Similarly Rame and Bose (2000) stated that effect of micronutrients are more pronounced when applied in combinations; the Mg + Cu + Zn showed maximum increase fruit weight than control. Control had the lowest fruit weight (122.3 g). Effect of different treatments of micronutrients foliar spray on persimmon yield and yield components was statistically significant ($p<0.05$). T5 (30 + 20 + 40 gm $ZnSO_4$ + Borax + $FeSO_4$) gave the highest persimmon yield (148.9 kg tree^{-1}) with an increase of 7.73% over control followed by T4 with an increase of 6.15% in yield over control. T3 and T2 increased persimmon yield over control by 4.45% and 2.2% respectively, while control had the lowest persimmon yield (137.4 kg tree^{-1}). Similar observations were also reported by Rahman and Haq (2006) they stated that foliar application of Zn, Mn and B on sweet orange trees increased significantly the fruit yield as compared to trees not sprayed with these nutrients.

Results showed that native foliar concentration of Zn, B and Fe were either very low or marginal while Mn and Cu were adequate as these two were also adequate in soil of the experimental orchard. The overall effect of micronutrients on persimmon leaves showed that foliar spray of Zn completely eliminated yellow intervienal blotches and produced lush green color in leaves. Similarly foliar application of Fe gave dark green color to the leaves and eliminated yellow color of young leaves. Foliar application of B had no apparent effect on persimmon leaves but fruit size was significantly increased in treatment where B was applied alone or in combination with other micronutrients. Similar observation were also reported by Shorrocks (1984) who suggested that deficiency of boron suspected on the basis of leaf symptoms should be confirmed by fruit symptoms. The results suggest that foliar application of micronutrients may be quite useful in correcting micronutrient deficiency in persimmon plants resulting in improved yield and yield attributes The results suggest that persimmon is very responsive to micronutrient applications in improving fruit quality and yield. Combined application of micronutrients (T5 = 30 + 20 + 40 g zinc sulphate + borax + iron sulphate) gave the highest yield and yield attributes. The response of the lone application of micronutrients were in the order Zn> Fe > B. Moreover foliar sprays of micronutrients significantly improved the fruit quality by increasing Zn, Fe and B contents.

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