

Effect of Foliar Application of Micronutrients on Fruit Quality of Peach

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Abstract

This experiment was conducted to study the effect of foliar spray of micronutrients on quality of peach fruits at Horticulture Farm, University of Agriculture Peshawar during 2010. The experiment was conducted in randomized complete design with six treatments and four replications on peach orchards (early grand). Our pre-treatment soil analysis showed silt loam soil class, alkaline and calcareous in nature and adequate in organic matter. The soil was deficient in P, Zn, Fe and B, whereas adequate in Mn and Cu. The fruit quality was evaluated and maximum fruit length, diameter and yield were noted in T₆ (Zn + Cu + Fe + Mn + B). The juice pH decreased and the juice acidity increased in a linear fashion after foliar spray of micronutrients. The total soluble solids of fresh fruit juice ranged 7.01% - 8.88% and vitamin C ranged from 4.80% - 7.90% after foliar spray. So the foliar spray of micronutrients significantly ($P \leq 0.05$) affected the quality of peach fruit.

Keywords

Acidity; Fruit Quality; Micronutrients; Peach; Spray; Vitamin C

1. Introduction

Peach (*Prunus persical* L.) belongs to the family Rosaceae with other species collectively known as “stone fruits”.

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Important varieties grown worldwide are Cling and Free Stone. Peshawar and Swat are best suited for Early Grand, Florida King 6-A and 7, 8, 9 peach cultivars. The soil and climatic conditions of Khyber Pakhtunkhwa are suitable for the production of peach. According to Agricultural Statistics of Pakistan [1], peach orchards covered 15.8 thousand ha area in Pakistan, producing 83.7 thousand tons of peach fruit, while in Khyber Pakhtunkhwa it covers an area of 6.2 thousand hectares producing 57.8 thousand tons of peaches. The main sources of micronutrients are parent material, sewage sludge, town refuse, fungicides and farmyard manure and are present in small amount in soil [2]. Micronutrients play a key role in plants growth and productivity [3]. Zinc is a component of almost 60 enzymes; it has a role in producing the growth hormone IAA. Zinc plays a key role in N metabolism of plant and Zn deficient plants have reduced protein content [4] [5]. Copper is essential for the growth of plant and helps in the formation of vitamin A [6]. Symptoms of copper deficiency include abnormal and stunted leaf development, stunted shoot growth with dieback, reduced flowering and fruit set, and small fruit with poor color and quality [7]. Iron forms important enzymes and is associated with chlorophyll synthesis. Iron deficient peach trees have small size, resulting in a large decrease in acceptable fruits [8]. Iron chlorosis reduces fruit production, reducing the number of fruits per tree, fruit size, fruit yield and affecting fruit quality parameters such as firmness and acidity. Fe fertilization increases fruit quality and yield in many crops [9]. Manganese is involved in photosynthesis, metabolism of nitrogen and carbohydrate. Boron is helpful in plant growth and productivity. It increases the germination of pollen grains and elongation of pollen tube, fruit setting and yield in orchards [10]. Boron is responsible for activation of dehydrogenase enzymes, sugar translocation, nucleic acids and plant hormones [11]. There are many soil and climatic factors affecting the availability of micronutrients to plants. The major factors include: pH, soil water content, organic matter, interaction among the nutrients and temperature. The availability of B and AB-DTPA extractable Zn, Cu, Fe and Mn decreases with increasing soil pH [12] [13]. Study shows the deficiency of Zn (17%), Cu (13%), Fe (45%), Mn (2%) and B (95%) in orchards. The soils are alkaline, non-saline, calcareous and low in organic matter in Peshawar Valley [14]. These micronutrients are more soluble in the acidic pH and their availability in soils varies considerably with the seasonal changes in temperature and moisture [15]. As peach trees are deep rooted so foliar application of micronutrients is a valuable tool for fighting against the micronutrient deficiencies. Curing micronutrient deficiencies through foliar application is a common practice in getting profitable yield and good quality fruit [16]. Foliar spray of micronutrients is advantageous over soil application, because of rapid response, effectiveness and elimination of deficiency symptoms due to certain micronutrients. Results indicated that spraying the trees twice or thrice is more effective than spraying once a year in improving micronutrients content of peach trees [10]. This study was aimed to study the effect of micronutrients (Zn, Cu, Fe, Mn and B) spray on fruit set, yield and fruit quality of peach orchards.

2. Materials and Methods

Experimental Design and Fertilizers: The experiment was conducted on peach orchards at University of Agriculture, Peshawar-Pakistan during 2010 (February-June). Twenty four trees were selected for this purpose. Six treatments with four replications were applied. A basal dose of 150 kg N ha⁻¹, 100 kg P₂O₅ ha⁻¹ and 100 kg K₂O ha⁻¹ as Urea, SSP and SOP was applied. The micronutrients Zn, Cu, Fe, Mn, B at rate of 5, 2.5, 5, 5, 1 Kg ha⁻¹ respectively were applied in split dose. The detail of the micronutrients doses and their combinations is given in **Table 1**. Before incorporation of basal dose of fertilizers, composite soil sample was taken for the determination of various physico-chemical characteristics. After foliar spray the fruit length (cm), diameter (cm), No. of fruits tree⁻¹, yield tree⁻¹, fruit volume, Juice pH, Juice acidity, Total Soluble Solids and Vitamin C were recorded.

Soil Analysis: Soil samples were analyzed for soil texture [17], pH [18], EC [19], organic matter [20], lime [21], extractable micronutrients, P and K [22] and B in leaf and soil [23].

Fruit Analysis: The fruit analysis was performed at edible maturity stage. Physical properties were measured by Maurer and Taylor method [24]. The chemical properties of fruit were determined according to the methods of AOAC [25].

Statistical Analysis: Data were subjected to analysis of variance and differences among treatments were evaluated [26] [27].

3. Results and Discussions

Physico-chemical characteristics of experimental soil: The Physico-chemical characteristics of soil are presented in **Table 2**. The soil was silt loam, pH ranged from 7.73 - 7.96, which was low in the surface and increased linearly with depth. The differences might be due to leaching of bases from the surface and its accumu-

Table 1. Micronutrient treatments used for foliar spray on peach orchard.

Treatments	Foliar spray of various micronutrients
T ₁	Control
T ₂	Zn (5 Kg ha ⁻¹)
T ₃	Zn + Cu (5 Kg ha ⁻¹ + 2.5 Kg ha ⁻¹)
T ₄	Zn + Cu + Fe (5 Kg ha ⁻¹ + 2.5 Kg ha ⁻¹ + 5 Kg ha ⁻¹)
T ₅	Zn + Cu + Fe + Mn (5 Kg ha ⁻¹ + 2.5 Kg ha ⁻¹ + 5 Kg ha ⁻¹ + 5 Kg ha ⁻¹)
T ₆	Zn + Cu + Fe + Mn + B (5 Kg ha ⁻¹ + 2.5 Kg ha ⁻¹ + 5 Kg ha ⁻¹ + 5 Kg ha ⁻¹ + 1 Kg ha ⁻¹)

Table 2. Physico-Chemical Characteristics of Experimental Soil.

Properties of soil	Unit	0 - 15 cm	15 - 30 cm	30 - 45 cm	45 - 60 cm
pH _(1:5)	-	7.73	7.89	7.93	7.96
EC _(1:5)	dS m ⁻¹	0.20	0.20	0.17	0.16
Soil Organic Matter (%)	%	2.07	1.93	1.86	1.83
Lime (%)	%	20.75	19.25	17.50	17
AB-DTPA extractable P	mg Kg ⁻¹	6.47	6.28	5.52	5.39
AB-DTPA extractable K	mg Kg ⁻¹	100	100	50	50
AB-DTPA extractable Zn	µg g ⁻¹	1.14	1.00	0.57	0.56
AB-DTPA extractable Cu	µg g ⁻¹	5.38	5.30	3.29	2.52
AB-DTPA extractable Fe	µg g ⁻¹	3.76	3.28	2.45	2.29
AB-DTPA extractable Mn	µg g ⁻¹	19.16	18.67	17.50	14.50
Dilute HCl available B	µg g ⁻¹	0.45	0.29	0.32	0.37
Soil Texture	Silt loam				

lation in subsurface. The pH of Peshawar soil is generally alkaline [12]. The EC of the suspension varied from 0.16 - 0.20 dS m⁻¹. The results showed that the soil organic matter ranged 1.83% - 2.07 % (marginal-adequate). The soil is calcareous due to the high CaCO₃ content in the parent material [12]. The extractable P ranged 5.39 - 6.47 mg Kg⁻¹. Data showed that extractable P was marginal. The K concentration in the surface (0 - 30 cm) soil was marginal and low in the subsoil (30 - 60 cm).

Micronutrients content in soil of peach orchards: The data regarding the AB-DTPA extractable micronutrients is presented in Table 2. The Zn content ranged 0.56 - 1.14 µg g⁻¹. The concentration ranged from low (<0.9 µg g⁻¹) to marginal (0.9 - 1.5 µg g⁻¹) in soil. About 70% of the cultivated soils in Pakistan are deficient in Zn [28]. The Cu content was high (>0.5 µg g⁻¹) in soil samples collected from four depths. The Fe content ranged low (<3.0 µg g⁻¹) to marginal (3.0 - 5.0 µg g⁻¹) levels. The Mn content ranged 14.50 to 19.16 µg g⁻¹ which was high (>1.0 µg g⁻¹) in all the depths. The soil of Khyber Pakhtunkhwa is adequate in Mn content as reported by Khattak and Perveen (1985). The acid soluble B ranged 0.37 - 0.45 µg g⁻¹. The concentration of B was low (<0.45 µg g⁻¹). Khattak and Perveen [29] reported 98% deficiency of B in soils of Khyber Pakhtunkhwa.

4. Fruit Quality

4.1. Physical Properties of Fruit

1) Fruit Length (cm): Fruit length was significantly ($P \leq 0.05$) influenced by micronutrients spray (Table 3). Maximum fruit length (6.41 cm) was noted in T₆ (Zn + Cu + Fe + Mn + B), followed by T₅ (Zn + Cu + Fe + Mn) and T₄ (Zn + Cu + Fe) whereas significantly short fruits (5.64 cm) were noted in control and Zn applied plants. These results were found in harmony with the work of Baloch [30] and Ramezani and Shekafandeh [31].

2) Fruit Diameter (cm): Fruit diameter was significantly ($P \leq 0.05$) increased by micronutrients spray (Table 3). Larger and healthy fruits (5.83 cm) were noted in T₆ (Zn + Cu + Fe + Mn + B) whereas, the poor were found in T₁ (control). Moreover, T₂ is similar to T₃. The increase in fruit diameter was linear from T₁ to T₆. The same trend was reported by Shahin *et al.* [32] and Ramezani and Shekafandeh [31] while working on plum and olive fruit, respectively.

3) Number of Fruit per Tree: The results significantly ($P \leq 0.05$) varied when different treatments of foliar

spray were applied (**Table 3**). Moreover, maximum number of fruits (615) were obtained in T₆ (Zn + Cu + Fe + Mn + B), followed by T₅ (Zn + Cu + Fe + Mn) with a fruit number of 585 followed by T₄ (Zn + Cu + Fe), while T₁ (control) gave minimum (448) number of fruits. Same results were reported by Shahin *et al.* [32] and Hassan *et al.* [4].

4) Fruit Yield (Kg/tree): Fruit yield was significantly ($P \leq 0.05$) increased by micronutrients spray (**Table 3**). The higher yield (64.54 Kg/tree) was obtained in case of T₆ (Zn + Cu + Fe + Mn + B). The results regarding T₂ (Zn), T₃ (Zn + Cu), T₄ (Zn + Cu + Fe) and T₅ (Zn + Cu + Fe + Mn) were statistically comparable but better than the control (untreated) where minimum yield (40.62 Kg/tree) was obtained. These results were found in harmony with the work of Nasiriet *al.* [33], Ibrahim *et al.* [34] and Khayyat *et al.* [35], where micronutrients were applied to citrus and date palm, which increased the yield in a linear fashion.

5) Fruit Volume (cm³): The results showed significant ($P \leq 0.05$) increase in fruit volume (**Table 3**). The maximum fruit volume (267.51 cm³) was obtained in T₆ (Zn + Cu + Fe + Mn + B) followed by T₅ (Zn + Cu + Fe + Mn) and T₄ (Zn + Cu + Fe). The poor fruit volume (195.01 cm³) was noted in T₁ (control). The increase in fruit volume is due to availability of applied nutrients.

4.2. Chemical Properties of Fruits

1) Juice pH: It can be seen from the results that the application of foliar spray significantly ($P \leq 0.05$) decreased the juice pH (**Table 4**). It was noted that higher juice pH (3.86) was reported in T₁ (control) followed by T₂ (Zn only), while the lower juice pH was noted in T₆, where all the micronutrients were applied. These findings were in line with the work of Tariq *et al.* [14].

2) Juice Acidity (%): The results showed that foliar spray significantly ($P \leq 0.05$) increased juice acidity over control (**Table 4**). It was noted that the maximum juice acidity (0.39%) was reported in plants sprayed with T₆ followed by T₅ and T₄. The minimum juice acidity (0.24%) was noted in control.

3) Total Soluble Solids (TSS): It can be seen from the results that the application of foliar spray significantly ($P \leq 0.05$) increased the total soluble solids (**Table 4**). It was noted that significantly ($P \leq 0.05$) higher total soluble solids (8.87%) were reported in T₆ followed by T₅ and T₄. The lower total soluble solids were noted in T₁ (control).

4) Vitamin C (mg/100mL): It can be seen from the results that the foliar spray significantly ($P \leq 0.05$) increased

Table 3. Effect of foliar spray of micronutrients on the physical properties of fruit.

Treatments	Length (cm)	Diameter (cm)	No. of fruit/tree	Fruit Yield Kg tree ⁻¹	Volume cm ³
Control (T ₁)	5.64 c	5.19 d	488 e	40.62 c	195.01 f
Zn (T ₂)	5.71 c	5.41 c	525 d	52.57 b	206.26 e
Zn + Cu (T ₃)	6.01 b	5.48 c	541 cd	51.66 b	222.51 d
Zn + Cu + Fe (T ₄)	6.07 b	5.57 bc	557 c	52.89 b	236.26 c
Zn + Cu + Fe + Mn (T ₅)	6.22 ab	5.68 ab	585 b	51.80 b	248.76 b
Zn + Cu + Fe + Mn + B (T ₆)	6.41 a	5.83 a	615 a	64.54 a	267.51 a
LSD ($P \leq 0.05$)	0.23	0.19	20.23	9.09	9.95
% CV	2.48	2.20	2.45	11.53	2.89

*Means are different significantly in columns at $P \leq 0.05$.

Table 4. Effect of foliar spray of micronutrients on the chemical properties of the fruits.

Treatments	Juice pH	J. acidity %	TSS %	Vitamin C %
Control (T ₁)	3.86 a	0.24 d	7.01 e	4.80 f
Zn (T ₂)	3.78 a	0.25 cd	7.26 de	5.39 e
Zn + Cu (T ₃)	3.70 a	0.28 bc	7.58 cd	5.91 d
Zn + Cu + Fe (T ₄)	3.70 a	0.29 b	8.01 bc	6.62 c
Zn + Cu + Fe + Mn (T ₅)	3.68 a	0.31 b	8.36 b	7.14 b
Zn + Cu + Fe + Mn + B (T ₆)	3.31 b	0.39 a	8.88 a	7.90 a
LSD ($P \leq 0.05$)	0.33	0.04	0.43	0.46
% CV	5.97	8.27	3.65	4.83

*Means are different significantly in columns at $P \leq 0.05$.

the vitamin C content in peach fruit (**Table 4**). It was noted that the maximum vitamin C (7.90 mg/100mL) content was reported in T₆, where all the micronutrients were applied. The minimum vitamin C (4.80 mg/100mL) content was reported in T₁ (control) where no spray was applied. These results revealed that foliar spray of micronutrients has a positive effect on vitamin C content. Hassan *et al.* [4] reported similar findings by applying micronutrients to plum orchards.

5. Conclusion

The obtained results in the present research proved that foliar application of micronutrients (Zn, Cu, Fe, Mn and B) alone and in combination were the most effective treatments in increasing chemical and physical parameters of peach fruit. To increase fruit length (cm), diameter (cm), no. of fruit/tree, fruit yield (kg/tree), volume (cm³), juice (pH), juice acidity (%), TSS (%) and vitamin C (%) under silt loam, calcareous and alkaline condition of Peshawar soil, it is recommended to apply foliar spray twice a year to the orchards in order to enhance the efficiency of micronutrients and avoid losses by leaching and interaction among the nutrients.

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Abbreviation

AB-DTPA: Ammonium Bicarbonate Diethylene Triamine Pentaacetic Acid
AOAC: Association of Official Analytical Chemists
B: Boron
CaCO₃: Calcium Carbonate
Cu: Copper
ECe: Electrical Conductivity in Extract
Fe: Iron
IAA: Indole Acetic Acid
K: Potassium
LSD: Least Significant Difference
Mn: Manganese
N: Nitrogen
P: Phosphorus
SOP: Sulphate of Potash
SSP: Single Super Phosphate
TSS: Total Soluble Solid
Zn: Zinc