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ORIGINAL ARTICLE

Influence of different nutrient sprays on fruit quality of cherry (*Prunus avium* L.)

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ABSTRACT
From the present study it can be concluded that the foliar application of nutrients such as zinc, boron, calcium and potassium at floral bud burst, 80% petal fall and pit hardening stages of the fruit resulted in improvement of vegetative, physical and chemical characters. In general foliar application of Zn + B + K with or without calcium oxide showed a significant increase in terms of fruit set, fruit yield, leaf area, fruit size, fruit weight, fruit volume, pulp-stone ratio, flesh thickness, leaf nitrogen, potassium and zinc when applied at floral bud burst, 80% petal fall and pit hardening stage of the fruit. Zn + B + K with or without calcium oxide sprays also resulted in significant increase of chemical parameters like total soluble solids, total sugars, juice content, anthocyanin content, ascorbic acid, acidity. Fruit nutrients Ca and B increased with the combined foliar application of boric acid, potassium sulphate and calcium oxide sprayed at different phenological stages which were also significantly effective in alleviating to some extent the physiological disorders like fruit cracking.
Key Words: *cherry, foliar application, zinc, boron, calcium and potassium, floral bud, fruit set, fruit yield, leaf area, fruit size, fruit weight, fruit volume*

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INTRODUCTION

Cherry (*Prunus avium* L.) is the most common stone fruit grown all over the temperate regions of world and its distribution is confined between 35° N and 55°S latitude [1]. The leading cherry producing countries are USA, Germany, Italy and France. In India, 95 per cent of the total cherry production is confined to Kashmir Valley of Jammu & Kashmir state and some parts of Himachal Pradesh and Uttar Pradesh. It is the season's first tree crop to reach the market, maturing within 60-70 days after full bloom and therefore, fetches premium price. In our state Guigne Pourpera Precece (*Awal Number*), Black Heart (*Siyah Gole*), Guigne Noir Grossa Lucenta (*Tontal*), Guigne Noir Hative (*Makhmali*), Biggareau Napolean (*Double Glass*) and Biggarreau Noir Grossa (*Misri*), are important sweet cherry varieties grown in plains, foot hills and upland areas [2]. The total area under cherry cultivation in J&K is about 3465 hectares with an annual production of 11445 MT [3]. However, the productivity is quite low as compared to cherry producing countries of the world. In Kashmir valley, sweet cherry is most commonly grown on the rainfed upland plateau areas, i.e. *Karewas* as there is no water stagnation. Cherry is rich in protein and sugar and has more calories than apple. Carotene and folic acid contents are also high. The fruit is a rich source of minerals like potassium, calcium, magnesium, iron and zinc [4]. Erratic distribution of rainfall results in the deficiency of most important nutrients like boron, zinc, potassium, and calcium at flowering and cell division stage which causes severe pollination problems and results in fruit drop, reduction in economic yield coupled with low fruit quality. Foliar nutrient application has become vital tool in fruit growing and a complementary practice to soil nutrition supply. Supply of mineral nutrients to the plants through foliar application is more rapid than soil and /or root application; however foliar application may cause damage if not properly applied. Moreover, proper foliar nutrient application may result in increase in fruit yield and improved quality, with relatively low costs and low environmental impact [5]. The role of potassium, zinc, calcium and boron in fruit growing is quite prominent and hence of paramount importance. Zinc and boron are essential for the physiological processes of cell division and growth. Increased boron content in floral buds often improves fruit set. Foliar boron application promotes flowering, fruit set and yield. Zinc

serves as a metal component of enzymes or as a cofactor of over 300 enzymes and proteins and has an early and specific effect on cell division, nucleic acid metabolism and protein synthesis while as insufficient amounts of zinc can reduce fruit bud formation [6]. Zinc has been identified as component of almost 60 enzymes; therefore, it has a role in many plant functions like activation of the enzyme tryptophan which is the precursor of auxin [7]. Calcium is considered as one of the most important nutrient element in controlling the metabolism of plant cell. Its role in prevention of various physiological disorders is well documented [8]. Calcium, an integral part of cell wall is necessary to maintain membrane stability and rigidity [9]. Plants subjected to calcium stress have been reported to undergo changes in diverse metabolic processes involving nucleic acid, nitrogen and carbohydrates. Potassium has a vital importance in increasing fruit growth, and carbohydrate storage. It improves photosynthesis in storage organs of fruits, seeds and tubers. It imparts tolerance to plants against various environmental stresses such as drought, wind, high and low temperatures. It also increases plant resistance to diseases and pests [10]. Potassium is an important solute in expanding cells and expansive growth is very sensitive to potassium deficiency. Moreover, it is needed for the enlargement of fruit [11] Potassium activates the enzymes involving in sugar biosynthesis and helps in translocation of sugars [12].
Keeping aforementioned facts in view, the present investigation aimed at increase the overall yield and quality of cherry fruits.

MATERIAL AND METHODS

The present investigation to study the "Influence of Different Nutrient Sprays on Fruit Quality of Cherry (*Prunus avium* L.) cv. Guigne Pourpera Precece (*Awal Number*)" was carried out in the Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar. The details of experimental materials and methods used are as under : Twelve year old trees of sweet cherry cv. Guigne Pourpera Precece (*Awal Number*) worked on *Prunus cerasus* L. root stock having uniform age, vigour and bearing intensity were selected for the present studies. The experiment was laid out in randomized complete block design (RCBD) with three replications. Different concentrations of zinc sulphate, calcium oxide, boric acid and potassium sulphate alone or in combinations were sprayed at different phenological stages viz; before floral bud burst, 80% petal fall and pit hardening stages. The following treatments were applied to the trees:

Treatments		Conc. (%)	Treatments		Conc. (%)
T_1	$ZnSO_4$	0.2	T_9	$CaO + K_2SO_4$	0.5 + 0.3
T_2	CaO	0.5	T_{10}	$H_3BO_3 + K_2SO_4$	0.1 + 0.3
T_3	H_3BO_3	0.1	T_{11}	$ZnSO_4+CaO+H_3BO_3$	0.2 + 0.5 + 0.1
T_4	K_2SO_4	0.3	T_{12}	$CaO+H_3BO_3+K_2SO_4$	0.5 + 0.1 + 0.3
T_5	$ZnSO_4$+ CaO	0.2 + 0.5	T_{13}	$ZnSO_4+H_3BO_3+K_2SO_4$	0.2 + 0.1 + 0.3
T_6	$ZnSO_4+H_3BO_3$	0.2 + 0.1	T_{14}	$ZnSO_4+H_3BO_3+K_2SO_4+CaO$	0.2 + 0.1+0.3 + 0.5
T_7	$ZnSO_4+K_2SO_4$	0.2 + 0.3	T_{15}	No spray	Control
T_8	$CaO+H_3BO_3$	0.5 + 0.1			

Preparation of spray materials and method of application

The different nutrient solutions were prepared separately by dissolving the required amount of salts in light hot water in small amounts and then raising the volume to the desired extent by the addition of more water. The trees were sprayed with foot pump using 10 litres of spray solution per tree. The spray was conducted by moving in clockwise and anti-clockwise directions to a slight run-off.

Harvesting, packing and storage

The fruits of each treatment were harvested at optimum maturity on the basis subjective estimation fruit colour and kept in shade to remove field heat. The uniformly matured fruits were selected and packed in card board cartons in a single layer, keeping stem end of the fruits downwards. The paper cuttings were placed between layers to avoid bruising. The fruits were taken to the laboratory for conducting analysis

Vegetative characteristics

Fruit set (%)

Fruit set was measured by counting flowers and mature fruits on part of comparable branches on lower, middle and upper different parts of every tree 1 to 2 meter above ground level. Fruit set was calculated from number of flowers and mature fruits on individual branches. Flowers were counted during full bloom and the number of fruits remaining on the same branches was recorded before harvest.

Yield (kg tree^{-1})

The fruit yield (kg tree^{-1}) under each treatment was determined by taking weight of all the fruits harvested and those used for investigation and were calculated on per tree basis.

Annual shoot growth (cm)

Four identical shoots were selected randomly from each tree at the beginning of annual shoot growth. Termination of such growth by the end of August was considered for final shoot growth.

Leaf area (cm^2)

Five leaves from each quadrant were picked from each tree and their leaf area was measured by using leaf area meter and then reading was averaged in cm^2.

Leaf nutrients, N, P, K, Ca, B and Zn

Collection of leaf samples

Leaf samples were accordingly collected at the middle of current season's growth around periphery of tree from 1st July- Mid August.

Preparation of leaf sample

After collection, the leaf samples were washed gently with tap water and later dipped in dilute HCL. Further, washing were repeated with single and double distilled water. The samples were then air dried on a filter paper and then oven dried at 60^0 C for 24 hours [13]. The samples were then crushed in a stainless steel blender to pass through 2 mm mesh and stored in poly bags for chemical analysis.

Estimation of leaf nutrient contents

Nitrogen analysis ; MicroKjeldhal's method was followed for nitrogen analysis.

P, K, Ca, Zn, B analysis

Phosphorus was determined by Vanado molybdo phosphoric yellow colour method [14]. The colour intensity was measured at 440 nm in double beam UV-vis spectrophotometer.

Potassium was estimated by flame photometric method using flame photometer 130 (Systronics).

Boron was estimated by using inductively coupled plasma spectrometry (ICP) and Ca and Zn were analyzed with the help of atomic absorption spectrophotometer (AAS 4141).

Physical characteristics

Fruit size

The length and breadth (cm) of individual fruits was recorded. The Length was measured from base to apex, and breadth (i.e. cheek) from side to side with the suture halfway between. The measurements were taken with the help of Vernier Calliper. The sample fruits of each treatment were measured. The average of all the readings thus obtained was calculated in cm^2.

Fruit weight

Fruits of each sample were weighed in a sensitive mono pan balance and average weight was determined by dividing the total weight obtained (g) by number of fruits in the sample.

Fruit volume

A 200 ml measuring cylinder was filled up to 100 ml mark and then 5 randomly selected fruits were put in this cylinder to record volume of water displaced by fruits. Average fruit volume was calculated as:

$$\text{Average fruit volume (cc)} = \frac{\text{Total number of water displaced by fruits together}}{\text{Total number of fruits used}}$$

The pulp-stone of each sample were weighed in a sensitive mono pan balance and the average weight was determined by dividing the total weight obtained (g) by number of fruits in the sample. Similarly, the pulp stone ratio was determined.

Flesh thickness (mm)

Flesh thickness was measured by pushing in a graduated thin copper rod upto the stone surface. Each fruit was subjected to three such measurements and average thickness was obtained (mm).

The cracking percentage was calculated as per procedure standardised by [15].

Statistical Analysis

The data thus obtained in respect of various observations were statistically analyzed as described by [16]. The significance of "F" test was tested at 5% level of significance. The critical difference value was determined when "F' test was significant.

RESULT AND DISCUSSION

Fruit set

The data presented in Table 1, reveals that fruit set of cherries was significantly influenced by nutrient sprays of zinc sulphate, calcium oxide, boric acid, potassium sulphate and their combinations. Fruit set recorded under different treatments ranged from 20.01 to 25.06 per cent. Highest (25.06 %) fruit set was recorded in fruits treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 followed by 24.70 per cent fruit set recorded in trees treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 and the lowest (18.82 %) was recorded in the untreated fruits. In the present studies fruit set increased with the combined foliar application of Zn + B + K sprays at bud burst, petal fall and half grown stage of fruit. Similar findings in fruit set with Zn + B at different stages were reported by [17, 18] in almond trees. The beneficial effect of boron and zinc in increasing fruit set may be due to higher availability of photosynthates and these chemicals are also associated with hormone metabolism which promotes synthesis of auxin, essential for fruit set and growth [19]. Foliar sprays of boron at the pre-bloom or bloom stages of fruit crops supplies available B at the critical periods of pollen formation, germination and fertilization just prior to seed and fruit set. Foliar applied boron is rapidly absorbed by the flowers. Also, boron increases flower production and retention, pollen tube elongation and germination and fruit development. The combined application of zinc sulphate and boric acid to increased fruit set can be attributed to the development of pollen tube, sufficient levels of nutrients in the pollen grain, as well as an increase in the duration of pollination [20].

Fruit yield

Nutrient sprays significantly influenced the fruit yield (Table 1). Maximum fruit yield of 11.95 kg was recorded in fruits from trees sprayed with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 which did not however, statistically differ from fruits treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 recording a fruit yield of 11.55 kg tree^{-1}. Untreated fruits recorded lowest yield of 8.32 kg tree^{-1}. Fruit yield in the present study was recorded highest in the trees treated with Zn + B + K in comparison to the control. [21] has also reported that fruit yield of pomegranate increased from 18.5 kg tree^{-1} in control to 26.37 kg tree^{-1} with the application of zinc sulphate, iron sulphate, manganese sulphate along with 1.5 per cent boric acid. The results obtained are in conformity with the results obtained by [20] wherein foliar application of Zn + B + K at flower initiation and at full bloom stage in sweet cherry significantly increased fruit yield. Increasing fruit yields due to Zn + B + K spray may primarily be attributed to their effects in increasing fruit set in addition to mobilization of food materials from source to sink affected by boron [19].

Annual shoot growth (cm)

Annual shoot growth was significantly influenced by different treatments (Table 1). All the nutrient treatments significantly increased the shoot growth. The shoot growth ranged from 19.03 to 23.83 cm. Highest shoot extension growth of 23.83 cm was recorded in trees treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 followed by trees having received 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 which recorded an annual shoot extension growth of 22.93 and minimum extension growth of 18.03 cm was recorded in untreated fruit trees. [22] Have also reported that the foliar application of zinc sulphate + boric acid increased the annual shoot growth in walnut. [23] Has attributed the increase in vegetative growth of tomato to physiological role of boron and its involvement in the metabolism of protein, synthesis of pectin, maintaining the correct water relation within the plant, re-synthesis of adenosine triphosphate (ATP) and translocation of sugar at development and fruiting stages. These findings are in conformity to the results obtained by [24] who found that the application of Zn+B increased the annual shoot growth in olive trees.

Leaf Area (cm^2)

Leaf area ranged from 67.47 to 76.45 cm^2 in various treatments (Table 2). Significantly higher leaf area (76.45 cm^2) was observed in trees having received 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 followed by 74.29 cm^2 recorded in trees treated with 0.2% $ZnSO_4$ +0.1% H_3BO_3. The lowest reading of 66.93 cm^2 was observed in the untreated trees. Foliar application of zinc sulphate, boric acid or potassium sulphate either alone or in combination increased the leaf area significantly as compared to control. However, the highest leaf area was recorded in the trees treated with Zn + B + K. These findings are in conformity to the results obtained by [25] who reported that the foliar application of boric acid and zinc sulphate significantly increased leaf area of strawberry. Similar findings were also recorded by [26].

Leaf nitrogen

The leaf nitrogen content ranged between 2.67 to 2.78 per cent under different treatments (Table 2).Trees treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 recorded the highest (2.78 %) content of leaf nitrogen as compared to the trees of other treatment including those of control. The lowest leaf nitrogen content (2.52 %) was recorded in untreated trees. No significant differences were observed in the leaf nitrogen content of trees treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 and 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 + 0.5% CaO.

Leaf nutrient content

Macro elements N, K and Ca in the present studies, were significantly increased by the application of Zn + B + K while as phosphorus showed a slight increase than other treatments with the application of Zn + B + K + Ca. Amongst micro elements zinc significantly increased by the application of Zn + B + K + Ca while as boron increased by the combined application of Z + B. The enhanced status of nutrient in the plant resulting from spraying different solutions might be attributed to quick absorption via leaves and the limited loss of the nutrients. [26] Also found that the foliar application of Fertifol Misr alone or in combination with GA_3 increased both leaf macro and micronutrients as compared to control.

Leaf phosphorus

Leaf phosphorus content was significantly influenced by nutrient sprays, it ranged from 0.167 to 0.169

per cent under different treatments (Table 2). Trees treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 + 0.5% CaO) exhibited higher (0.169 per cent) phosphorus content which, however, did not significantly differ from the trees treated with 0.2% $ZnSO_4$, 0.5% CaO, 0.3% K_2SO_4 and 0.5% CaO+ 0.3% K_2SO_4 each of which recorded leaf phosphorus content of 0.168 per cent. Lowest leaf phosphorus content (0.167 %) was observed in untreated trees. The leaf potassium content in treated trees ranged from 1.71 to 2.07 per cent (Table 2). Significantly highest (2.07 %) leaf potassium content was recorded in trees treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 followed by 0.1% H_3BO_3 + 0.3% K_2SO_4 which recorded leaf potassium content of 2.03 per cent. The least leaf potassium content (1.60 %) was recorded in untreated trees. The leaf calcium content in treated trees ranged between 2.43 to 2.86 per cent (Table 2). Highest leaf calcium content of 2.86 per cent was recorded in the trees sprayed with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 + 0.5% CaO followed by nutrient combination of 0.5% CaO + 0.1% H_3BO_3 + 0.3% K_2SO_4 which recorded leaf calcium content of 2.78 per cent. Lowest leaf calcium content (2.30 %) was observed in the untreated trees. All the calcium related treatments showed an increasing trend in the leaf calcium content as compared to other treatments including control.

Leaf zinc content

The leaf zinc content in treated trees ranged between 64.00 to 78.50 ppm (Table 2). All the treatment combinations with zinc resulted in significant increase in the leaf zinc content as compared to other nutrient combinations including untreated ones. Highest leaf zinc content (78.50 ppm) was recorded in the trees sprayed with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 + 0.5% CaO followed by nutrient spray of 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 which recorded leaf zinc content of 78.30 ppm. The lowest leaf zinc content (63.05 ppm) was recorded in untreated trees.

Leaf boron content

The leaf boron content in treated trees was significantly influenced by the nutrient treatments. The leaf zinc content in the treated trees ranged between 19.14 to 22.80 ppm (Table 2). Highest (22.80 ppm) leaf boron content was recorded in the trees sprayed with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 which did not significantly differ with the treatment combinations involving boron. Lowest reading (17.38 ppm) was recorded in the unsprayed trees.

Fruit size

Fruit size under different nutrient treatments varied from 2.31 to 3.20 cm^2 (Table 3). In case of boron treatments alone or in combination, generally an increasing trend in the fruit size was observed as compared to other treatments exclusive of boron and it ranged between 2.90 to 3.20 cm^2. Nutrient spray of 0.2% $ZnSO_4$ + 0.1% H_3BO_3 recorded fruit size of 2.79 cm^2. Highest fruit size (3.20 cm^2) was recorded in the fruits treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 followed by 3.14 cm observed in fruits treated with 0.1% H_3BO_3 + 0.3% K_2SO_4. Lowest reading of 2.16 cm was recorded in untreated fruits.

The results revealed that the application of nutrient sprays alone or in combination significantly increase fruit size. The maximum fruit size was recorded by the foliar application of Zn + B + K. [27] also reported that the foliar spray of potassium, zinc, boron and molybdenum on guava cv. 'Allahabad Safeda' significantly increased fruit size as compared to control. Sprays containing boric acid is reported to increase the fruit size as it causes cell division or nucleic acid synthesis within fruit growth and development period and consequently fruit growth improves. Fruit weight varied from 3.12 to 4.25g in fruits treated with different nutrient (Table 3). Fruit weight showed increasing trend under the treatments of boron alone or in combination with 0.5% CaO, 0.3% K_2SO_4, 0.2% $ZnSO_4$ + 0.5% CaO, 0.5% CaO + 0.3% K_2SO_4, 0.2%$ZnSO_4$ + 0.3% K_2SO_4, 0.2% $ZnSO_4$ + 0.5% CaO + 0.3% K_2SO_4. Highest fruit weight (4.25 g) was recorded in fruits treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4. Lowest reading (3.17 g) was recorded in the untreated fruits, and (3.12 g) in fruits treated with 0.2% $ZnSO_4$ + 0.5% CaO.

Fruit weight

The fruit weight showed a pronounced effect with application of nutrient spray. The highest fruit weight was recorded with the application of Zn + B + K sprayed at bud burst, petal fall and half grown stages of fruit. Similar findings in fruit weight was reported by [28] who observed that potassium sprays at 0.1 and 2.0 per cent and Zn + B at on cherry increased the fruit weight significantly as compared to other treatments.

Fruit volume

Fruit volume varied from 3.19 to 3.57 cm^3 under various nutrient treatments (Table 3). All the treatments resulted in an significant increase in fruit volume as compared to control except those of 0.5% CaO treated ones. Highest fruit volume (3.57 cm^3) was recorded in the fruits treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3+ 0.3% K_2SO_4. Lowest fruit volume (3.15 cm^3) was recorded in untreated fruits.

Pulp-stone ratio

Pulp-stone ratio ranged from 15.04 to 17.69 cm under various treatments (Table 3). Highest ratio (17.69) was recorded in the fruits treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 followed by a ratio of 17.02 recorded in fruits treated with 0.1% H_3BO_3 alone. Lowest stone/pulp ratio of 14.58 was recorded in untreated fruits which were statistically at par with the fruits treated with 0.5% CaO, recording a pulp/stone ratio of 15.04. The findings revealed that Zn + B + K proved very effective in enhancing the pulp-stone ratio of cherry fruit recording a reading of 17.69. The increase in pulp-stone ratio is attributed to the increased fruit weight and decreased stone weight in these treatments. [24] Also reported increased pulp-stone ratio in case of Indian gooseberry by the of borax treatment.

Flesh thickness

Flesh thickness of fruits ranged from 5.93 to 6.76 mm under different treatments (Table 3). All the treatments excepting one involving 0.2% $ZnSO_4$ resulted in significantly enhanced thickness of the fruit flesh as compared to untreated fruits. The control treatment recorded a flesh thickness of 5.53mm which was, however statistically at par with fruits treated with 0.2% $ZnSO_4$ recording a fruit flesh thickness of 5.93 mm. Highest flesh thickness (6.76 mm) was recorded in the fruits sprayed with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4.

These findings are in agreement with those of [29] on citrus. Statistical analysis of the data revealed that flesh thickness was significantly higher in trees treated with Zn + B + K i.e. 6.76 mm than untreated ones which is 5.53 mm. [30] while conducting the nutrient analysis of sweet cherry observed that the average flesh thickness of sweet cherry is 6.03 mm which is quite lower than the present study. The increase in flesh thickness may be because of the nutrient foliar applications. These findings are in agreement with [29] on citrus.

Table-1 : Effect of nutrient application on fruit set, fruit yield and effect of nutrient application on annual shoot growth & leaf area in sweet cherry cv. Guigne Pourpera Precece (Awal Number)

Treatments	Treatment combination	Fruit set (%)	Fruit yield (kg tree^{-1})	Treatments	Treatment combination	Annual shoot growth (cm)	Leaf area (cm^2)
T_1	$ZnSO_4$ (0.2%)	22.89 (4.88)*	10.50	T_1	$ZnSO_4$ (0.2%)	22.80	71.20
T_2	CaO (0.5%)	21.01 (4.68)	9.03	T_2	CaO (0.5%)	19.03	67.47
T_3	H_3BO_3 (0.1%)	23.00 (4.98)	11.20	T_3	H_3BO_3 (0.1%)	19.94	69.63
T_4	K_2SO_4 (0.3%)	22.05 (4.79)	10.26	T_4	K_2SO_4 (0.3%)	19.73	67.65
T_5	($ZnSO_4$ + CaO)	23.83 (4.98)	10.60	T_5	($ZnSO_4$ + CaO)	21.68	68.11
T_6	($ZnSO_4$ + H_3BO_3)	24.70 (5.10)	11.55	T_6	($ZnSO_4$ + H_3BO_3)	23.83	74.29
T_7	($ZnSO_4$ + K_2SO_4	23.27 (4.92)	11.35	T_7	($ZnSO_4$ + K_2SO_4	22.50	73.85
T_8	(CaO + H_3BO_3)	23.90 (4.98)	11.30	T_8	(CaO + H_3BO_3)	21.50	70.18
T_9	(CaO + K_2SO_4)	23.25 (4.92)	10.23	T_9	(CaO + K_2SO_4)	21.23	68.33
T_{10}	(H_3BO_3 + K_2SO_4)	23.44 (4.94)	11.06	T_{10}	(H_3BO_3 + K_2SO_4)	21.43	69.33
T_{11}	($ZnSO_4$ + CaO + H_3BO_3)	24.10 (5.00)	11.07	T_{11}	($ZnSO_4$ + CaO + H_3BO_3)	22.32	70.58
T_{12}	CaO + H_3BO_3 + K_2SO_4)	23.92 (4.98)	11.03	T_{12}	(CaO + H_3BO_3 + K_2SO_4)	21.63	69.95
T_{13}	($ZnSO_4$ + H_3BO_3 + K_2SO_4)	25.06 (4.86)	11.95	T_{13}	($ZnSO_4$ + H_3BO_3 + K_2SO_4)	22.93	76.45
T_{14}	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	24.50 (5.04)	11.45	T_{14}	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	22.87	74.15
T_{15}	(Control)	18.82 (4.44)	8.32	T_{15}	(Control)	18.03	66.93
	C.D ($p \leq 0.05$)	0.02	0.52		C.D ($p \leq 0.05$)	0.30	0.29

*Figures in parenthesis are square root transformed values

Table-2 :Effect of nutrient application on leaf N, P, K and Ca content and effect of nutrient sprays on leaf Zn and leaf B content in sweet cherry cv. Guigne Pourpera Precece (Awal Number)

Treatments	Treatment combination	Leaf nitrogen (%)	Leaf phosphorus (%)	Leaf potassium (%)	Leaf calcium (%)	Treatments	Treatment combination	Leaf zinc (ppm)	Leaf boron (ppm)
T_1	$ZnSO_4$ (0.2%)	2.73 (1.92)	0.168 (1.08)	1.71 (1.64)	2.48 (1.85)*	T_1	$ZnSO_4$ (0.2%)	77.30	19.14
T_2	CaO (0.5%)	2.71 (1.92)	0.167 (1.08)	1.73 (1.64)	2.69 (1.91)	T_2	CaO (0.5%)	64.00	19.75
T_3	H_3BO_3 (0.1%)	2.70 (1.92)	0.168 (1.08)	1.72 (1.64)	2.46 (1.85)	T_3	H_3BO_3 (0.1%)	64.60	22.25
T_4	K_2SO_4 (0.3%)	2.67 (1.91)	0.168 (1.08)	1.90 (1.69)	2.53 (1.87)	T_4	K_2SO_4 (0.3%)	66.0	19.65
T_5	($ZnSO_4$ + CaO)	2.72 (1.92)	0.165 (1.07)	1.75 (1.65)	2.60 (1.89)	T_5	($ZnSO_4$ + CaO)	75.00	19.55
T_6	($ZnSO_4$ + H_3BO_3)	2.76 (1.93)	0.167 (1.08)	1.73 (1.64)	2.57 (1.88)	T_6	($ZnSO_4$ + H_3BO_3)	78.10	22.80
T_7	($ZnSO_4$ + K_2SO_4	2.71 (1.92)	0.165 (1.07)	1.93 (1.70)	2.54 (1.87)	T_7	($ZnSO_4$ + K_2SO_4	74.60	19.40
T_8	(CaO + H_3BO_3)	2.72 (1.92)	0.166 (1.07)	1.78 (1.66)	2.66 (1.90)	T_8	(CaO + H_3BO_3)	65.60	21.67
T_9	(CaO + K_2SO_4)	2.71 (1.93)	0.168 (1.08)	1.94 (1.71)	2.65 (1.90)	T_9	(CaO + K_2SO_4)	65.00	19.96
T_{10}	(H_3BO_3 + K_2SO_4)	2.75 (1.93)	0.166 (1.07)	2.03 (1.73)	2.65 (1.90)	T_{10}	(H_3BO_3 + K_2SO_4)	65.60	20.92
T_{11}	($ZnSO_4$ + CaO + H_3BO_3)	2.76 (1.93)	0.164 (1.07)	1.76 (1.65)	2.76 (1.93)	T_{11}	($ZnSO_4$ + CaO + H_3BO_3)	77.00	22.75
T_{12}	(CaO + H_3BO_3 + K_2SO_4)	2.71 (1.92)	0.166 (1.07)	1.84 (1.68)	2.78 (1.93)	T_{12}	(CaO + H_3BO_3 + K_2SO_4)	66.60	22.21
T_{13}	($ZnSO_4$ + H_3BO_3 + K_2SO_4)	2.78 (1.94)	0.167 (1.08)	2.07 (1.74)	2.75 (1.95)	T_{13}	($ZnSO_4$ + H_3BO_3 + K_2SO_4)	78.30	22.66
T_{14}	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	2.77 (1.93)	0.169 (1.08)	1.87 (1.69)	2.86 (1.93)	T_{14}	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	78.50	22.63
T_{15}	(Control)	2.52 (1.87)	0.167 (1.08)	1.60 (1.60)	2.30 (1.81)	T_{15}	(Control)	63.05	17.38
	C.D ($p \leq 0.05$)	0.02	0.001	0.06	0.01		C.D ($p \leq 0.05$)	0.14	0.68

*Values in parenthesis are square root transformed values

Table-3 :Effect of nutrient application on fruit size and fruit weight, effect of nutrient application on fruit volume and pulp stone ratio and effect of nutrient sprays on flesh thickness and fruit cracking in sweet cherry cv. Guigne Pourpera Precece (*Awal Number*)

Treatments	Treatment combination	Fruit size (cm^2)	Fruit Weight (g)	Treatment combination	Fruit volume (cm^3)	Pulp/stone ratio (g)	Treatment combination	Flesh thickness (mm)
T_1	$ZnSO_4$ (0.2%)	2.71	3.44	$ZnSO_4$ (0.2%)	3.37	15.54	$ZnSO_4$ (0.2%)	5.93
T_2	CaO (0.5%)	2.31	3.36	CaO (0.5%)	3.19	15.04	CaO (0.5%)	6.06
T_3	H_3BO_3 (0.1%)	3.11	4.12	H_3BO_3 (0.1%)	3.42	17.02	H_3BO_3 (0.1%)	6.36
T_4	K_2SO_4 (0.3%)	2.81	3.62	K_2SO_4 (0.3%)	3.39	16.39	K_2SO_4 (0.3%)	6.16
T_5	($ZnSO_4$ + CaO)	2.54	3.12	($ZnSO_4$ + CaO)	3.33	15.59	($ZnSO_4$ + CaO)	6.06
T_6	($ZnSO_4$ + H_3BO_3)	2.79	3.32	($ZnSO_4$ + H_3BO_3)	3.39	15.65	($ZnSO_4$ + H_3BO_3)	6.03
T_7	($ZnSO_4$ + K_2SO_4	2.95	3.33	($ZnSO_4$ + K_2SO_4	3.44	15.36	($ZnSO_4$ + K_2SO_4	6.23
T_8	(CaO + H_3BO_3)	2.96	3.55	(CaO + H_3BO_3)	3.46	15.70	(CaO + H_3BO_3)	6.43
T_9	(CaO + K_2SO_4)	2.98	3.25	(CaO + K_2SO_4)	3.49	15.33	(CaO + K_2SO_4)	6.13
T_{10}	(H_3BO_3 + K_2SO_4)	3.14	3.82	(H_3BO_3 + K_2SO_4)	3.53	16.43	(H_3BO_3 + K_2SO_4)	6.60
T_{11}	($ZnSO_4$ + CaO + H_3BO_3)	2.90	3.64	($ZnSO_4$ + CaO + H_3BO_3)	3.36	15.56	($ZnSO_4$ + CaO + H_3BO_3)	6.20
T_{12}	(CaO + H_3BO_3 + K_2SO_4)	2.96	3.68	(CaO + H_3BO_3 + K_2SO_4)	3.37	15.52	CaO + H_3BO_3 + K_2SO_4)	6.13
T_{13}	($ZnSO_4$ + H_3BO_3 + K_2SO_4)	3.20	4.25	($ZnSO_4$ + H_3BO_3 + K_2SO_4)	3.57	17.69	$ZnSO_4$ + H_3BO_3 + K_2SO_4)	6.76
T_{14}	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	3.03	3.75	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	3.52	16.70	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	6.56
T_{15}	(Control)	2.16	3.17	(Control)	3.15	14.58	(Control)	5.53
	C.D ($p \leq 0.05$)	0.50	0.64	C.D ($p \leq 0.05$)	0.06	0.49	C.D ($p \leq 0.05$)	0.52

*Values in parenthesis are square root transformed values

CONCLUSION

From the present study it can be concluded that the foliar application of nutrients such as zinc, boron, calcium and potassium at floral bud burst, 80% petal fall and pit hardening stages of the fruit resulted in improvement of vegetative, physical and chemical characters. In general foliar application of Zn + B + K with or without calcium oxide showed a significant increase in terms of fruit set, fruit yield, leaf area, fruit size, fruit weight, fruit volume, pulp-stone ratio, flesh thickness, leaf nitrogen, potassium and zinc when applied at floral bud burst, 80% petal fall and pit hardening stage of the fruit. Zn + B + K with or without calcium oxide sprays also resulted in significant increase of chemical parameters like total soluble solids, total sugars, juice content, anthocyanin content, ascorbic acid, acidity.

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