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ORIGINAL ARTICLE

Reducing the Incidence and intensity of Gummosis and fruit cracking on cherry trees (*Prunus avium* L.) through nutrient sprays

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ABSTRACT
From the present study it can be concluded that the foliar application of nutrients such as, 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 gummosis and fruit cracking.
Key words; *Gymosis, Zinc, boron, calcium, sprays, phenological stages, physiological disorders*

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INTRODUCTION

Gummosis is one of the major constraints in the production of quality stone fruits. Cherry is also severely affected by gummosis. In plants gum formation is induced both by biotic and abiotic stresses such as fungal infection, insect attack, flooding and mechanical or chemical injury. Factors which stimulate gum exudation also promote ethylene production in plant tissues. It is believed that ethylene is main factor for gum induction in stone fruits such as cherry, plum, peach, apricot, almond etc. Gummosis reduces tree growth, fruit yield and quality, thereby reducing its economic value. Gummosis starts with the onset of rains, attributed to rise in osmotic pressure of cells and breakage of cell walls at the weakest points and thus is considered a physiological disorder. The foliar application of borax with lime strengthens the cell wall and prevents gummosis besides maintaining hormonal balance to prevent fruit drop [1]. Keeping aforementioned facts in view to address the problem of gummosis, thereby reducing economic losses was under taken. While studying the hormonal control of gummosis in *Rosaceae,* it has been found that the main factor responsible for the induction of gummosis in stone fruits is ethylene [2]. [3] while investigating the hormonal regulation of gummosis in grape hyacinth bulbs found the application of ethepon, at 1 and 2 per cent (w/w) exceeded gums around th e basal plate of grape hyacinth bulbs. Moreover, the application of gaseous ethylene at .01 and .001 per cent (v/v) also induced gummosis in the hyacinth bulbs. [4] found the highest juice content (78.5%) in fruits of Indian gooseberry cv. 'NA7' treated with $CaCO_3$+ borax at 0.4 per cent followed by 0.4 per cent borax (77.1 %) and 0.4 per cent $CaCO_3$ and 0.6 per cent $CaCO_3$ (76.4 %).Minimum reading (74.2%) was recorded in control. In two years study with 'Anna' apple [5] observed significantly lower acidity of 0.44 and 0.42 per cent in fruits treated with 2.5 mg L^{-1} Fertifol Misr (N, P, K, Mg, Zn, Fe, Mn, Cu, Mo, and B) plus GA_3 at 20 ppm as compared to control fruits which recorded 0.56 and 0.53 per cent acidity during the first and second season, respectively. Foliar application of 0.8 per cent zinc sulphate to guava cv. 'L-49' resulted in an acid content of 0.31 per cent followed by 0.30 per cent recorded in 0.4 per cent borax treatment and least acid content of 0.02 per cent was observed in untreated fruits [6]. In Indian gooseberry cv. 'NA7' the acidity varied from 1.75 per cent in 0.2 per cent borax treated fruits as compared to maximum acidity of 2.47 per cent recorded in untreated fruits [4].

[7] observed that the foliar application of zinc sulphate and boric acid alone or in combination increased acidity of guava fruits. The highest acidity was recorded with the foliar application of 0.6 per cent zinc sulphate + 0.5 per cent boric acid (0.550%) followed by 0.5 per cent zinc sulphate + 0.6 per cent boric acid (0.546%) and the lowest was recorded in control (0.378 %). [4] found that maximum total soluble solids content of 16.20 per cent in fruits treated with 0.4 per cent calcium carbonate plus borax as compared to control which recorded a total soluble solids content of 14.50 per cent. The treatment application of calcium chloride and potassium chloride each at 2.0 per cent recorded significantly high total sugar content of 10.06 and 9.92 per cent, respectively as compared to that of control which recorded total sugar content of 8.30 per cent in sweet cherry. [6] recorded the highest total sugars of 7.51 per cent with foliar application of 0.4 per cent borax followed by 0.8 per cent zinc sulphate recording 7.05 per cent total sugars as compared to 6.10 per cent total sugars recorded in untreated fruits. [4] observed that the highest ascorbic acid in Indian gooseberry cv. 'NA7' was recorded in fruits treated with 0.4 per cent $CaCO_3$+ borax recording 626.49 mg 100^{-1} and minimum acid content of 610.7 mg 100^{-1} g was recorded in control. Foliar boron application has increased boron, potassium, calcium and magnesium content of the sound apple fruits [8]

MATERIAL AND METHODS

The present investigation to study the "To reduce the incidence and intensity of gummosis on cherry trees **(*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 **which were also significantly effective in alleviating to some extent the physiological disorders like gummosis and fruit cracking.** 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			

Gummosis incidence intensity (%)

The incidence of gummosis was measured from main trunk, three scaffold branches and nine branches/twigs from each tree. These were randomly selected and examined for the presence of gummosis and recorded as per cent gummosis incidence.

$$\text{Gummosis incidence (\%)} = \frac{\text{No. of gummosis units}}{\text{Total No. of assessed units}} \times 100$$

The per cent intensity of gummosis was calculated after rating the level of gummosis on branches and twigs on 0-5 scale adopted by [9] with little modifications.

Scale used for categorizing different levels of gummosis of cherry

Category	**Numerical value**	**Criterion**
I	0	No gummosis
II	1	0.1-10% of branch/twig surface area gummosis
III	2	10-20% of branch/twig surface area gummosis
IV	3	20-30% of branch/twig surface area gummosis
V	4	30-40% of branch/twig surface area gummosis
VI	5	More than 40% of branch/twig surface area gummosis

$$\text{Gummosis intensity (\%)} = \frac{\Sigma(nxV)}{NxS} \times 100$$

Where

n = number of branches or twigs in each category

V = numerical value of each category

N = number of branches or twigs examined, and

S = the maximum numerical value.

Organoleptic evaluation

The random sample of fruits from each treatment was taken and was used for sensory evaluation by a panel of four judges on the basis of external appearance of fruit colour, taste, firmness, aroma flesh colour skin colour. A five point hedonic scale was used for evaluation. Fruits scoring 5,4,3,2 and 1 were considered to be excellent, very good, good, fair and poor in quality.

Chemical characteristics

Juice content (%)

The content was measured by pressing out juice from a known pulp weight with the help of a laboratory model basket press. The quantity of the juice obtained was expressed as percent of pulp (v/w) by using the formula :

$$\text{Juice content} = \frac{\text{Volume of juice (ml)}}{\text{Weight of pulp (g)}} \times 100$$

Acidity (%)

The total titrable acidity was determined by titration as suggested by [10]. A known weight of sample was used. Mixed thoroughly with distilled water. The volume was made upto 250 ml and filtered through Whatman No.4 filter paper. Ten ml sample solution was titrated against N/10 NaOH using phenolphthalein as indicator. The total titrable acidity was determined in terms of malic acid on the basis of 1ml N/10 NaOH being equivalent to 0.0067 g anhydrous malic acid.

Total soluble solids (%)

The total soluble solids (TSS) content was directly read on hand refractometer (0-32% range) and the values corrected at 20^{o} C [10].

Total sugars (%)

Twenty five grams of fruit pulp thoroughly mixed with ditilled water in a waring beaker and 25 ml of lead acetate was added to extract the juice from filtrate. To this 25 ml of potassium oxalate was also added for removing excess lead, and volume was made upto 250 ml by adding distilled water. The solution was filtered through Whatman filter paper No.1 from the above aliquot 100 ml of solution was taken and hudrolysed by adding 100 ml of concentrated hydrochloric acid and kept overnight. The excess of HCL was neutralised by saturated sodium hydroxide solution. Total sugars were estimated by titrating solution against mixture containing 5 ml of each Fehling's solution A and B using methylene blue as indicator. The titration was continued till brick red colour appeared.

Ascorbic Acid (mg 100^{-1} g of fruit)

Ascorbic acid was estimated by titration method using 2, 6-dichloro indo phenol as suggested by [10]. A known weight of fruit pulp was macerated with the help of pestle and mortar containing 25 ml of 3 per cent metaphosphoric acid. The content, were quantitatively transferred into a 100 ml volumetric flask and the volume was made upto 1000 ml with 3 percent metaphosphoric acid and aliquot was titrated against standardised 2, 6-dichloro phenol indo phenol dye solution to a light but distinct rose pink colour point which persisted for more than five seconds. The results were expressed in mg of ascorbic acid 100^{-1} gram of fruit sample.

Anthocyanin (µg 100^{-1} g of fruit)

Total anthocyanin content was extracted by using 95 percent ethanol-1.5 N HCL (85:15) and estimation made by calorimetric procedure as suggested by Rangana [10]. 100 g fruit was blended with 100 ml of ethanolic HCL in a blender at high speed. The solution was transferred into a 500 ml glass stoppered volumetric flask using approximately 50 ml of ethanolic HCL for washing the blender jar and was stored overnight in a refrigerator at 4^{0}C. Next day solution was filtered through Whatman, No 1 paper using Buchnor funnel. The flask and the residue on the filter paper were repeatedly washed with ethanolic HCL until approximately 450 ml of extract was collected. Then the extract was transferred to another 500 ml volumetric flask and the volume was made upto 500 ml. Then about 2ml of the filtered extract was taken and made to 100 ml with ethanolic HCL to yield optical density measurement (OD) on spectrophotometer within the optimum range of the instrument. The optical density of samples were recorded at the length of maximum absorption.

Fruit Nutrient content K, Ca, Zn and B

Collection of fruit samples

Fruit sample was collected as per procedure suggested by [11].

Preparation of fruit samples

Samples of pulp were dried in oven and then grinded in an electric homogenizer. One gm of this powder was put in 250 ml conical flasks to which 15 ml of di-acid (nitricacid: perchloric acid, 9:4) was added. The flasks were covered with a glass lid and left overnight for auto digestion. Later, the flasks put on hot plate with low heat till dense brown fumes appeared, followed by keeping flasks on high temperature. Condensing of these fumes at the neck of the flask gave the indication of end point. The flasks were removed until 1-2 ml solution remained. After cooling, the volume was made upto 50 ml by adding distilled water. The solution was filtered through Whatman's filter paper No.1 and the filtrate was stored in plastic bottles for further analysis.

Fruit analysis

Potassium was estimated by 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).

Fruit cracking (%)

At first fruits were taken out of the box immediately after harvest to observe the number of cracked fruits.

$$\text{Fruit cracking (\%)} = \frac{\text{No. of cracked fruits}}{\text{Total number of observed fruits}} \times 100$$

Statistical Analysis

The data thus obtained in respect of various observations were statistically analyzed as described by [12]. 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

Table- 1:Effect of nutrient application on gummosis incidence and intensity, effect of nutrient sprays on organoleptic evaluation and effect of nutrient application on juice content and acidity in sweet cherry cv. Guigne Pourpera Precece (*Awal Number*)

Treatments	Treatment combination	Gummosis incidence (%)	Gummosis intensity (%)	Treatment combination	Organoleptic rating (1-5 points)	Treatment combination	Juice Content (%)	Acidity (%)
T_1	$ZnSO_4$ (0.2%)	23.66 (4.96)	10.50 (3.38)*	$ZnSO_4$ (0.2%)	3.37	$ZnSO_4$ (0.2%)	51.91	1.62 (1.61)*
T_2	CaO (0.5%)	21.50 (4.74)	8.00 (2.98)	CaO (0.5%)	3.52	CaO (0.5%)	45.57	1.44 (1.56)
T_3	H_3BO_3 (0.1%)	24.25 (5.82)	10.00 (3.30)	H_3BO_3 (0.1%)	3.76	H_3BO_3 (0.1%)	53.28	2.31 (1.81)
T_4	K_2SO_4 (0.3%)	25.00 (5.89)	11.50 (3.52)	K_2SO_4 (0.3%)	3.50	K_2SO_4 (0.3%)	50.88	1.94 (1.71)
T_5	($ZnSO_4$ + CaO)	24.45 (5.84)	8.25 (3.82)	($ZnSO_4$ + CaO)	3.47	($ZnSO_4$ + CaO)	50.32	1.68 (1.63)
T_6	($ZnSO_4$ + H_3BO_3)	23.50 (4.94)	9.30 (3.19)	($ZnSO_4$ + H_3BO_3)	3.37	($ZnSO_4$ + H_3BO_3)	54.02	2.42 (1.84)
T_7	($ZnSO_4$ + K_2SO_4	22.42 (4.83)	10.25 (3.34)	($ZnSO_4$ + K_2SO_4	3.37	($ZnSO_4$ + K_2SO_4	53.91	2.43 (1.85)
T_8	(CaO + H_3BO_3)	20.25 (4.68)	6.00 (2.62)	(CaO + H_3BO_3)	3.58	(CaO + H_3BO_3)	49.17	1.66 (1.63)
T_9	(CaO + K_2SO_4)	22.25 (4.81)	8.50 (2.87)	(CaO + K_2SO_4)	3.88	(CaO + K_2SO_4)	50.26	1.73 (1.65)
T_{10}	(H_3BO_3 + K_2SO_4)	23.66 (4.96)	10.75 (3.41)	(H_3BO_3 + K_2SO_4)	4.04	(H_3BO_3 + K_2SO_4)	55.22	2.86 (1.96)
T_{11}	($ZnSO_4$ + CaO + H_3BO_3)	22.75 (4.87)	9.85 (3.28)	($ZnSO_4$ + CaO + H_3BO_3)	3.57	($ZnSO_4$ + CaO + H_3BO_3)	53.69	2.78 (1.94)
T_{12}	(CaO + H_3BO_3 + K_2SO_4)	21.50 (4.74)	10.15 (3.33)	(CaO + H_3BO_3 + K_2SO_4)	4.14	CaO + H_3BO_3 + K_2SO_4)	55.87	2.67 (1.91)
T_{13}	($ZnSO_4$ + H_3BO_3 + K_2SO_4)	22.64 (4.85)	9.80 (3.27)	($ZnSO_4$ + H_3BO_3 + K_2SO_4)	4.01	$ZnSO_4$ + H_3BO_3 + K_2SO_4)	54.84	2.90 (1.97)
T_{14}	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	23.00 (4.89)	10.33 (3.35)	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	3.61	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	57.10	2.89 (1.97)
T_{15}	(Control)	29.00 (5.47)	15.30 (3.83)	(Control)	2.47	(Control)	48.72	1.42 (1.55)
	C.D ($p \le 0.05$)	0.02	0.05	C.D ($p \le 0.05$)	0.68	C.D ($p \le 0.05$)	0.02	0.01

*Figures in parenthesis are square root transformed values

The data presented in Table 1, revealed that the nutrient sprays significantly reduced the gummosis incidence. Trees treated with 0.5% CaO% + 0.1% H_3BO_3 resulted in a significant decrease in incidence of gummosis, recording a percentage of 20.25 followed by 21.50 per cent observed in trees treated either with 0.5% CaO alone or 0.5% CaO+ 0.1% H_3BO_3 + 0.3% K_2SO_4. The highest gummosis incidence of 29.00 per cent was recorded in untreated trees.

Gummosis intensity

Gummosis intensity ranged from 6.00 to 11.50 per cent in various treatments Table 2,. Trees treated with 0.5% CaO + 0.1% H_3BO_3 recorded significantly minimum gummosis intensity (6.00%) followed by the trees treated with 0.5% CaO alone, recording a gummosis intensity of 8.00 per cent. Significant differences in percentage of gummosis intensity were observed between different treatments. Highest percentage of gummosis intensity to the tune of 15.30 per cent was observed in untreated trees.

The findings recorded during the course of study revealed that gummosis incidence and intensity was decreased significantly with the foliar application of boric acid + calcium oxide followed by calcium oxide alone. These findings are in conformity with the results obtained by [1] in almond wherein foliar application of various treatments such as borax + lime at 0.5 per cent and 1 per cent during different growth stages reduces the gummosis incidence and intensity followed by lime alone at 1.0-2.5 per cent concentration. The reduction may be due to foliar application of borax with lime which strengthens the cell wall and prevents gummosis. The borax also helps in carbohydrate mobilization possibly forming borate complex and enhancing the formation of lignin and suberine to make the cells strong Organoleptic rating as assessed by a panel of judges on 5.00 point numerical scale, varied from 3.37 to 4.14 (Table 1). Significantly improved organoleptic rating of 4.14 points was recorded in fruits treated with 0.5% CaO + 0.1% H_3BO_3 + 0.3% K_2SO_4 followed by 4.04 points in fruits treated with 0.1% H_3BO_3 + 0.3% K_2SO_4 which was, however at par with all other treatments excepting control which recorded lowest organoleptic reading of 2.47 points. Similar, results were observed by [13])

Chemical characteristics

Juice content ranged from 45.57 to 57.10 ml 100^{-1} g fruit in various treatments (Table 1). Fruits treated with 0.5% CaO alone or in combination generally showed a decreasing trend in fruit juice content as compared to other treatments. Fruits treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 + 0.5% CaO recorded the highest (57.10 ml 100^{-1} g) juice yield. Lowest yield of 45.57 ml 100^{-1} g was recorded in fruits treated with 0.5% CaO followed by 48.72 ml 100^{-1} g in control. Juice content in the present study was increased significantly the application of Zn + B + K + Ca followed by Zn + B + K in comparison to control. [14] have reported similar increase in juice content of grapes with the application of potassium sulphate at 1.0 per cent. The results obtained are in conformity with those of [15] who reported maximum juice content with spray of boric acid at full bloom of pomegranate.

Fruit acidity was significantly influenced by the nutrient sprays. It ranged from 1.44 to 2.90 per cent in terms of maleic acid (MA) in different treatments (Table 2). Significantly higher acid content (2.90 %) was recorded in fruits treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 which was, however statistically at par with 2.89 per cent recorded in fruits treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 + 0.5% CaO. Lowest acid content (1.42 %) was recorded in untreated fruits.

Fruit acidity was significantly influenced by the nutrient treatments. It ranged from 1.42-2.90 per cent in terms of maleic acid (MA) in different treatments. Significantly higher acid content (2.90 %) was recorded in fruits treated with Zn + B + K and lowest acid content of 1.42 per cent was recorded in untreated fruits. Application of 0.6 per cent zinc sulphate + boric acid has been ported to increase the acid content in fruits of guava [7].

The total soluble solids (TSS) content varied from 12.33 to 15.73 per cent in fruits treated with different treatments (Table 2). Perusal of the data revealed that all the nutrient treatments enhanced total soluble solids content of the fruits. Significantly highest (15.73 per cent) total soluble solids content was recorded in fruits treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 + 0.5% CaO followed by 15.66 per cent observed in fruits treated with 0.1% H_3BO_3 alone. Lowest (11.54 %) total soluble solids.

Present results are in conformity to the results obtained by [16] who found that the highest total soluble solids were observed in mango treated with potassium nitrate. He also observed that $ZnSO_4$ in case of cv. Langra and boric acid in case of cv. Alphanso. [6] found that TSS can be obtained with the foliar application of borax 0.4 per cent followed by $ZnSO_4$ 0.8 per cent. Increase in TSS might be that boron helps in sugar transport.

The nutrient sprays of calcium, boron, zinc and potassium compounds significantly influenced the total sugar content in cherry fruits at harvest. The total sugar content varied from 9.10 to 13.75 (Table 2). Significantly high (13.75 %) total sugar content was recorded in fruits treated with 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 + 0.5% CaO followed by 13.66 per cent total sugar content recorded in fruits treated with 0.1% H_3BO_3. Lowest reading (7.99 %) was recorded in the untreated fruits.

In the present studies combined application of zinc sulphate, boric acid, potassium sulphate and calcium oxide treatments resulted in significantly higher sugars than the control. [17] in date palm observed that boron and potassium spraying treatments significantly increased fruit chemical characteristics including total sugars. Potassium and boron is considered to be functional in the transport of carbohydrates and translocation of sugars [18].

The ascorbic acid content in the treated samples varied with the treatments of nutrient components and it ranged from 9.44 to 11.84 mg 100^{-1} g of fruit pulp (Table 2). Significantly higher ascorbic acid content of 11.84 mg 100^{-1} g of fruit pulp was recorded in fruits sprayed with nutrient combination of 0.2% $ZnSO_4$ + 0.1% H_3BO_3 + 0.3% K_2SO_4 + 0.5% CaO) followed by 11.01 mg 100^{-1} g of fruit pulp recorded in fruits sprayed with 0.1% H_3BO_3 + 0.3% K_2SO_4. Lower reading of 8.76 mg 100^{-1} g of fruit pulp was recorded in untreated fruits.

The best results during the present investigation were obtained by the application of Zn + B + K + Ca followed by B + K, which was found significantly superior to control. [19] has recorded a significant increase in ascorbic acid content by the application of Mn, K, Ca and B at 20 mg L^{-1}, 1 per cent, 2 per cent and 2000 mg L^{-1} respectively. [20] in strawberry also found the similar results and observed that highest vitamin C content was observed in maximum concentration of $ZnSO_4$ and boric acid (300-200 mg L^{-1} Zn + B). This increase in vitamin C content might be due to continued synthesis of its precursor like glucose-6 phosphate during conversion of starch into various sugars and slow rate of oxidation.

The anthocyanin content varied from 41.23 to 44.73 μg 100^{-1} g fruit pulp under different treatments at the time of harvest (Table 2). The highest anthocyanin content of 44.73 μg 100^{-1} g of fruit pulp was recorded in fruits sprayed with nutrient combination of 0.5% CaO + 0.1% H_3BO_3 + 0.3% K_2SO_4 followed by 44.43 μg 100^{-1} g of pulp recorded in fruits treated with 0.1% H_3BO_3 + 0.3% K_2SO_4. In case of control fruits, an average anthocyanin content of 38.03 μg 100^{-1} g of fruit pulp was recorded.

Table- 2 : Effect of nutrient application on TSS and total sugars and effect of nutrient sprays on ascorbic acid and anthocyanin content in sweet cherry cv. Guigne Pourpera Precece (*Awal Number*)

Treatments	Treatment combination	TSS (%)	Total sugars (%)	Treatment combination	Ascorbic acid (mg^{-100} g)	Anthocyanin (μg^{-100} g)
T_1	$ZnSO_4$ (0.2%)	13.00 (3.74)	9.57 (3.22)*	$ZnSO_4$ (0.2%)	9.44	42.93
T_2	CaO (0.5%)	12.33 (3.64)	9.10 (3.15)	CaO (0.5%)	9.53	42.50
T_3	H_3BO_3 (0.1%)	15.66 (4.08)	13.66 (3.39)	H_3BO_3 (0.1%)	9.82	43.90
T_4	K_2SO_4 (0.3%)	14.33 (3.91)	9.52 (3.22)	K_2SO_4 (0.3%)	9.81	42.86
T_5	($ZnSO_4$ + CaO)	13.00 (3.74)	8.00 (3.97)	($ZnSO_4$ + CaO)	10.62	42.06
T_6	($ZnSO_4$ + H_3BO_3)	13.12 (3.75)	10.92 (3.43)	($ZnSO_4$ + H_3BO_3)	9.72	43.40
T_7	($ZnSO_4$ + K_2SO_4	12.73 (3.70)	10.57 (3.38)	($ZnSO_4$ + K_2SO_4	9.80	41.23
T_8	(CaO + H_3BO_3)	14.00 (3.87)	11.09 (3.45)	(CaO + H_3BO_3)	10.05	43.16
T_9	(CaO + K_2SO_4)	14.12 (3.88)	9.94 (3.28)	(CaO + K_2SO_4)	10.20	41.33
T_{10}	(H_3BO_3 + K_2SO_4)	15.00 (3.99)	10.02 (3.29)	(H_3BO_3 + K_2SO_4)	11.01	44.43
T_{11}	($ZnSO_4$ + CaO + H_3BO_3)	13.56 (3.81)	11.73 (3.55)	($ZnSO_4$ + CaO + H_3BO_3)	10.09	43.73
T_{12}	CaO + H_3BO_3 + K_2SO_4)	15.33 (4.04)	12.05 (3.59)	(CaO + H_3BO_3 + K_2SO_4)	10.44	44.73
T_{13}	$ZnSO_4$ + H_3BO_3 + K_2SO_4)	15.45 (4.05)	12.65 (3.67)	($ZnSO_4$ + H_3BO_3 + K_2SO_4)	10.34	43.06
T_{14}	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	15.73 (4.08)	13.75 (3.82)	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	11.84	44.20
T_{15}	(Control)	11.54 (3.53)	7.99 (2.96)	(Control)	8.76	38.03
	C.D ($p \leq 0.05$)	0.05	0.01	C.D ($p \leq 0.05$)	0.15	0.26

*Figures in parenthesis are square root transformed values

[21] reported that anthocyanin content in mature 'Buttner Red' sweet cherry increased with foliar application of boron. Our results on colouration of fruit are further supported by the work of [22] who

showed that 'Santa Rosa' plum treated with pre-harvest spray of boric acid produced significant effect on anthocyanin content.

The effect of various nutrient sprays on fruit K content was highly significant (Table 3). Higher fruit K content of 2.76 per cent was observed in fruits treated with nutrient spray of 0.1% H_3BO_3 + 0.3% K_2SO_4 and the lowest fruit K content (1.60 %) was recorded in the untreated fruits. Further, perusal of Table 13 revealed that higher K accumulation was observed in the fruits treated with nutrient sprays containing either 0.3% K_2SO_4 alone or in combination

The effect of various nutrient sprays on fruit calcium (Table 3) was highly significant. Highest fruit calcium content of 4.88 per cent was observed in a nutrient spray of 0.1% H_3BO_3 + 0.3% K_2SO_4 + 0.5% CaO followed by 4.72 per cent fruit calcium content recorded in the fruits treated with 0.5% CaO + 0.1% H_3BO_3. The lowest fruit calcium content of 3.27 per cent was recorded in untreated fruits. The fruit zinc content varied from 70.00 to 88.00 ppm under different nutrient spray treatments of cherry (Table 3). Highest zinc content (88.00 ppm) was recorded in the fruits treated with a nutrient spray of 0.2% $ZnSO_4$ + 0.1% H_3BO_3 and the lowest reading (66.5 ppm) of zinc was recorded in the untreated fruits. Perusal of the data presented in the Table 3 also reveals that the fruits treated with nutrient spray of zinc either alone or in combination with other nutrients showed an increased trend in zinc accumulation as compared to rest of the treatments.

Fruit boron content ranged from 16.29 to 23.85 ppm under different treatments at the time of harvest. Highest content (23.85 ppm) of boron was recorded in fruits treated with nutrient spray of 0.1% H_3BO_3 + 0.3% K_2SO_4 + 0.5% CaO and the lowest reading of 14.38 ppm was recorded in untreated fruits (Table 3). Further, as is evident from the Table 3, the nutrient sprays containing boron alone or in combination with other nutrients showed an increased trend in the accumulation of boron in the fruit as compared to other treatments.

Table- 3:Effect of nutrient sprays on fruit K and Ca contentand effect of Nutrient application on fruit zinc and boron content in sweet cherry cv. Guigne Pourpera Precece (*Awal Number*)

Treatments	Treatment combination	Fruit K (%)	Fruit Ca (%)	Treatment combination	Fruit Zn (ppm)	Fruit B (ppm)	Fruit cracking (%)	Fruit cracking (%)
T_1	$ZnSO_4$ (0.2%)	1.80 (1.67)	3.30 (2.06)*	$ZnSO_4$ (0.2%)	86.00	16.47	2.78 (1.94)*	2.78 (1.94)*
T_2	CaO (0.5%)	1.73 (1.65)	4.15 (2.26)	CaO (0.5%)	70.00	16.29	2.10 (1.94)	2.10 (1.94)
T_3	H_3BO_3 (0.1%)	1.88 (1.69)	3.61 (2.14)	H_3BO_3 (0.1%)	70.50	21.25	2.47 (1.76)	2.47 (1.76)
T_4	K_2SO_4 (0.3%)	2.05 (1.74)	3.22 (2.05)	K_2SO_4 (0.3%)	71.00	16.43	2.80 (1.86)	2.80 (1.86)
T_5	($ZnSO_4$ + CaO)	1.75 (1.65)	4.41 (2.32)	($ZnSO_4$ + CaO)	85.00	16.55	2.71 (1.92)	2.71 (1.92)
T_6	($ZnSO_4$ + H_3BO_3)	1.62 (1.61)	3.88 (2.20)	($ZnSO_4$ + H_3BO_3)	88.00	23.43	2.73 (1.93)	2.73 (1.93)
T_7	($ZnSO_4$ + K_2SO_4	2.33 (1.82)	3.79 (2.18)	($ZnSO_4$ + K_2SO_4	86.00	17.40	2.74 (1.93)	2.74 (1.93)
T_8	(CaO + H_3BO_3)	1.71 (1.64)	4.72 (2.39)	(CaO + H_3BO_3)	71.00	21.46	2.25 (1.80)	2.25 (1.80)
T_9	(CaO + K_2SO_4)	2.15 (1.77)	4.48 (2.33)	(CaO + K_2SO_4)	72.00	16.96	2.30 (1.81)	2.30 (1.81)
T_{10}	(H_3BO_3 + K_2SO_4)	2.76 (1.93)	3.94 (2.22)	(H_3BO_3 + K_2SO_4)	71.50	21.82	2.64 (1.90)	2.64 (1.90)
T_{11}	($ZnSO_4$ + CaO + H_3BO_3)	1.85 (1.68)	4.51 (2.34)	($ZnSO_4$ + CaO + H_3BO_3)	85.50	23.75	2.63 (1.90)	2.63 (1.90)
T_{12}	(CaO + H_3BO_3 + K_2SO_4)	2.20 (1.78)	4.88 (2.42)	(CaO + H_3BO_3 + K_2SO_4)	86.00	23.85	2.00 (1.73)	2.00 (1.73)
T_{13}	($ZnSO_4$ + H_3BO_3 + K_2SO_4)	2.23 (1.79)	3.96 (2.22)	($ZnSO_4$ + H_3BO_3 + K_2SO_4)	87.00	23.21	2.60 (1.89)	2.60 (1.89)
T_{14}	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	2.18 (1.78)	4.45 (2.33)	($ZnSO_4$ + H_3BO_3 + K_2SO_4 + CaO)	86.50	23.07	2.52 (1.87)	2.52 (1.87)
T_{15}	(Control)	1.60 (1.61)	3.27 (2.07)	(Control)	66.50	14.38	3.54 (2.13)	3.54 (2.13)
	C.D ($p \leq 0.05$)	0.01	0.01	C.D ($p \leq 0.05$)	2.05	1.54	0.01	0.01

*Figures in parenthesis are square root transformed values with other nutrients as compared with rest of the treatments.

Foliar application of treatments significantly increases the fruit nutrient of cherries. Fruit potassium showed a significant increase by the application of boric acid and potassium sulphate. While as calcium and boron content was enhanced by the combined application of boric acid, potassium sulphate and calcium oxide. However, zinc content showed a significant increase when treated with a combined foliar spray of zinc sulphate and boric acid. [8] reported that boron spray treatment increased B, K and Mg content of the sound fruits of apple. Boron and potassium spray markedly increased fruit contents of macro and micro nutrients [17].

The data presented in Table 3, revealed that fruit cracking varied from 2.00 to 2.80 per cent under different treatments. Significantly less (2.00 per cent) fruit cracking was observed in fruits treated with 0.5% CaO + 0.1% H_3BO_3 , + 0.3% K_2SO_4 followed by 2.10 per cent fruit cracking observed in fruits treated 0.5% CaO alone. Highest (3.54 %) fruit cracking was observed in fruits of control. Further, perusal of Table 3 also revealed that all the nutrient treatment combinations involving calcium showed a decreased trend in fruit cracking. The effect of treatments on fruit cracking in the present investigation revealed that the combined foliar application of Ca + B + K significantly reduced the cracking of fruits followed by Ca alone. Studies suggest that calcium, together with potassium plays a very important physiological role in controlling of plasma colloids and the strength of the cell walls. The most of physiological and storage disorders of fruits are correlated positively with calcium deficiency.

CONCLUSION

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 gummosis and fruit cracking.

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