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Efficacy of Foliar Nutrient Sprays on Vegetative Traits of Sweet Cherry cv. Regina under High Density Plantation

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ABSTRACT: To know the scale of efficacy of nutrients in upholding the vegetative health of sweet cherry and to find out the best treatment combination, two micronutrients (boron and zinc) and a macronutrient (potassium) were sprayed solo and in combinations at the time of white bud stage (>50%), in the form of boric acid (H_3BO_4), zinc sulphate heptahydrate ($ZnSO_4$. $7H_2O$) and potassium sulphate (K_2SO_4). The details of the treatments were as; T_0= Control; T_1= H_3BO_4@0.15%; T_2= $ZnSO_4$@0.25%; T_3= K_2SO_4@10%; T_4= H_3BO_4@0.15%+ $ZnSO_4$@0.25%; T_5= H_3BO_4@0.15%+ K_2SO_4@0.40%; T_6= $ZnSO_4$@0.25%+ K_2SO_4 @0.40%; T_7= H_3BO_4 @0.15%+ $ZnSO_4$@0.25%+ K_2SO_4@0.40%. Zinc sulphate heptahydrate ($ZnSO_4$. $7H_2O$) sprays, solo or in combination with boric acid and potassium sulphate showed more efficacy in promoting the growth characteristics of sweet cherry cv. Regina. However, during both the seasons of investigation treatment combination T_7 (H_3BO_4 @0.15% + $ZnSO_4$@0.25%+ K_2SO_4@0.40%) showed the highest efficacy in maintaining the overall vegetative vigour of the sweet cherry cv. Regina.

Keywords: Sweet cherry, nutrient sprays, efficacy, plant health and leaf area.

INTRODUCTION

Cherry is one of the most cherished fruits recognised by buyers because of its quality characteristics, great calorific value, and bioactive compounds (Jan *et al*., 2020). However, commercial yield and quality produce are only possible when the plant adequately receives the nutrients for attaining proper vegetative structure to support the sink photosynthate supply (Taiz and Zeiger, 2010). Sweet cherry trees are most often infected by the bacterial canker (Spotts *et al*., 2010; Thomidis and Exadaktylou, 2008) thereby reducing the vigour of the plant to support the crop load properly. Therefore, proper nutrition is indispensable in upholding a healthy and productive sweet cherry orchard. Plant nutrients are actively involved in plant structure, carbohydrate metabolism, and electron transport. Potassium, which plays a role in physiological processes such as osmotic regulation, cell division and transport of sugars and photo assimilates (Liu *et al*., 2000; Wang *et al*., 2013). Zinc is acritical nutrient element that affects many physiological and vegetative processes in plants (Marschner, 2012). Each nutrient element has specialized functions in the plant and the shortage of a certain nutrient element cannot be eradicated by another nutrient element (Durner, 2013). The key to obtaining fruit with desired quality characteristics is the regulation of vegetative characteristics as these, directly and indirectly, determine the quality of the produce. In general, fruit trees produce small fruits due to unhealthy growth and improper balance between the vegetative and generative structures (Whiting and Lang, 2004). The ratio of leaves to fruit is an important parameter that govern the crop load and size of fruits. The prime quality of sweet cherry fruit is attained with 10 fruit per cm^2 of branch cross-sectional area (Bound, 2013). An increase in the leaves: fruit ratio is linked with an increase in the mass and content of the extract and an increase in the ratio of sugars to acids. With anoptimum leaves: fruit area, the fruits attain deeper colour and show advanced maturity (Usenik *et al*., 2010). In the backdrop of above mentioned facts, this study was conducted with an intention to determine the efficacy of solo and combined of boron, zinc and potassium treatments on certain significant vegetative parameters in sweet cherry cv. Regina.

MATERIAL AND METHODS

The study was carried out in the high density experimental sweet cherry orchard at SKUAST-K, Shalimar, Srinagar, during two consecutive years 2019 and 2020 on six years old sweet cherry trees cv. Regina (Fig. 1). The plants having uniform vigour and size were selected for the study. Two micronutrients (H_3BO_4 and $ZnSO_4$) and a macronutrient (K_2SO_4) were sprayed solo and in combinations at the time of white bud stage (>50%). The details of the treatment composition were as; T_0= Control; T_1= H_3BO_4@0.15%; T_2= $ZnSO_4$@0.25%; T_3= K_2SO_4@10%; T_4= H_3BO_4@0.15%

+ $ZnSO_4$@0.25%; T_5= H_3BO_4@0.15% + K_2SO_4@0.40%; T_6= $ZnSO_4$@0.25%+ K_2SO_4 @0.40%; T_7= H_3BO_4 @0.15% + $ZnSO_4$@0.25%+ K_2SO_4@0.40%. Treatments were replicated thrice in a randomized block design (RBD), each replicate consisted of single tree. The study included eight (08) treatments and number of cherry trees (experimental units) selected were twenty four (24).

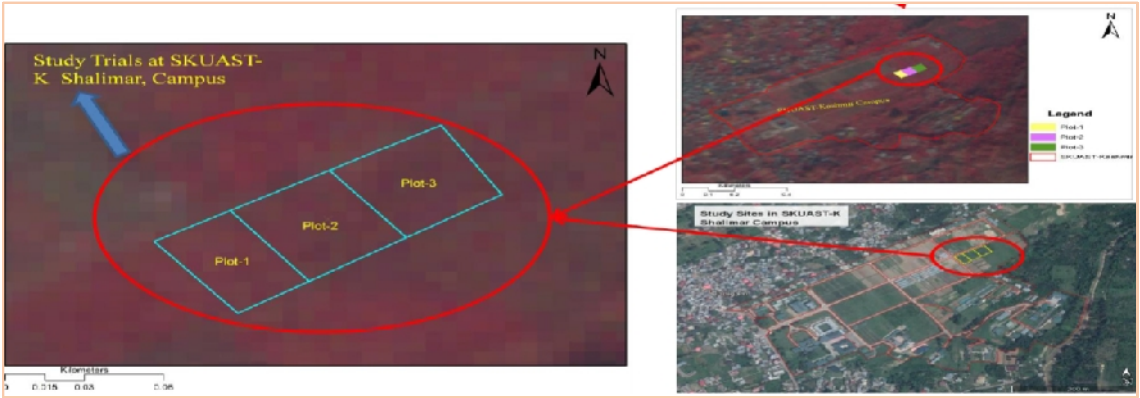

Fig. 1. Map showing the experimentation site in the SKUAST-Kashmir, Shalimar campus, India.

Vegetative growth parameters were measured according to the standard procedures as follows;

Incremental tree height (%): This was taken before the beginning and after the end of the growing period with the assistance of a graduated stuff and expressed in percentage (Fig. 2).

Incremental tree spread (%): Initial and final measurements were taken with the help of measuring tape across the tree in north-south and east-west directions. The enhancement in spread was operated upon and was represented as per cent increment

Incremental tree volume (%): The volume of tree was calculated by using the formula given by Westwood (Westwood, 1993): "For a tree that is taller than its width; Tree volume $= \frac{4}{3}\pi\, ab^2$; where, π = 3.1428, a = ½ of the major axis, b = ½ of the minor axis"

Incremental trunk cross sectional area (%): The TCSA was calculated by using the following formula; Trunk cross section area $(cm^2) = \frac{Girth^2}{4\pi}$

Annual shoot extension growth (cm): Ten shoots were selected randomly from the periphery of each tree at shoulder height at the cessation of development and the average extension growth was expressed in centimetres.

Leaf area (cm^2): Twenty five leaves were collected at random from the periphery of each experimental plant and the area of the leaf was obtained using Systronics leaf area meter-211 (Fig. 2).

Data was analysed using SPSS-22 and OPStat softwares.

Fig. 2. Leaf area and tree height measurement using Systronics leaf area meter-211 (left) and measuring stuff (right), respectively.

RESULTS AND DISCUSSION

The present studies revealed that all the nutrient sprays exhibited a significant influence on the vegetative growth parameters. Growth characteristics in terms of incremental tree height (10.76 and 10.84%) (Fig. 3), incremental tree spread (24.65 and 24.75%), incremental tree volume (37.94 and 38.02%), incremental trunk cross-sectional area (11.08 and 11.12%), annual shoot extension growth (32.14 and 32.27cm)and leaf area (74.45 and 74.50cm^2) (Table 1, 2 and 3) were found significantly higher ($P < 0.05$) in treatment combination T_7 (H_3BO_4 @0.15% + $ZnSO_4$@0.25%+ K_2SO_4@0.40%) as compared to the rest of the treatments during both the seasons of experimentation.

Table 1: Influence of nutrient sprays on incremental tree height and spread in sweet cherry cv. Regina.

Treatment	Incremental tree height (%)			Incremental tree spread (%)		
	2019	2020	Pooled	2019	2020	Pooled
T_0	9.03	9.09	9.06	23.05	23.12	23.09
T_1	9.64	9.70	9.67	23.83	23.89	23.86
T_2	9.71	9.78	9.75	23.84	23.94	23.89
T_3	9.10	9.17	9.14	23.20	23.29	23.25
T_4	10.55	10.62	10.59	24.50	24.60	24.55
T_5	10.16	10.23	10.20	23.91	24.01	23.96
T_6	10.24	10.31	10.28	24.02	24.13	24.08
T_7	10.76	10.84	10.80	24.65	24.75	24.70
CD. ($p\leq0.05$)	**0.04**	**0.06**	**0.06**	**0.06**	**0.05**	**0.04**

T_0= Control; T_1= H_3BO_4@0.15; T_2= $ZnSO_4$@0.25; T_3= K_2SO_4@10; T_4= H_3BO_4 + $ZnSO_4$@0.15 + 0.25; T_5= H_3BO_4 + K_2SO_4@0.15 + 0.40; T_6= $ZnSO_4$ + K_2SO_4@0.25 + 0.40; T_7= H_3BO_4 + $ZnSO_4$ + K_2SO_4@0.15 + 0.25+0.40 (Concentration in %).

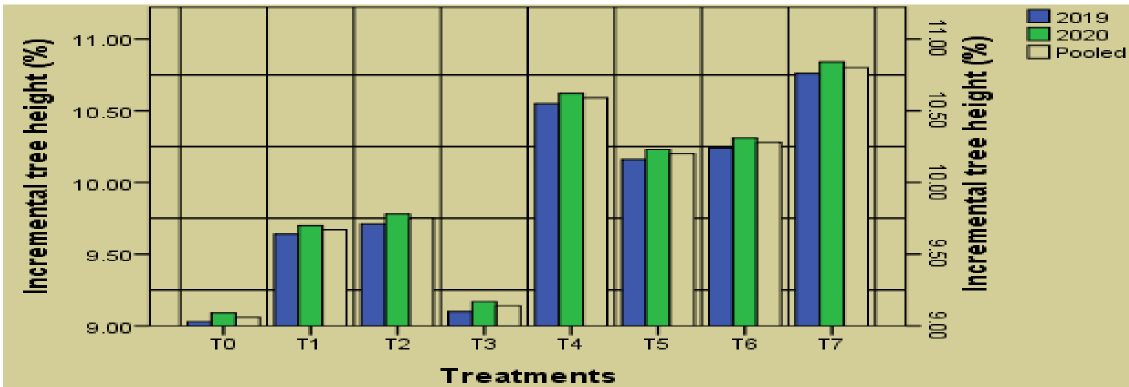

Fig. 3. Cluster graph showing the year-wise efficacy of nutrient sprays on incremental tree height of sweet cherry.

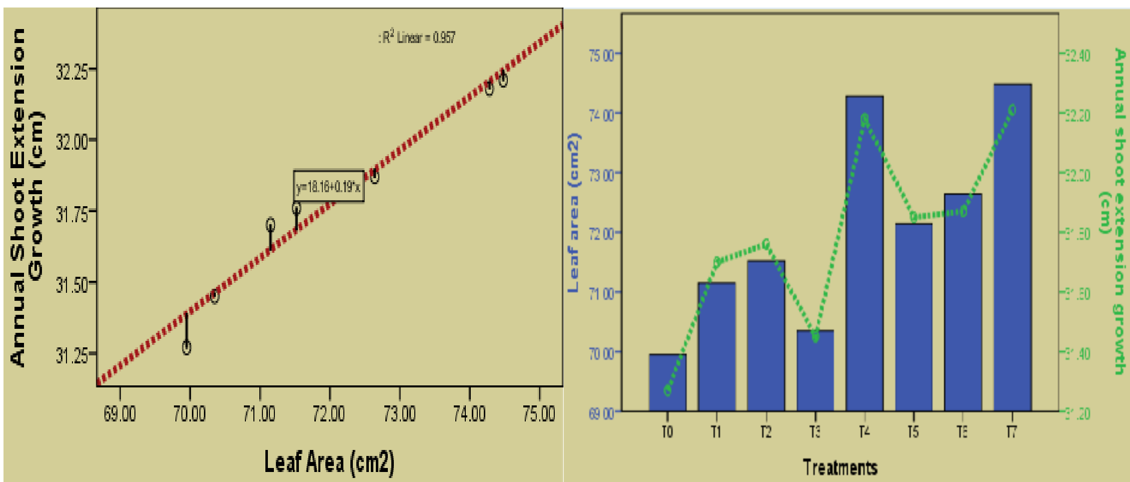

Fig. 4. Scatter diagram (left) and dual axis bar graph (right): showing the strong positive correlation (r=0.978; R^2=0.957) between leaf area (cm^2) and annual shoot extension growth (cm) in sweet cherry cv. Regina.

Further, correlation studies showed a strong positive relationship (r=0.978; R^2=0.957) between leaf area and annual shoot extension growth (Fig. 4). In general, zinc sulphate ($ZnSO_4$) sprays, solo or in combinations with boric acid and potassium sulphate showed more efficacy in promoting the growth characteristics of sweet cherry cv. Regina.

These results obtained are in concurrence with the findings of Dhurve *et al*., (2018) and Mosa *et al*., (2015) who reported significant increment in the growth characteristics with the application of different plant growth regulators in apple and pomegranate, respectively. Significant increase in tree growth characters with potassium, boron and zinc applications have also been reported by El-Shazly and Dris (2004). Improvement in growth characteristics of sweet cherry by nutrient sprays may be attributed to the fact that potassium enhances tree growth because it is a stimulator of enzymes associated with the synthesis of proteins and plays a key part in translocation of carbohydrates during photosynthesis (Liu *et al*., 2000). Potassium is also actively involved in the chlorophyll formation process (Malik and Srivastava, 2000).

Table 2: Influence of nutrient sprays on incremental volume and tree TCSA in sweet cherry cv. Regina.

Treatment	Incremental tree volume (%)			Incremental tree TCSA (%)		
	2019	2020	Pooled	2019	2020	Pooled
T_0	36.34	36.42	36.38	9.88	9.95	9.91
T_1	37.00	37.07	37.04	10.42	10.48	10.45
T_2	37.08	37.15	37.12	10.48	10.55	10.52
T_3	36.53	36.61	36.57	10.11	10.18	10.15
T_4	37.65	37.75	37.70	10.87	10.94	10.91
T_5	37.12	37.22	37.17	10.54	10.61	10.58
T_6	37.24	37.33	37.28	10.66	10.70	10.68
T_7	37.94	38.02	37.98	11.08	11.12	11.10
CD. ($p \leq 0.05$)	**0.06**	**0.11**	**0.07**	**0.12**	**0.04**	**0.05**

T_0= Control; T_1= H_3BO_4@0.15; T_2= $ZnSO_4$@0.25; T_3= K_2SO_4@10; T_4= H_3BO_4 + $ZnSO_4$@0.15 + 0.25; T_5= H_3BO_4 + K_2SO_4@0.15 + 0.40; T_6= $ZnSO_4$ + K_2SO_4@0.25 + 0.40; T_7= H_3BO_4 + $ZnSO_4$ + K_2SO_4@0.15 + 0.25+0.40 (Concentration in %).

The increase in growth due to application of boron could be ascribed to its role in nitrogen metabolism, phytohormones regulation and active cell proliferation. Further, zinc plays a crucial role in biosynthesis of tryptophan (Hassan *et al*., 2020), a precursor of indole-3 acetic acid. It is involved in several enzymes in plant metabolic processes and osmoregulation of plants (Broadley *et al*., 2007; Gupta *et al*., 2011).

Table 3: Influence of nutrient sprays on incremental annual shoot extension growth and leaf area in sweet cherry cv. Regina.

Treatment	Annual shoot extension growth (cm)			Leaf area (cm^2)		
	2019	2020	Pooled	2019	2020	Pooled
T_0	31.22	31.31	31.27	69.92	69.98	69.95
T_1	31.66	31.74	31.70	71.12	71.17	71.15
T_2	31.71	31.80	31.76	71.49	71.54	71.52
T_3	31.41	31.49	31.45	70.32	70.38	70.35
T_4	32.14	32.22	32.18	74.25	74.31	74.28
T_5	31.80	31.90	31.85	72.11	72.17	72.14
T_6	31.81	31.93	31.87	72.62	72.67	72.64
T_7	32.14	32.27	32.21	74.45	74.50	74.48
CD. ($p \leq 0.05$)	**0.02**	**0.05**	**0.04**	**0.03**	**0.13**	**0.07**

T_0= Control; T_1= H_3BO_4@0.15; T_2= $ZnSO_4$@0.25; T_3= K_2SO_4@10; T_4= H_3BO_4 + $ZnSO_4$@0.15 + 0.25; T_5= H_3BO_4 + K_2SO_4@0.15 + 0.40; T_6= $ZnSO_4$ + K_2SO_4@0.25 + 0.40; T_7= H_3BO_4 + $ZnSO_4$ + K_2SO_4@0.15 + 0.25+0.40 (Concentration in %).

CONCLUSION

Commercial yield and quality produce are only possible when the plant sufficiently receives the nutrients for attaining proper vegetative structure to support the sink photosynthate supply. Proper nutrition is indispensable in upholding a healthy and productive sweet cherry orchard. In this study, all the vegetative characteristics were significantly influenced by the foliar nutrient sprays, regardless of the treatment. Treatment combinations containing zinc showed higher efficacy in promoting the vigour of sweet cherry when compared to the rest of the treatments. Treatment combination T_7 (H_3BO_4@0.15%+ $ZnSO_4$@0.25%+ K_2SO_4@0.40%) proved to be best in upholding the overall plant health.

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Conflict of Interest: Authors have declared that no competing interests exist.

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