Effect of foliar application of orthosilicic acid on leaf and fruit nutrient content of apple cv. "Red Delicious".

Original Research Article

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ABSTRACT

Present investigation on the "Effect of foliar application of orthosilic acid on leaf and fruit nutrient content of apple cv. Red Delicious." was undertaken at a private orchard Pulwama during 2014 and 2015. The experiment comprising of five treatments viz, control, orthosilicic acid @ 0.5 ml/litre, 0.75 ml/litre, 1.5 ml/litre and 3.0 ml/litre was laid out in Randomized Complete Block Design with three replications. The trees were treated with foliar sprays of orthosilicic acid at green tip stage, petal fall stage, fruitlet stage, fruit development stage-II and fruit development stage-III. The results revealed that leaf and fruit nutrient content was significantly affected by treatments. Maximum leaf N (2.18 and 2.15 %), P (0.30 and 0.27 %), K(2.21 and 2.18 %) and Ca (1.95 and 1.90 %) content and fruit N (0.53 and 0.57 %), P (0.052 and 0.057 %), K (0.65 and 0.69 %) and Ca (0.060 and 0.064 %) content was recorded in trees sprayed with orthosilicic acid @ 3.0 ml/litre during the two years respectively which was at par with leaf N (2.07 and 2.04 %), P (0.28 and 0.24 %), K (2.09 and 2.03 %) and Ca (1.85 and 1.81 %) content and fruit N (0.51 and 0.55 %), P (0.050 and 0.053 %). K (0.63 and 0.66 %) and Ca (0.058 and 0.062 %) content in trees sprayed with orthosilicic acid @ 1.5 ml/litre. In conclusion the result of this study highlights the role of silicon in improving nutrient content in apple.

Keywords :

Apple, foliar spray, orthosilicic acid, leaf nutrient content.

I. INTRODUCTION

Apple (*Malus×domestica* Borkh.) an important temperate fruit of the North-Western Himalayan region has been under cultivation since time immemorial. It is a typical temperate tree fruit, more than 80% of the world's supply being produced in Europe. Apple is believed to have originated in the Caucasus mountains of south-western Asia, where the native *Malus* species could have mixed and given fruits of a size and quality attractive to man. The apple has existed in Europe, both in wild and in cultivated forms, from time immemorial and appears to have been developed there at the beginning of the Christian era. The westward movement of the apple from Europe was a natural sequence of colonization of North America by the early settlers. Apple belongs to family Rosaceae, subfamily Pomoideae, genus Malus with 17 basic chromosome number. Somatic number is 34, sometimes 51, 68, 85. Apple needs balanced nutrition for optimum growth and fruit production, and in turn potential yields. A deficiency or excess of nutrients can cause substantial damage to the plant. Besides macronutrients like nitrogen, phosphorous, potassium and calcium, the tree responds to micronutrient and some of the beneficial element like silicon.

There are contradictory opinions on the effects of Si in the plant. This is partly due to the unpredictable and limited absorption and uptake of Si by the plant. Nevertheless there is increasing proof that Si has many beneficial roles in crop performance. Silicon (Si) after oxygen is the most common element of the earth's crust. Silicon is present in almost any soil type, mainly as silicates, silicon dioxide, (mono- and poly-) silicic acid and biogenic silica, but only monosilicic acid (Si(OH)4) is plant available, but its concentration is very low due to its instability. With increasing concentration it polymerizes and is no longer bioavailable. Furthermore, the solubility of monosilicic acid can be decreased by interactions with heavy metals, iron, aluminium and manganese. Due to these factors, there is a silicic acid deficiency in many types of soil. So far Si-fertilizers (like silicates, diatomaceous earth and biogenic silica sources such as rice-hull ash), orthosilicic acid are used as an indirect source of silicic acid increasing growth and yield. By transformation from these silicon sources monosilicic acid is formed and taken up by the roots, transported via the xylem in the transpiration stream and distributed within plant tissues. In leaf sheaths and leaf blades silicic acid polymerizes into amorphous silica, which is deposited into the cell wall, cell lumen, intracellular spaces and trichomes increasing tissue strength. Although the dry weight of Si in the dry matter of plants ranges from <0.1 % to >10 %, Si is not recognized as 'essential' in classically defined terms, however its importance in plant growth and plant development is nowadays increasingly recognized. Plants differ in their ability to accumulate Si. Silicic acid uptake by the plant is mainly an active process mediated by specific transporters. Physiological studies have shown that the differences in Si uptake and accumulation result from the capacity of the roots to absorb silicic acid. Based on their Si content plants have been classified as Si accumulator, intermediate-type and excluder species. In general monocots are Si accumulators and dicots belong to the intermediate-type or the rare excluder types, because dicotyledonous plants have a lower tendency to accumulate Si and some species may grow adequately with levels of about 0.1 % Si in plant tissue. Nevertheless, in Si deficient conditions dicots also show stunted growth, are structurally weak and more prone to abiotic and biotic stresses. Besides this Silicon plays an important role in increasing the uptake and transport of nutrients like nitrogen, phosphorous, potassium, calcium and magnesium thus increasing the concentration of these nutrients in leaves and fruits thereby resulting in higher yield of superior quality fruits with prolonged storability. Therefore, based on the possible benefits of silicon, the present study was planned to know the response of orthosilicic acid to leaf and fruit nutrient content of apple cv. "Red Delicious".

II. MATERIALS AND METHODS

The field experiment was carried out during season 2014-2015 at private orchard Nikas Pulwama, Kashmir (J&K) to study the effect of orthosilicic acid on leaf and fruit nutrient content of apple cv. Red Delicious. The twenty year-old Red Delicious apple trees of uniform size, vigour and bearing capacity were selected for experimentation. The experiment comprising of 5 treatments *viz*., control, orthosilicic acid @ 0.5 ml/litre, 0.75 ml/litre, 1.5 ml/litre and 3.0 ml/litre was laid out in Randomized Complete Block Design with three replications. The trees were treated with foliar sprays of orthosilicic acid at green tip stage, petal fall stage, fruitlet stage, fruit development stage-II and fruit development stage-III. Observation on leaf and fruit nutrient content was recorded from fully mature leaves and fruits. Leaf and fruit samples were collected as per the procedure described by Chapman (1964) from each replicate and analyzed for their nutrient content. Nitrogen was estimated by Micro-Kjeldahl's method. Phosphorous was estimated by Vanado molybdo-phosphoric yellow colour method. Potassium was estimated by Flame Photometric method and calcium content was estimated by Versenate method (Jackson, 1973).

III. RESULTS AND DISCUSSION

Data presented in Table-1 shows that leaf N, P, K and Ca content was significantly affected by treatments. Present studies reveal that highest leaf N (2.18 and 2.15 %), P (0.30 and 0.27 %), K (2.21 and 2.18 %) and Ca (1.95 and 1.90 %) content was recorded in trees sprayed with orthosilic acid @ 3.0 ml/l which was at par with leaf N (2.07 and 2.04 %), P (0.28 and 0.24 %), K (2.09 and 2.03 %) and Ca (1.85 and 1.81 %) content of trees sprayed with orthosilicic acid @ 1.5 ml/litre and lowest leaf N (1.68 and 1.63 %), P (0.15 and 0.12 %), K (1.66 and 1.60 %) and Ca (1.50 and 1.47 %) content was recorded in trees receiving no treatment. Silicon application might have avoided leaching of nitrogen from the soil and thus helped in more uptake. Similar results were observed by Lalithya *et al.* (2014) in sapota, Bhavya (2010) in Bangalore Blue grapes, Stamatakis *et al.* (2003) in tomato and Kamenidou and Toddy, (2008) in ornamental sunflower. Silicon in solution rendered more phosphorous available to plants reversing its fixation as silicon itself competed for phosphorous fixation sites and thus, slowly released P and helped in more uptake. The above results are in conformity with the findings of Lalithya *et al.* (2014) in sapota, Bhavya (2010) in Bangalore Blue grapes, Pulz *et al.* (2008) in potato. Highest potassium and calcium content in leaves of apple trees as a result of application of orthosilicic acid @ 3.0 ml/l might be due to the synergistic effect of silicon on potassium and because of the role of silicon in increasing the uptake of calcium. Nesreen *et al.* (2011) recorded that, the application of potassium silicate increased per cent K in leaf.

Fruit nutrient content of apple cv. Red Delicious was also significantly affected by different concentrations of orthosilicic acid applied as foliar spray. The data presented in Table-2 reveals that highest N (0.53 and 0.57 %), P (0.052 and 0.057 %), K (0.65 and 0.69 %) and Ca (0.060 and 0.064 %) content was recorded in fruits harvested from trees trees sprayed with orthosilicic acid @ 3.0 ml/l which was at par with N (0.51 and 0.55 %), P (0.050 and 0.053 %), K (0.63 and 0.66 %) and Ca (0.058 and 0.062 %) content of fruits harvested from trees sprayed with orthosilicic acid @ 1.5 ml/litre and lowest N (0.35 and 0.39 %), P (0.0.038 and 0.040 %), K (0.50 and 0.53 %) and Ca (0.043 and 0.045 %) content was recorded in fruits harvested from trees receiving no treatment. The highest fruit N, P, K and Ca content of tree under treatment orthosilicic acid @ 3.0 ml/litre and 1.5 ml/litre might be due the fact that silicon helps in more absorption of nutrients like calcium, has synergistic effect with potassium, prevents leaching of nitrogen and fixation of phosphorous thereby resulting in the higher concentration of these nutrients in apple fruits. Similar results were noticed by Lalithya *et al.* (2014) in sapota, Bhavya (2010) in Bangalore Blue grape.

Table. 1: Effect of foliar application of orthosilicic acid on leaf nutrient content of apple cv. "Red Delicious":

Treatments	Leaf N (%)		Leaf P (%)		Leaf K (%)		Leaf Ca (%)	
	2014	2015	2014	2015	2014	2015	2014	2015
S_0 (Control)	1.68	1.63	0.15	0.12	1.66	1.60	1.50	1.47
S_1 (0.5 ml/l)	1.70	1.68	0.17	0.15	1.69	1.70	1.54	1.52
S_2 (0.75 ml/l)	1.87	1.90	0.22	0.21	1.88	1.87	1.70	1.68
S_3 (1.5 ml/l)	2.07	2.04	0.28	0.24	2.09	2.03	1.85	1.81
S_4 (3.0 ml/l)	2.18	2.15	0.30	0.27	2.21	2.18	1.95	1.90
C.D	**0.15**	**0.13**	**0.04**	**0.05**	**0.16**	**0.17**	**0.14**	**0.16**

Table. 2: Effect of foliar application of orthosilicic acid on fruit nutrient content of apple cv. "Red Delicious":

Treatments	Fruit N (%)		Fruit P (%)		Fruit K (%)		Fruit Ca (%)	
	2014	2015	2014	2015	2014	2015	2014	2015
S_0 (Control)	0.35	0.39	0.038	0.040	0.50	0.53	0.043	0.045
S_1 (0.5 ml/l)	0.36	0.41	0.040	0.042	0.52	0.54	0.045	0.047
S_2 (0.75 ml/l)	0.47	0.52	0.045	0.047	0.57	0.60	0.051	0.053
S_3 (1.5 ml/l)	0.51	0.55	0.050	0.053	0.63	0.66	0.058	0.062
S_4 (3.0 ml/l)	0.53	0.57	0.052	0.057	0.65	0.69	0.060	0.064
C.D	**0.04**	**0.03**	**0.004**	**0.005**	**0.04**	**0.05**	**0.003**	**0.005**

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