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Effect of preharvest foliar spray of nutrients on the quality improvement of apple (*Malus domestica* Borkh.) in Uttarakhand

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Abstract

The present investigation was carried out at the Horticulture Research Block, Ranichauri of Uttarakhand University of Horticulture and Forestry during the year 2013. The experiment was laid out in Randomized Block Design with three replications and 11 treatment. Preharvest foliar nutrients sprays was done individually and in combination after fruit set. After harvesting fruits were stored upto 90 days. Maximum total sugars (12.09%) was observed in the fruits treated with foliar application of macronutrient @ 1.5% and maximum TSS and ascorbic acid content found maximum in fruits which were treated with potassium (foliar application of K_2SO_4 @ 1.5%) followed by macronutrients and minimum in control after 90 days of storage. Thus, three foliar spray of NPK mixture @ 1.5% on during first week of May, June and July was found to be most effective in increasing the fruit quality of apple in the mid hill condition of Uttarakhand.

Keywords: Apple (*Malus domestica* Borkh), foliar spray, nutrients, quality

1. Introduction

Modern pome fruit production calls for greater attention to plant nutrition because of higher density planting, the need for higher fruit production from young plantings, replanting of old orchards due to a shortage of good new land, increased demand for better quality fruit and never-longer storage times (Bright, 2005) [5]. Nutrition play a vital role in maintaining the quality and production of fruits. The nutrition of pome fruits has received a considerable attention in recent years because of their role in high production of quality fruits.

The major nutrients (N, P, K, and Ca) which can be precisely applied either through foliar applications or fertigation have major effect on fruit quality. Nitrogen is an integral component of many compounds including chlorophyll, nucleic acid, proteins and enzymes which are essential for plant growth and development. It is also illustrated that nitrogen is essential for the use of carbohydrate within the plant and stimulates growth and development. It plays an important role in the uptake of other nutrients. Phosphorus is the second major macronutrient and essential for the better development and healthy growth of the plant and shows greater resistance against diseases. Potassium is the third major plant nutrient, it is essential for the development of strong plants. It helps plant to resist diseases, protects them from the cold and protects during dry weather by preventing excessive water loss (Sah *et al.*, 2014) [14].

Nitrogen is a major element, required by all plants, adequate nitrogen is essential for tree growth, leaf cover, blossom formation, fruit set and fruit size, all of which combine to determine crop yield (Mengel *et al.*, 2001 and Bright, 2005) [12, 5]. Nitrogen is required for the initial growth of deciduous trees in the spring during cell division (Ernani and Dias, 1999 and BI *et al.*, 2003) [9]. Neilsen and Neilsen (2009) [13] reported that increased P foliar spray increased yield and decreased water core and browning. Potassium fertilization increased fruit color and quality without increasing bitter pit. K is the key nutrient in osmoregulation and the maintenance of cell turgor and therefore closely related to firmness and crispness of the fruit. Fruits rich in K are moreresistant to sunscald (Ebert, 2009) [7].

Although considerable research has been conducted on the role of nutrients on enhancing the quality and yield of apple but the work done on this aspect under Uttarakhand conditions is lacking, therefore, the need of undertaking research on effect of preharvest foliar sprays of nutrients on yield and quantity a of apple is strongly being felt especially for quality production of this crop in Uttarakhand.

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2. Material and methods

The experimental site is located at Ranichauri about 11 Kms from Chamba at an altitude of about 2000 m above mean sea level. Geographic position of experimental site is between latitude 30°15' N and longitude 78°02' E under mid hills of Garhwal region of Uttarakhand. The region represents a humid temperate climate with an annual rainfall of 1278.40 mm.

The experiment was conducted on apple tree cv. Royal Delicious. In this experiment three sprays of different treatments were applied at an interval of thirty days after fruit set. First spray was done 1st May 2013, second spray on 1st June 2013 and third on 1st July 2013. Each treatment has one tree per replication. Lab parameters by Factorial Randomized Block Design with. The data lab parameters were analysed using Factorial Randomized Block Design by Factorial with 11 treatments namely T₁ (foliar application of borax @ 0.5%), T₂ (foliar application of borax @ 1%), T₃ (foliar application of CaCl₂ @ 0.4%), T₄ (foliar application of CaCl₂ @ 0.6%), T₅ (foliar application of K₂SO₄ @ 1%), T₆ (foliar application of K₂SO₄ @ 1.5%), T₇ (foliar application of macronutrient NPK @ 1%), T₈ (foliar application of macronutrient @ 1.5%), T₉ (foliar application of micronutrient @ 0.5%), T₁₀ (foliar application of micronutrients @ 1%) and T₁₁ (control). Fruit harvested from different treatments were brought to the Horticulture Lab after proper sorting and grading fruits were selected at random from different treatments and were stored upto 90 days and the physico-chemical analysis were done at

an interval of 30 days. The quality parameter recorded as follows:

The total soluble solids present in fruit pulp were recorded at room temperature using Erma hand refractometer and were corrected using Standard Reference Tables and expressed in terms of °Brix at 20°C. Vitamin C content was calculated as mg/ 100 ml juice and total sugars content were determined according to AOAC (1990) [1].

3. Results and discussion

Total Soluble Solids

Fruit T.S.S were increased with increases the storage intervals (Table 1). Among the treatments highest Fruit T.S.S was recorded with the foliar application of K₂SO₄ @ 1.5%. The data also shows that there was significant difference among interactions. Highest fruit T.S.S was observed in T₃, T₆ and T₈ at 90 days of storage while lowest in T₁₁ treatment (control) at 0 days. The highest T.S.S of the fruit recorded with the foliar application of K₂SO₄ @ 1.5% and it might be due to the higher availability of potassium to the fruit plants. Potassium participates in numerous enzymatic reactions and is an important factor for the development of fruit colour and TSS content. Potassium help in sugar translocation in plants, thus its application increases total soluble solid contents (Jauhari and Singh, 1971) [11]. Similar results have been reported in pear (Gill *et al.*, 2012) [10], guava (Dutta, 2004) [6].

Table 2: Effect of pre harvest foliar spray of nutrients on fruit T.S.S (°Brix) of Apple cv. Royal Delicious during storage.

Treatments	Storage Intervals (D)				Mean
	0 days	30 days	60 days	90 days	
T ₁	9.70	10.20	12.20	13.40	11.37
T ₂	9.73	10.26	12.00	13.33	11.33
T ₃	9.73	10.70	12.33	13.93	11.67
T ₄	9.86	10.76	12.36	13.56	11.64
T ₅	9.93	11.06	12.56	13.70	11.81
T ₆	10.36	11.33	12.53	13.93	12.04
T ₇	9.80	10.53	12.26	13.56	11.54
T ₈	10.06	11.23	12.70	13.93	11.98
T ₉	9.70	10.50	12.06	13.13	11.35
T ₁₀	10.16	10.30	12.26	13.23	11.49
T ₁₁	9.59	11.00	12.20	13.26	11.51
Mean	9.87	10.71	12.31	13.54	
Treatment (T) Storage interval (D) Interaction (T×D)					
SE± 0.40 0.24 0.80					
CD _{0.05} 0.11 0.68 0.22					

Ascorbic Acid

Ascorbic content of apple decrease with increases the storage intervals. The perusal of data in Table 2 clearly indicate that fruit ascorbic acid is significantly varies among different treatments and storage interval. Among the treatments

maximum ascorbic acid was recorded in T₆ (foliar application of K₂SO₄ @ 1.5%). Maximum ascorbic acid was observed in T₆ (foliar application of K₂SO₄ @ 1.5%) at 0 days interval, while minimum in T₁₀ (foliar application micronutrients @ 1%) at 90 days of intervals.

Table 2: Effect of pre harvest foliar spray of nutrients on fruit ascorbic acid (mg/100g) of Apple cv. Royal Delicious during storage.

Treatments	Storage Days (D)				Mean
	0 days	30 days	60 days	90 days	
T ₁	8.23	7.78	7.30	6.25	7.39
T ₂	8.72	7.81	6.98	6.14	7.41
T ₃	8.12	7.76	7.01	5.86	7.19
T ₄	8.34	7.64	6.69	5.40	7.02
T ₅	8.88	7.68	6.91	5.36	7.21
T ₆	9.26	7.96	7.02	5.70	7.48
T ₇	8.24	7.88	6.74	5.34	7.05
T ₈	8.89	7.82	7.06	5.99	7.44
T ₉	8.61	7.57	6.74	5.33	7.06
T ₁₀	8.54	7.48	6.64	5.29	6.99

T ₁₁	7.96	7.90	7.02	5.37	7.06
Mean	8.53	7.75	6.92	5.64	
Storage interval (T) Treatment (D) Interaction (T×D)					
SE± 0.80 0.48 0.16					
CD _{0.05} 0.22 0.13 0.45					

Potassium as a macro nutrient plays a great regulatory role in many physiological and biochemical processes of plant. Potassium is important in the formation and functioning of proteins, fats, carbohydrates and chlorophyll and in maintaining the balance of salt and water in plant cells. Potassium plays important action not only in regard to its content in plant tissue but also with respect to its physiological and biochemical function (Bowling 1972) [4]. Potassium is very mobile in the plant since it is transported directly towards the meristematic tissues. K participates in numerous enzymatic reactions and is an important factor in the development of fruit colour, TSS and vitamin C content. Similar results have been found in guava (Bhatia *et al.*, 2001, Dutta, 2004 and Eliwa *et al.*, 2003) [2, 6, 8].

Total Sugar

The total sugar percent in apple increase with increases the storage intervals. The critical examination of data indicates that total sugar content varied significantly among all the treatments and storage interval (Table 4). Among the treatments maximum total sugar was recorded in T₈ treatment (foliar application of macronutrients @ 1.5%) and minimum in T₁₁ treatment (control). The data also shows that there was significant difference among the interactions. Maximum total sugar was observed in T₈ treatment (foliar application of macronutrients @ 1.5%) at 90 days of storage while minimum T₁₁ treatment (control) at 0 days of intervals. Application of macronutrients resulted in higher sugar content, it might be due to higher sugar translocation in plants.

Table 4: Effect of pre harvest foliar spray of nutrients on fruit total sugar (%) of Apple cv. Royal Delicious during storage.

Treatments	Storage Intervals (D)				
	0 days	30 days	60 days	90 days	Mean
T ₁	9.65	10.48	12.81	14.73	11.84
T ₂	9.69	10.68	12.80	14.77	11.98
T ₃	9.65	10.40	12.95	14.89	11.97
T ₄	9.66	10.28	12.69	14.65	11.82
T ₅	9.83	10.38	12.78	14.98	11.99
T ₆	9.70	10.50	12.96	14.85	12.00
T ₇	9.80	10.31	12.68	14.70	11.87
T ₈	9.76	10.57	13.03	15.02	12.09
T ₉	9.67	10.32	12.64	14.64	11.81
T ₁₀	9.75	10.45	12.59	14.53	11.83
T ₁₁	9.48	10.11	12.37	14.19	11.53
Mean					
Treatment (T) Storage interval (D) Interaction (T×D)					
SE± 0.44 0.26 0.88					
CD _{0.05} 0.12 0.74 0.24					

On the basis of the results it can be concluded that preharvest foliar application of macronutrients on apple fruits cv. Royal Delicious were found best among the nutrients in terms of quality improvement of apple fruits. Total sugar gave significant effect with increases the storage intervals. TSS and ascorbic acid content found maximum in fruits which were treated with potassium followed by macronutrients. Conclusively, it emerges that the pre harvest foliar spray of macronutrients (20:20:20 NPK) @ 1.5% was more effective in improving the quality and quantity of apple.

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