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EVALUATION OF AQUAFERT AS A FOLIAR FERTILIZER ON APPLE CV. ROYAL DELICIOUS

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ABSTRACT

Insufficient nutrient availability and occurrence of intermittent drought other stress during critical growth periods are the significant limiting factors in production of apple in dry temperate region of Kinnaur, Himachal Pradesh. Foliar fertilization is a common practice of supplying fruit crop production with mineral nutrients, especially under limited soil nutrient availability conditions. To evaluate the potential effectiveness of foliar application of Aquafert foliar apple in apple growing regions of Himachal Pradesh, an experiment was conducted at Regional Horticultural Research & Training Station, Sharbo (Kinnaur, Himachal Pradesh), to determine the response of Aquafert as a foliar fertilizer on apple cv. Royal Delicious. It turns out that three rounds foliar application of Aquafert foliar apple 100 g/plant at 15, 30 and 45 days after petal fall stage of fruit development has shown better influence on fruiting and quality parameters of Apple cv. Royal Delicious. Higher fruit weight (182.50 g), fruit diameter (76 mm), yield (32 kg), Reducing Sugars (6.05 %), Total sugars (7.14 %), visual fruit colour (94%) and Shelf life (142 days) was recorded with Aquafert foliar apple 100 g/plant at 15, 30 and 45 days after petal fall stage.
Keywords **:** Aquafert foliar apple, Quality, Fruit weight, Fruit set, Royal Delicious, Kinnaur.

Introduction

Apple is the major fruit crop grown in most of the temperate regions of Kinnaur, Himachal Pradesh and in the present scenario it is extended to the low-lying areas of the district. Introduction of new cultivars along with improved planting systems, the area under apple plantation has extended from temperate to lower elevations of Kinnaur, Himachal Pradesh. As plantations have expanded from temperate to lower sub-temperate regions, the production of quality fruits has gone down. The quality fruit production is restricted to the cold dry temperate regions only with limited fruit production. In the higher reaches of Kinnaur district, quality fruits are often harvested, however, such climate reduces the diameter and yield of fruits and the lower regions of Kinnaur have reciprocal results. In Kinnaur district, this fruit accounts for about 86.37% and 99.15% of the total area and fruit production. The area under apple in Kinnaur district has been increased from 670 hectares in 1970-71 to 10911 hectares by 2020-21 (Anonymous, 2023). During the year 2020-21, 73330 MT of apples were produced, which contributes more than 450 crores to the GDP and is the highest recorded in the history of Kinnaur district since its inception in 1960. It marks the pinnacle of the success story of the spread of horticulture activities as well as substantial economic upliftment of the tribal community of the district, who were earlier heavily dependent on traditional crops for livelihood. The apple productivity level has gradually increased from 3.85 MT in 1970-71 to 6.72 MT in 2020-21 (Anonymous, 2023). Low productivity and low production of export quality fruits is a matter of great concern among the farming community of this district. To improve the productivity and quality of fruits to meet export standards, the horticulture sector is constantly seeking new practices to be integrated into apple production systems. Two types of fertilization used in temperate fruit production in Kinnaur, which include soil (conventional type) and foliar fertilization. Foliar fertilization has to be increased along with judicious conventional fertilization to achieve high yield and quality production. Improper use of conventional fertilizer applications through the soil at critical plant stages leads to increased yields, but indirectly affects soil and crop quality (Abdelaziz *et al.,* 2007). Leaching, groundwater contamination and reduced utilization of nutrients by plants are the main problems of soil application. Foliar nutrition significantly improved the efficiency of fertilizers, with minimal adverse environmental effects (Amiri *et al.,* 2008). The main advantage of foliar feeding is that it can be used under conditions of very limited root nutrient uptake and readily available to plants. Deficiencies of nitrogen, phosphorus, potassium, calcium, magnesium, boron, zinc, iron, copper and manganese concentrations in apple fruit production resulted in reduced growth, fruiting and quality attributes. Foliar nutrition spray is a technique of supplementing nutrients to plants in order to achieve a more efficient fertilization (Amiri *et al.,* 2008). In addition, the use of foliar fertilization has significantly improved crop productivity and foliar mineral nutrient concentration compared to no foliar application. Macro-elements such as phosphorus, potassium and sulphur play an important role in improving fruit yield and fruit quality (Srivastava, 2012). Phosphorus is a major limiting factor for plant growth and yield as it plays many important roles in cell division, photosynthetic processes, enzyme activation, metabolism and

movement of sugars (Azeem *et al.,* 2010). Similarly, potassium is an essential element and has a significant effect on stomatal opening and closing, enzyme activity, cell division, protein synthesis, sugar and starch production, which in turn reduces fruit drop, increases juice content, total soluble solids (TSS), improves and nutrients uptake (Ashraf *et al.,* 2010). Khalid *et al.,* (2021) concluded that foliar application of phosphorus and potassium significantly improved titratable acidity and ascorbic acid content. Besides the fungicidal effect of sulphur, the primary function of sulphur in the plant is often overlooked. Sulphur is an essential element for the growth and development of plants. It is the building block for the synthesis of amino acids, proteins, coenzymes, sulfolipids, and polysaccharides. The plant requires 0.1 to 0.5% Sulphur by dry weight for its optimal growth (Marschner 2012). Sulphur is the fourth nutrient after N, P and K, whose deficiency is widespread in India. sulphur deficiency is mainly observed due to higher crop yield and hence, higher rates of Sulphur removal by crops, and less use of sulphur-containing fertilizers (Messic, 2003). Adequate sulphur supply can affect the yield and quality of crops because of the need for protein and enzyme synthesis, as well as it being a component of the amino acids, methionine and cysteine (Kalaiyarasan *et al.,* 2020). The foliar feeding of apple trees with macronutrients, including potassium and phosphorus, is not easily achievable, mostly due to the inability of foliar feeding to satisfy the large fruit demand for these elements. To study the inference of complex foliar fertilizer like Aquafert foliar apple on fruit and quality characteristics of apple the present investigation have been envisaged. Hence, the objective of the present study was to study the effect of foliar application of Aquafert foliar apple on fruit weight, fruit diameter, yield, reducing sugars, total sugars, visual fruit colour and shelf life of apple cv. Royal Delicious.

Materials and Methods

An experiment was conducted in a private orchard at Sharbo, Kinnaur, Himachal Pradesh for the evaluation of foliar nutrition product Aquafert Foliar Apple during the year 2021. Aquafert Foliar Apple is a 100% soluble inorganic crystalline powder fertilizer containing 5% Phosphorus, 26% Potassium and 13% Sulphur, rich in other vital nutrients and low in chlorine and harmful heavy metals. The plants selected for the test were uniform in size, vigor and were sixteen years of age, planted at a spacing of 4.5 x 4.5 m. All plants received a uniform dose of fertilizers according to university recommendations and plant protection measures were the same in all treated trees. The treatments consisted of T_1: Aquafert Foliar Apple @ 100 g per plant (15, 30 and 45 days after petal fall), T_2: Aquafert Foliar Apple @ 100 g per plant (15 and 45 days after petal fall), T_3: Aquafert Foliar Apple @ 75 g per plant (15, 30 and 45 days after petal fall), T_4: Aquafert Foliar Apple @ 75 g per plant (15 and 45 days after petal fall), T_5: Control (No foliar application of inorganic fertilizer during early fruit development stage spanning from 15 to 45 days after petal fall). The experiment was laid out in a randomized block design with four replicates. Fruit samples collected during September were weighed, washed and kept for analysis. The diameter of the fruits was measured with vernier caliper and the weight of the fruits was recorded on a sensitive balance. The TSS content was directly read on Zeis's hand refractometer by putting a drop of fruit juice on prism and reading as Brix° at 20ºC (A.O.A.C., 1980). The acidity of the collected fruits was determined by diluting a known amount of fruit juice and titrating against 0.1 N sodium hydroxide solution, using phenolphthalein as an indicator, and expressed as percent of malic acid. Other chemical analyzes of fruits were determined according to standard methods. Ten fruits were randomly selected from each treatment and placed under normal environmental conditions as well as the remaining five fruit samples were kept at room temperature to determine shelf life (days). Color percentage is calculated on the basis of visible fruit skin color. The obtained data were tabulated and analyzed under analysis of variance (ANOVA) procedure of statistical analysis system (SAS).

Results and Discussion

Fruiting attributes

The data pertaining to increase in fruiting characteristics i.e. fruit weight, fruit size, yield influenced by the different concentration of Aquafert foliar apple is presented in Table 1. The data clearly indicates that the effect of different treatments varied non-significantly except fruit yield. Among the treatments, the fruit yield was recorded maximum (32.00 Kg/tree) in the T_4 followed by treatment T_3 (31.00 Kg/tree), T_2 (30.75 kg/tree) and T_4 (27.00 kg/tree). These treatments were significantly at par with each other. All the Aquafert treatments enhanced fruit yield over control, which had the least increase in fruit yield. This was evidenced through the studies of Amiri, *et al.* (2008) who found foliar nutritional spray a technique of supplementing nutrient to plants to achieve a more efficient fertilization and significantly improving productivity. Narayan *et al.* (2022) further suggest that sulphur deficiency affects biomass, overall morphology, yield, and nutritional value of the plant. sulphur is known to play a vital role in the formation of amino acids, had favourable effect on yield attributes due to proper portioning of photosynthetic from source to sink. These findings are in line with the report by Kalaiyarasan *et al.* (2020). The application of different sources of potassium on fruit yields and quality markedly increased the yield and quality parameters of apple (Yousuf *et al.,* 2018). The treatment T_1 was observed to have the highest fruit diameter (76.00 mm), which was non-significantly higher than rest of the treatments, whereas, lowest (71.25 mm) fruit diameter was recorded in treatment T_5 had fruit diameter statistically at par with rest of the treatments. The treatments under study with respect fruit weight was non-significant, whereas, highest fruit weight (182.50 g) was recorded in treatment T_1 and lowest fruit weight (161.25 g) observed in control, T_5. These results are in harmony with those obtained by Azeem *et al.* (2018), who reported that foliar fertilization of macronutrients plays several important roles in cell division, photosynthesis processes, enzyme activation, metabolism and sugar movement. The treatment under study was non-significant with respect to fruit weight, whereas, highest fruit weight (182.50 g) was recorded in treatment T1 and lowest fruit weight (161.25 g) was observed in control, T5. These results are in line with the results obtained by Azeem *et al.* (2018).

Quality attributes

It is further apparent from the perusal of the data presented in Table 2 that the treatments of Aquafert foliar apple non-significantly influenced total soluble solids, titratable acidity, reducing sugars, shelf life, total sugars,

ascorbic acid and visual colours of fruits, except fruit firmness. Maximum fruit firmness (15.70 kg/cm^2) of apple fruits were recorded in treatment T_2, followed by Treatment T_3 & T_4, which, were statistically higher than rest of the treatments. While, minimum (12.85 kg/cm^2) fruit firmness of apple fruits were recorded in untreated control (T_5). In general, all Aquafert treatments increased fruit firmness over the control. Macro-nutrients like phosphorus and potassium play an important role in improving fruit yield and fruit quality Srivastava (2012). In the present study, the treatment differences on apple cv Royal Delicious quality parameters except firmness of fruits were found statistically non-significant. The maximum (11.25 0B) TSS was found in treatments T_2 & T_3, whereas; minimum (10.50 0B) TSS was found in T_4. This may be due to the role of potassium on stomatal opening and closing, enzyme activity, cell division, protein synthesis, sugar and starch production, which in turn improves total soluble solids (Ashraf *et al.,* 2010). Potassium uptake is expected to aid CO_2 assimilation and subsequent carbohydrate synthesis, which was probably higher due to increased potassium fertilization, thus, significantly increasing fruit TSS. These results are consistent with those of Kath and Awasthi (1989) and and Daroshenko *et al.* (2005) while working on different cultivars of apple. Furthermore, during the study, maximum acidity (0.15 %) was observed in T_4 and the minimum (0.12 %) in T_2. Observations on reducing sugars, shelf life and total sugars, there were non-significant differences between treatments, as maximum reducing sugars (6.05 %), shelf life (142 days) and total sugars (7.14 %) were observed under T_1, while, T_5 showed minimum reducing sugars (5.36 %), shelf life (138 days) and total sugars (6.85 %). Potassium improves both fruit quality as well as quantity, thus often described as a quality element for fruit production, in addition to vitamin C, it improves uniformity and speeds fruit ripening resistance to disease, scratches and physical damage thus improving shelf life (Awasthi *et al.,* 1993). Ascorbic acid content was observed to be maximum (10.56 mg/100 g) in treatment T_3, while its minimum value (9.48 mg/100 g) was reported in treatment T_2. Khalid *et al*. (2021) also observed that foliar application of phosphorus and potassium significantly improved titratable acidity and ascorbic acid content. Moreover, maximum (94.00%) coloration was observed in treatment T_4, while minimum (79.00%) was observed in control. Fruit acidity as per results showed decreasing trend with different sources of potassium application because of variation in K_2O content (Yousaf *et al.,* 2018).

Conclusions

It can be concluded that three rounds of foliar Aquafert foliar apple application @ 100g/plant at 15, 30 and 45 days after Petal Fall stage of fruit development have shown better influence on fruiting and quality parameters of Apple cv. Royal Delicious. In addition, the effect of different Aquafert foliar apple treatments varied non-significantly except fruit yield and fruit firmness. However, Aquafert foliar apple application @ 100g/plant at 15, 30 and 45 days after petal fall stage of fruit development resulted in improvement in fruiting and quality parameters.

Table 1: Effect of different concentration of Aquafert foliar apple on fruiting attributes of Royal Delicious cultivar of Apple.

Treatment	Yield (kg/tree)	Fruit Diameter (mm)	Fruit Weight (g)
T_1	32.00	76.00	182.50
T_2	30.75	74.13	171.75
T_3	31.00	74.75	174.50
T_4	27.00	73.00	163.00
T_5	18.75	71.25	161.25
CD (P=0.05)	**8.78**	**NS**	**NS**

Table 2: Effect of different concentration of Aquafert foliar apple on quality attributes of Royal Delicious cultivar of Apple.

Treatment	Fruit firmness (kg/cm^2)	TSS (^{0}Brix)	Acidity (%)	Reducing Sugars (%)	Shelf life (days)	Total Sugars (%)	Ascorbic Acid(mg/100g)	Visual fruit Colour (%)
T_1	13.40	11.00	0.13	6.05	142	7.14	10.08	94.00
T_2	15.70	11.25	0.12	5.77	142	6.96	9.48	87.00
T_3	14.88	11.25	0.14	5.49	140	7.05	10.56	92.00
T_4	14.05	10.50	0.15	5.49	140	6.85	10.45	83.00
T_5	12.85	10.75	0.13	5.36	138	6.85	10.08	79.00
CD (P=0.05)	1.73	NS	NS	NS	NS	NS	NS	NS

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