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Effect of Different Sources and Concentrations of Pre-harvest Calcium and Boron Sprays on the Quality and Yield of Apple (*Malus x domestica* Borkh.)

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ABSTRACT

A field study was carried out by KVK, Anantnag to determine the effect of different sources and concentrations of calcium and boron on yield and quality of apple cv. Red Delicious. Boron was sprayed at pink bud stage and at petal fall stage, whereas calcium at walnut stage and next two sprays at three weeks interval after first spray. The results of the study were promising as there was a significant improvement in both yield and quality of apple. The results clearly showed that calcium and boron regardless of source and concentration improved both yield and quality of apple over control. However, Calcium ($Cacl_2$) as dehydrated source @ 0.3 per cent and Boron as boric acid @ 0.15 per cent proved to be the best treatment over other treatments was statistically at par with results obtained with solubar at similar concentration for yield parameters. Furthermore, an average enhancement of yield to the tune of 29.83 per cent and quality in terms of A grade apples to the tune of 55.31 per cent were achieved over control. Thus, it can be concluded that foliar sprays of calcium and boron on apple not only increase yield, but also improve quality that results in significantly higher economic returns.

Key Words: Apple, Boric acid, Calcium chloride, Nutrition, Quality.

INTRODUCTION

Apple (*Malus x domestica* Borkh.) is the principal fruit crop of Jammu & Kashmir and remains one of the most important sector contributing to the economy of the state. Red Delicious is the most important commercial cultivar which accounts for lions share in apple production. The state leads in production and productivity in the country but the productivity bears a poor comparison to the apple countries of the west. Nutrition plays a vital role in growth and productivity of fruit trees. Among various factors affecting growth and development, the lack of balanced nutrition is considered one which affect the growth, fruit setting, quality and yield. Application of calcium and boron may partially help to overcome this problem. Calcium is required for cell elongation and cell division. There is now evidence that auxin induced H^+ secretion of meristimatic cells is related to the presence of ca^{2+} (Marme,1983). The application of calcium inhibits fruit abscission and delays its senescence, increase fruit pull force and firmness (Faust, 1975). On the other hand, boron plays a major role in enhancing cell division, biosynthesis of carbohydrates and proteins, flowers pollination and fertilization. It plays an important role in fruit setting through encouraging germination and growth of pollen grains. Additionally, boron is involved in physiological and biochemical processes inside the plant cell, altering the concentration and translocation of nutrients (Tariq and Mott, 2007). Calcium and boron are therefore very important nutrients which can improve yield and quality of apple. During the last decades, the foliar application of mineral elements has become an established procedure in fruit plants to increase the production and improve the quality of produce. In principle, the physiology of nutrient uptake by

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leaves is comparable to root uptake. However, in contrast to roots, the knowledge of regulation of nutrient uptake by leaves is still limited. This is also true for mobility of distinct nutrients within plants, which has to be considered for a successful foliar application.

Foliar application of nutrients can supply essential elements directly to the foliage and fruit at times when rapid response may be desired. Furthermore, certain organs of the tree may require more of a particular nutrient than does the entire tree (Faust and Shear, 1968). There is a wide disparity among the growers with regard to the source and concentration of calcium and boron to be used. Therefore, the objectives of the study were to find out the effect of different sources and concentrations of foliar sprays of boron and calcium on yield, quality and economics of apple.

MATERIALS AND METHODS

The present study was carried out on nineteen year old Apple trees cv. Red Delicious worked on seedling rootstock spaced at 7m x 7m at Mehmoodabad village of District Anantnag during 2016-17. Initial nutrient status of the orchard soil was assessed with regard to pH, organic carbon, N, P, K, Ca and B (Table 1). Two sources each of calcium ($CaCl_2$ –fused and $CaCl_2$- dehydrated) and boron (Boric acid and Solubar) were used. Similarly, two concentrations of each source *viz,* Boron @ 0.1 per cent and 0.15 per cent and Calcium @ 0.2 per cent and 0.3 per cent were used. Thus, the experiment consisted of sixteen treatment combinations replicated three times established under randomized completely block design (RCBD-Factorial). Routine cultural practices were followed during the course of experiment. The details of the treatment combinations were as under:

T0 = Control (Untreated trees)

T1 = Boric acid @ 0.1% + $CaCl_2$ (fused) @ 0.2 %

T2 = Boric acid @ 0.1% + $CaCl_2$ (fused) @ 0.3 %

T3 =Boric acid @ 0.15% + $CaCl_2$ (fused) @ 0.2 %

T4 =Boric acid @ 0.15% + $CaCl_2$ (fused) @ 0.3 %

T5 =Boric acid @ 0.1% + $CaCl_2$ (dehydrated) @ 0.2 %

T6 =Boric acid @ 0.1% + $CaCl_2$ (dehydrated) @ 0.3 %

T7=Boric acid @ 0.15% + $CaCl_2$ (dehydrated) @ 0.2 %

T8=Boric acid @ 0.15% + $CaCl_2$ (dehydrated) @ 0.3 %

T9=solubar @ 0.1% + $CaCl_2$ (fused) @ 0.2 %

T10=solubar @ 0.1% + $CaCl_2$ (fused) @ 0.3 %

T11=solubar@ 0.15% + $CaCl_2$ (fused) @ 0.2 %

T12=solubar @ 0.15% + $CaCl_2$ (fused) @ 0.3 %

T13=solubar @ 0.1% + $CaCl_2$ (dehydrated) @ 0.2 %

T14=solubar @ 0.1% + $CaCl_2$ (dehydrated) @ 0.3 %

T15=solubar @ 0.15% + $CaCl_2$ (dehydrated) @ 0.2 %

T16=solubar @ 0.15% + $CaCl_2$ (dehydrated) @ 0.3 %

Boron was sprayed at two stages, first one at pink bud and second at petal fall stage, whereas calcium was sprayed at three stages, first spray at walnut stage of apple, followed by three weeks of interval. The observations with regard to yield was estimated as kg/tree, quality in terms of percentage grades per tree as (A, B and C grades) and economics in the form of benefit cost ratio was done as per the method of Torane *et al* (2011). The data were analyzed as per the standard method of Snedecor and Cochran (1989) and data in the tables are presented as means using least significant difference (LSD) test at 0.05 level of significance.

RESULTS AND DISCUSSION

Yield and quality Attributes

The data (Table 2) revealed that the average yield of trees sprayed with calcium and boron increased significantly over control irrespective of source and concentration used. The maximum yield (161.49 kg/tree) was obtained in the trees which were sprayed with boron in the form of boric acid @ 0.15 per cent and calcium chloride- dehydrated @ 0.3 per cent (T8) followed by Boron as solubar @ 0.15 per cent and calcium chloride as dehydrated source @ 0.3 per cent (T16) which were statistically at par with each other, thereby recorded an increase

Table 1. Initial nutrient status of the orchard soil

pH	O.C (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)	Ca (meq/l)	B (ppm)
6.73	0.89	372.40	14.20	53.05	7.81	0.44

Table 2. Effect of different sources and concentrations of Calcium and Boron on Yield and quality of Apple cv. Red Delicious.

Treatment	Yield (kg/tree)	Quality (%)		
		A	b	c
T0	124 .38	34.42	42.00	23.58
T1	143.25	38.1	41.71	20.19
T2	144.41	40.48	40.39	18.15
t3	148.17	43.02	39.32	17.43
t4	149.42	45.42	38.50	16.25
t5	144.17	47.10	38.59	14.00
t6	145.14	52.18	38.08	10.71
t7	160.24	51.61	37.54	11.18
t8	161.49	53.46	37.61	8.64
t9	142.24	37.33	42.68	20.50
t10	143.34	39.62	41.39	19.43
t11	146.53	43.03	40.16	17.25
t12	148.39	44.08	38.68	17.41
t13	143.32	46.56	37.24	16.14
t14	144.54	52.71	37.16	10.41
t15	159.05	51.43	37.65	11.32
t16	161.36	52.08	37.95	9.54
LSD (0.05)	0.15	0.10	0.13	0.06
±S.E Mean diff	0.074	0.050	0.062	0.030
A-A Grade Apples; B- B Grade Apples and C- C Grade apples				

in yield by (29.83 %) over control. Similarly, sprays of calcium and boron improved quality attributes of apple over control. Highest A grade apples (55.31%) were observed in the treatment (T8) which was superior to all other treatments recorded an increase of 50.93 per cent over control. Furthermore, the lowest %age of C grade apples (8.64 %) and (9.54%) were observed in T8 and T16 treatments, respectively. This significant increase in fruit yield of apple can be attributed to the fact that boron increases effective pollination and thereby fruit set and hence yield. Fruit size and shape are often related to seed number and distribution within the fruit. Cytokinins, auxins and gibberllins produced by developing seed may be responsible for these effects (Frank, 1986). Furthermore, Dong *et al* (1997) stated that the effect of boron on fruit quality might occur indirectly through effects on the seed production. The significant increase in yield with calcium and boron sprays have also been noted by Svagzyds *et al* (1995) who reported that an increase in yield by 21.10-22.70 per cent were achieved in comparison to control. Similarly, Kumar *et al* (2003) reported that pre-harvest spray of boric acid significantly increased the fruit yield of apple. Better coloured fruit of apple cv. Red

Table 3. Effect of Calcium and Boron sprays on cost benefit analysis of Apple cv. Red Delicious

Treatment	Average gross returns (Rs/ha)	Average cost involved (Rs/ha)	B:C Ratio
T0	9,49,416	4,23,300	2.24
T1	11,35,260	5,00,968	2.27
T2	11,61,372	5,10,612	2.27
t3	12,20,736	5,23,872	2.33
t4	12,58,068	5,28,156	2.38
t5	12,32,976	5,09,592	2.42
t6	13,03,968	5,13,060	2.54
t7	14,25,756	5,66,508	2.52
t8	14,69,208	5,70,996	2.57
t9	11,25,672	5,02,860	2.24
t10	11,54,436	5,06,736	2.28
t11	12,14,616	5,17,956	2.35
t12	12,33,996	5,24,688	2.35
t13	12,12,780	5,06,736	2.39
t14	12,97,032	5,16,769	2.50
t15	14,13,924	5,62,224	2.51
t16	14,58,377	5,70,384	2.55

Delicious were obtained with preharvest sprays of boron either alone or in combination with calcium chloride (Bhat and Farooqui, 2004). Significant enhancement in fruit yield and quality of Navel Orange fruits with boric acid and calcium chloride have also been reported by Hikal *et al* (2017).

Economic Returns

The economic analysis of different treatments has been presented in Table 3. It was evident that because of variations in average fruit yield and quality of apple in different treatments, average gross returns and average net returns to the growers were higher from T8 and T16 as compared to other treatments. Furthermore, higher benefit cost ratio of 2.57 demarcates the superiority of calcium as dehydrated source and boron as boric acid or solubar @0.3 per cent and 0.15 per cent, respectively over control and other treatments. The results were in conformity with that of Gurteg *et al* (2012).

CONCLUSION

In conclusion both boron and calcium are very important nutrients to be sprayed for enhancing both yield and quality of apples and thus higher profit. Boron sprayed in the form of boric acid or solubar @ 0.15 per cent at pink bud stage and at petal fall stages and calcium as calcium chloride in the form of dehydrated source @ 0.3 per cent proved to be the best combination for achieving the desired results both in terms of yield and quality. Hence, spray of boron @ 0.15 per cent either as boric acid or solubar and calcium as dehydrated source @ 0.3 per cent is advisable for getting good yield and better quality in apple.

REFERENCES

Bhat K M and Farooqui K D(2004). Effect of foliar sprays of calcium and boron on fruit quality of apple cv. Red Delicious under water stress conditions. *SKUAST J Res* **6**: 204-206.

Faust M (1975). the role of calcium in the respiratory mechanism and senescence of apples. *Res Scientific* **238**: 87-92.

Faust M and Shear C B(1968). Corking disorders of apples: a physiological and biochemical review. *Botanical Rev* **34**: 441-469.

Frank G(1986). *Apple*. In hand book of fruitset development. Eds. S.P. Monselise, pp. 1-40, CRC Press, Boca Raton, Florida.

Gurteg S, Pal S S and Singh A S (2012). Effect of Age of seedlings and irrigation on mortality, bolting, bulb weight and yield of Onion (*Allium cepa* **L.)**. *Krishi Vigyan.* **1**(1): 10-13

Hikal A R F, Ibrahim M A and Abdelaziz R A (2017). Effect of different treatments of calcium and boron on productivity and fruit quality of navel orange fruits. E*gypt J Hort* **44** (1): 119-126.

Kumar J, Rehalia A S, Rana S S and Chandel J S(2003). Effect of pre and post-bloom sprays of urea and boric acid on growth, yield and fruit quality of apple cv. Red Delicious. *Prog Hort* **35**: 14-19.

Marme D(1983). *Calcium transport and function*. **In**: Inorganic plant nutrition. Eds.A. Lauchli and R.L. Bieleski. pp. 599-625.

Snedecor G W and Cochran W G (1989). *Statistical Methods*. 8th Edition. Affiliated East-West Press, Lowa State University, p. 77.

Svagzyds S, Tagliavini M N and Millard G H (1995). Mineral nutrition of deciduous fruit plants. *Acta Hort* **383**: 487-490.

Tariq M and Mott C J B (2007). Effect of boron on the behaviour of nutrients in soil-plant systems-a review. *Asian J Plant Sci* **6**: 195-202.

Torane S R, Naik B K, Kulkarni V S and Talathi J M (2011). Farming systems diversification in North Konkan Region of Maharashtra. An economic analysis. *Agril Econ Res Rev* **24**(1): 91-98.

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