



**EFFECTS OF CALCIUM CHLORIDE AND CALBORN APPLICATION ON SOME
PHYSIOLOGICAL AND MORPHOLOGICAL CHARACTERISTICS OF APPLE
CULTIVARS**

**JAFAR ABILI¹, SEYEDMOJTABA MOUSAVI², SAEED PIRI³, VAHID ABDOSI¹,
SAJJAD ZARE^{4*}**

1 Science and Research Branch, Islamic Azad University, Tehran Iran

2 Young Researchers and Elite Club, Abhar Branch, Islamic Azad University, Abhar Iran

3 Abhar Branch, Islamic Azad University, Abhar Iran

Faculty of Agriculture, Lorestan University, Lorestan

*Corresponding Author

ABSTRACT

This study was conducted to evaluate the effects of Calbore and calcium chloride on some physiological and morphological characteristics of apple cultivars by RCBD design with 3 replications. Varieties included: Red Delicious, Golden Delicious and Fuji. Spray was performed by 3 levels (Every 20 days). At the end of experiment, we evaluated traits such as Fruit Weight, Counting the flowers 20 days after full flower, Counting the fruit one week before harvesting, Yield, pH, Calcium, New shoot length, photosynthesis, Penetrometer and Bore. The results indicate that the using of Calbore increased yield compared with control also Varieties showed different responses to spray. Fuji and Red Delicious cultivars had highest (35.56 kg) and lowest (21.5 kg) yield, respectively. Spray of Calbore had highest and lowest effects on Fuji and red delicious cultivar respectively also Spray of CaCl₂ had highest and lowest effects on Fuji and red delicious cultivars respectively.

Keywords: Varieties of apples, fertilizer, elements

INTRODUCTION

Calcium (Ca) is an important nutrient element, which can affect apple quality and quantity. Calcium deficiency develops primarily during the early part of the growing season which develops during the latter part of the growing season, and senescent breakdown, which forms during and after storage. It is a constituent of cell wall and it plays an important role in carbohydrate change into sugars (Elliot, 1996). High levels of insoluble calcium contain in often soils, despite that tree grown in these soils will show a calcium deficiency (Boynton et al., 2006), spray application of calcium to the apple tree is the most effective method for calcium usage. The calcium uptake in some trees will be reduced by the presence of high amount of other cations such as magnesium, ammonium, iron, aluminum and especially potassium, due to their antagonistic effect for their absorption (Kulkarni et al., 2010). CaCl_2 showed improvement of fruits storability under cold storage (Wahdan et al., 2011). The pre and post-harvest application of chemicals like calcium chloride and calcium nitrate are known to influence the quality and shelf-life of fruits during storage (Gill et al., 2005). The desirable Ca content may be different for various cultivars, In common, it is suggested that Ca content 45-

60 mg/kg of fresh fruit weight is suitable (Dris et al., 1998).

Boron is essential in the normal development of new tissues in shoot tips, flowers, fruit, and roots. Boron has long been essential in pollen development, pollination and fruit set. The boron content of unopened flower buds tends to be fairly high and as growth proceeds the boron content of the resulting tissues tends to decline (Jones, 1998). Sprays of boron are frequently needed to maintain adequate levels of boron to avoid development of deficiency problems in the fruit. Apple quality and quantity in large extent is determined by the genotype of the cultivars, also some other factors may influence expression of these traits. The objectives of this study were to determine the effects of calcium and Calborn on quantity and quality apples.

MATERIAL AND METHODS

Khodabandeh City, Zanzan province, Iran was selected for this research, it's Geographical coordinates was between 48 degrees and 35 minutes east and latitude 36 degrees 7 minutes north. The experiment was arranged in completely randomized design with 3 replications. First and second factors included cultivars (Foji, Golden, Reddelicious) and spray application (Control,

Calcium chloride, Caleborn) respectively. Sprayed with intervals of 20 days was repeated three times. At each time, spray included 45 cc of Caleborn in 20 liters of water and 40 ml of calcium chloride in 20 ml of water. Some traits were evaluated such as Fruit yield, First Fruit falling, Second Fruit falling, Stiffness, LAI, Photosynthesis and Length of new branch.

RESULT AND DISCUSSION

Fruit Weight: According to result, it was observed that two factor didn't have significant on fruit weight.

Counting the flowers 20 days after full flower: According to analysis of variance, it was determined that only fertilizer had significant effect on this trait at 5% statistical probability, but interaction between treatment showed non-significant effect on Counting the flowers 20 days after full flower (Table 1). Application of calcium chloride and Caleborn showed 16 and 6% increase compared to control, respectively. Highest values of this trait were obtained by calcium chloride, caleborn and calcium chloride in reddelicious, Fuji and Golden cultivars, respectively (Table 2).

Counting the fruit one week before harvesting: According to analysis of variance, it was determined that cultivars and fertilizer had significant effect on Counting

the fruit one week before harvesting at 1% statistical probability, also interaction between treatment showed significant effect on this trait at 5% statistical probability (Table 1). Reddelicious had highest (18.55) fruit number at one week before harvesting (Table 2). Application of calcium chloride and Caleborn showed 35 and 33% increase compared to control, respectively. Highest values of this trait were obtained by calcium chloride (46.97), caleborn (42.42) and calcium chloride (47.54) in reddelicious, Fuji and Golden cultivars, respectively (Table 2).

Yield: According to analysis of variance, it was determined that cultivars and fertilizer had significant effect on Yield at 1% statistical probability, but interaction between treatment showed non-significant effect on yield (Table 1). Fuji had highest (35.56 kg) yield (Table 2) and Application of calcium chloride and Caleborn showed 26 and 47% increase compared to control, respectively. Highest values of this trait were obtained by caleborn in reddelicious (26 kg), Fuji (42.33 kg) and Golden (28 kg) cultivars (Table 2).

pH: According to analysis of variance, it was determined that only varieties had significant effect on pH at 1% statistical probability, but main effect and interaction between treatment showed non-significant effect on pH (Table 1). Reddelicious had highest

(3.52) pH (Table 2) and it showed 7 and 4% increase compared to Fuji and Golden cultivars, respectively.

Calcium: According to analysis of variance, it was determined that varieties, fertilizer and their interaction had significant effect on Calcium at 1% statistical probability (Table 1). Reddelicious had highest (4.42 ppm) Calcium (Table 2) and it showed 73 and 69% increase compared to Fuji and Golden cultivars, respectively. Application of calcium chloride and Caleborn showed 34 and 10% increase compared to control, respectively. Highest values of this trait were obtained by calcium chloride in reddelicious (5.91 ppm), Fuji (2.76 ppm) and Golden (2.73 ppm) cultivars (Table 2).

New shoot length: According to analysis of variance, it was determined that varieties and fertilizer had significant effect on new shoot length at 1% statistical probability, also interaction between treatment showed significant effect on new shoot length at 5% statistical probability (Table 1). Reddelicious had highest (55.7 cm) new shoot length (Table 2) and it showed 69% increase compared to Fuji and 2 fold to Golden cultivar approximately. Application of calcium chloride and Caleborn showed 24 and 17% decrease compared to control, respectively. Highest values of this trait were

obtained by control (69.33 cm), caleborn (60 cm) and control (33 cm) in reddelicious, Fuji and Golden cultivars, respectively (Table 2).

Photosynthesis: According to analysis of variance, it was determined that varieties had significant effect on Photosynthesis at 5% statistical probability, but fertilizer and interaction between treatment showed non-significant effect (Table 1). Fuji had highest (13.55 mol/ms) photosynthesis (Table 2) and it showed 39 and 23% increase compared to reddelicious and Golden cultivars, respectively.

Penetrometer: According to analysis of variance, it was determined that cultivars and fertilizer had significant effect on penetrometer at 1% statistical probability, but interaction between treatment showed non-significant effect on (Table 1). Reddelicious had highest (864.3 kg/cm²) penetrometer (Table 2) and it showed 14 and 16% increase compared to Fuji and Golden cultivars, respectively. Application of calcium chloride and Caleborn showed 19 and 29% increase compared to control, respectively. Highest values of this trait were obtained by caleborn in reddelicious (956.7 kg/cm²), Fuji (822 kg/cm²) and Golden (856.7 kg/cm²) cultivars (Table 2).

Bore: According to analysis of variance, it was determined that cultivars, fertilizer and

them interaction had significant effect on fruit bore at 1% statistical probability (Table 1). Fuji had highest (34.22 ppm) Bore (Table 2) and it showed 13 and 27% increase compared to Red Delicious and Golden cultivars, respectively. Application of calcium chloride and Caleborn showed 4 and 8% decrease compared to control, respectively. Highest values of this trait were obtained by Caleborn (31.04 ppm), control (37.37 ppm) and calcium chloride (30.02 ppm) in Red Delicious, Fuji and Golden cultivars (Table 2).

Several factors affect the development and production of fruit trees, Mineral make up a significant portion of plants and plant physiology, they involved in a number of pathway. The results suggest that Caleborn application increased yield in compared to the control. Bore have a positive effect on yield with involvement in activities such as protein synthesis, glucose transport, metabolism of plant hormones, these facts

were indicated by our results. Calcium increase the yield through improvement of permeability and stability of the cell membrane and growth of pollen and activate a number of enzymes involved in cell division and enlargement. Manganaris *et al*, (2006) reported that Calcium chloride was effective in increasing the stiffness of peaches. The results indicate that the using of Caleborn increased yield compared with control also varieties showed different responses to spray. Calcium treatment reduce respiration, ethylene production and delay the beginning of fruit ripening apple, avocado and mango (Joyce *et al.*, 2001). Fuji and Red Delicious cultivars had highest (35.56 kg) and lowest (21.5 kg) yield, respectively. Spray of Caleborn had highest and lowest effects on Fuji and Red Delicious cultivar respectively also Spray of CaCl_2 had highest and lowest effects on Fuji and Red Delicious cultivars respectively.

Table 1: Analysis of variance for traits

S.O.V.	df	Fruit Weight (gr)	Counting the flowers 20 days after full flower	Counting the fruit one week before harvesting	Yield (kg)	pH	Calcium (ppm)	New shoot length(cm)	photosynthesis	Penetrometer	Bore length
replication	2	36.33	32.10	4.30	16.68*	0.01	0.0002	134.93	0.49	2110.33	0.0003
Varieties	2	42.11	38.17	36.95**	495.90**	0.12**	4.151**	2158.26**	34.62*	39963.44**	122.46**
Fertilizer	2	267.11	94.43*	63.42**	241.37**	0.01	0.26**	370.26**	2.60	93785.33**	13.77**
Varieties * fertilizer	4	108.56	46.21	14.49*	7.59	0.01	0.026**	150.48*	2.61	4531.94	23.6**
error	16	203.96	22.77	3.95	3.23	0.01	0.0001	47.76	2.64	2264.79	0.0002
C.V.		13.2	11.52	12.24	6.62	5.53	26.16	15.04	14.24	6.04	6.00

*and** showed statistical significant probability at 5 and 1%, respectively

Table 2: Effect of treatment on means of studied traits (Duncan 5%)

		Fruit Weight (gr)	Counting the flowers 20 days after full flower	Counting the fruit one week before harvesting	Yield (kg)	pH	Ca (ppm)	New shoot length(cm)	photosynthesis	Penetrometer	Bore length
	Reddelicious	109	a 43.24	a 18.55	a 21.5	c 3.527	a 4.421	a 55.78	b 9.692	a 864.3	b 30.17
	Fuji	109.9	a 39.19	a 14.76	a 35.56	c 3.294	c 2.549	a 54	a 13.55	b 753.6	a 34.22
	Golden	105.8	a 41.86	a 15.4	b 24.39	b 3.379	b 2.612	b 28.11	b 11	b 744.8	c 26.85
	Ctrl	113.6	a 38.38	b 13.17	b 21.78	c 3.373	c 2.773	a 53	a 10.8	c 677.1	a 31.59
	Calcium chloride	102.7	a 44.83	a 17.9	b 27.56	a 3.383	a 3.732	b 40.44	a 11.67	b 807.1	ab 30.54
	Calborn	108.4	a 41.06	ab 17.64	a 32.11	a 3.443	b 3.077	b 44.44	a 11.77	a 878.4	b 29.12
Reddelicious	Ctrl	108	a 38.55	ab 13.09	d 16.17	g 3.503	c 3.58	a 69.33	d 8.643	e 724	bc 30.01
	Calcium chloride	103.3	a 46.97	a 20.33	ab 22.33	ef 3.513	a 5.913	bc 51.67	cd 9.84	ab 912.3	bc 29.47
	Calborn	115.7	a 44.2	ab 22.21	a 26	cd 3.563	b 3.77	c 46.33	bcd 10.59	a 956.7	bc 31.04
Fuji	Ctrl	119.7	a 35.15	b 13.17	d 28.67	c 3.323	b 2.547	bc 56.67	abc 12.46	ef 691.7	a 37.37
	Calcium chloride	101.7	a 39.99	ab 15.39	cd 35.67	b 3.29	d 2.76	c 45.33	ab 13.63	de 747	bc 32.12
	Calborn	108.3	a 42.42	ab 15.73	cd 42.33	a 3.27	b 2.34	ab 60	a 14.56	cd 822	b 33.16
Golden	Ctrl	113	a 41.46	ab 13.26	d 20.5	f 3.293	b 2.4	d 33	bcd 11.28	f 615.7	c 27.37
	Calcium chloride	103	a 47.54	a 17.97	bc 24.67	de 3.347	b 2.737	d 24.33	abcd 11.55	de 762	bc 30.02
	Calborn	101.3	a 36.57	b 14.97	cd 28	c 3.497	a 2.7	d 27	cd 10.17	bc 856.7	d 23.16

REFERENCES

- [1] Boynton D, Oberly Gh (2006). Temperate to tropical fruit nutrition, Somerville, New Jersey, USA, Somerset Press., 1-50 and 489-503.
- [2] Elliot Dc (1996). Calcium involvement in plants hormones action. Plenum Press, New York., 285-292.
- [3] Gill Ps, Nav S, JawandhaSk (2005). Post-harvest handling of mango. Revi. Punjab Agri.Univ., 4: 150-160.
- [4] Jones, J.B., Jr (1998). Plant Nutrition Manual. CRC Press LLC, Boca Raton, FL
- [5] Joyce, D. C., Shorter, A. J., & Hockings, P. D. (2001). Mango fruit calcium levels and the effect of postharvest calcium infiltration at different maturities. *Scientia horticulturae*, 91(1), 81-99.
- [6] Kulkarni V, Foord G, Hamilton D (2010). Calcium and mango fruit quality. *J. Trop. Agri.*, 4 (1-2): 57-60.
- [7] Manganaris, G. A., Vasilakakis, M., Diamantidis, G., & Mignani, I. (2006). Diverse metabolism of cell wall components of melting and non-melting peach genotypes during ripening after harvest or cold storage. *Journal of the Science of Food and Agriculture*, 86(2), 243-250.
- [8] Wahdan Mt, Habib Se, Bassal Ma, QaoudEm (2011). Effect of calcium chloride and Gibberellic acid on storability of "SuccaryAbiad" mango fruits under cold storage. *J. Amer. Sci.*, 7(5): 493-501.