

Effect of calcium and boron on reproductive performance of sweet cherry cv Bigarreau Noir Grossa

GI HASSAN, MUZAFFAR MIR, BABITA KHACHI* and S SLATHIA*

Division of Fruit Science
Sher-e-Kashmir University of Agricultural Sciences and Technology
Srinagar, J&K, India

*Department of Fruit Science

Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan 173230 HP

Email for correspondence: drmuzaffarcqar@gmail.com

ABSTRACT

The present studies were conducted in a private orchard on Zabarwan Hills near the university campus of SKUAST-Kashmir, J&K during 2010 and 2011. Four chemicals viz calcium nitrate, chelated Ca, boric acid and solubor were tested on 18 year old sweet cherry trees of cv Bigarreau Noir Grossa (Misri). Treatment combination C_2B_4 including calcium nitrate @ 0.10 per cent Ca and solubor @ 0.02 per cent B proved to be most effective treatment for improving flowering attributes like bloom density (20.06 buds/cm² BCSA), bloom index (0.74) and pollen germination (69.30%) which were significantly enhanced.

Keywords: Cherry; reproductive performance; calcium; boron

INTRODUCTION

Sweet cherry (*Prunus avium* L.) is one of the most important stone fruits of temperate region. This miniature wonder fruit is packed with health benefiting nutrients and unique antioxidants (melatonin). Cherries are native to eastern Europe and Asia minor regions belonging to the family Rosaceae. By virtue of the temperate climatic conditions 90 per cent of the total cherry production of India is confined to Kashmir valley of J&K state. The area and production

under sweet cherry is 3466 hectares and 11445 MT respectively with the productivity of 3.30 MT/ha which is quite low as compared to advanced cherry growing countries like Italy, France, USA and Turkey (Anon 2011). In Kashmir valley sweet cherry is mostly grown on the Karewas (upland plateaus) which are totally rainfed and water holding capacity is very poor. Very meagre amount of rainfall (~700 mm) coupled with its erratic distribution results in nutrient deficiency in general and that of Ca and B in particular

at flowering and fruit development stage which causes severe pollination problems, poor fruit set, low productivity and inferior fruit quality that ultimately gets reflected by striking drop in economic well being of farmers.

Calcium and boron are among the essential nutrients found deficit in most of the soils. Generally B deficiency in plant is observed on coarse textured soils (Gupta 1979, Shorrocks 1997) due to intensive leaching of this nutrient from top soil layers (Kadir 2004). On the other hand Ca is considered to be deficit in highest rainfall areas and is less mobile in soils (Zatylnyl and St-Pierre 2006). The importance of B as one of the essential nutrients was first time reported by Warington (1923). Its role in reproductive performance has been well documented by scientists all over the world (Callan et al 1978, Hanson and Breen 1985, Zude et al 1998, Stampar et al 1999, Stampar et al 2000). Likewise Ca is essential for plant growth, cell division, membrane stability, cell elongation and turgidity (Drake et al 1985, Saure 2005). Boron is the key nutrient for flowering, fruiting and internal and external fruit quality. It is involved in sugar transport, lignifications, RNA metabolism, respiration, indole acetic acid (IAA) metabolism, cell wall synthesis and carbohydrate metabolism (Jeremy 2007). In cherry B deficiency results in little shoot growth; some buds may fail to open in the spring whereas others may open then shrivel and die; leaves are

distorted in shape with irregular serration and may cup or roll in a downward direction and feel thick and leathery. Fruits may become hard, shrivelled and blotchy. Like boron calcium is also an important nutrient in plant nutrition. Where calcium is abundant in the soil it is abundant in leaves since it is taken up passively by growing roots (not requiring an energy source). Apparently only the region just behind the tips of a growing root is capable of calcium uptake (unlike K and P) so factors inhibiting root growth also inhibit its uptake. Calcium moves almost exclusively in the xylem with very small concentrations being found in the phloem. Therefore once in an organ (such as a mature leaf) calcium is not readily transported out even during senescence. Fruit calcium levels are low since nutrients in fruit tissues are supplied mostly by the phloem. For this reason fruit and leaf calcium levels are poorly correlated meaning leaf samples cannot be used to determine the fruit's calcium status.

Although soil application is the most common method of fertilizer application to the fruit trees however for quick response foliar nutrient application is preferred. Foliar application also entails efficient and economic use of fertilizers besides minimising ground water pollution. Further plants sometime grow at rates that are faster than the ability of the roots to absorb and translocate minerals to the critical leaf, flower and fruit tissues. Foliar sprays can often help to overcome deficiency and

maintain optimum nutrient levels of those critical tissues. There are different sources of both boron and calcium for foliar sprays. Calcium can be applied through calcium chloride, calcium nitrate, calcium hydroxide, chelated calcium etc. Likewise B can also be supplied through borax, boric acid, disodium octaborate tetra-hydrate etc. It has been observed that $\text{Ca}(\text{NO}_3)_2$ was as effective in improving the storability as that of CaCl_2 however $\text{Ca}(\text{NO}_3)_2$ sprays were more effective in increasing fruit Ca compared to CaCl_2 or CaHPO_4 (Wojcik and Szwonek 2002). Except CaCl_2 and H_3BO_3 other sources of B and Ca have not been tested so far in Kashmir valley for their impact on bloom density, bloom index, pollen germination and viability of cherry.

MATERIAL and METHODS

The investigations were carried out in a private orchard (Zabarwan Hills) near Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, J&K during 2010 and 2011. The orchard is located at an elevation of 1650 m amsl on northern sloppy aspect of Zabarwan Hill. The soil at the experimental site was sandy loam in texture and low in nutrient status. The experiment was laid out on 18 year old trees of sweet cherry cv Bigarreau Noir Grossa Misri in the randomized block design (factorial) with 25 treatments. Each

treatment was replicated thrice having one tree per replication. The details of treatments are given in Table 1. In the experiment healthy, visually identical and 18 year old trees of sweet cherry cv Bigarreau Noir Grossa Misri were selected. No irrigation was given during the experimental period. Boron was sprayed at bud swell and white bud bloom stage whereas calcium was sprayed at 7 days after petal fall (DAPF) and 7 days before harvest. Flowers at balloon stage were collected along with twigs from the experimental trees. The twigs were kept dipped in water till the flowers opened under tube light. A drop of 2 per cent acetocarmine was poured on glass slide and pollen from 1-2 flowers were dusted on and covered with a cover slip. Viability was observed under binocular microscope (Olympus C x 14 RF). Pinkish stained pollen grains were counted as viable and unstained were considered non-viable. Pollen germination was determined by dusting the grains on the artificial medium containing 1 per cent agar + 10 per cent sucrose and incubated at constant temperature of 25°C in dark for 24 hours. Pollen grains having pollen tube length more than diameter were considered germinated. Five year old branches (two on each tree) were selected and marked with paint to record branch diameter, number of flower buds and number of vegetative buds before blooming and the values were put for calculations as:

$$\text{Bloom density} = \frac{\text{Flower buds}}{\text{cm}^2 \text{ BCSA}} \quad \text{where branch cross sectional area (BCSA)} = \pi r^2$$

$$\text{Bloom index} = \frac{\text{\# Flower buds}}{\text{\# Flower buds} + \text{vegetative buds}}$$

RESULTS and DISCUSSION

The treatments C₁ and C₂ recorded overall positive effect on the bloom density, bloom index and pollen germination. This could be due to the reason that calcium nitrate increases carbohydrate synthesis which in turn enhances the bloom density, index and pollen germination (tube growth). Chelated calcium (C₃ and C₄) recorded the negative impact on all the reproductive parameters (Table 2) and the results are in close agreement with the records of Lee et al (2009) who observed decreased pollen germination rate and pollen tube growth in pear which received calcium treatment at the concentration of 200 mg/l. However pollen viability was not influenced by either calcium nitrate (C₁ and C₂) or by chelated calcium (C₃ and C₄). Pollen tube upon germination needs continuous nutritional support as compared to pollen viability when the pollen remains nutritionally less active. Further in these experiments bloom density and index remained unchanged in first year but were significantly improved by B applications in the next year. Study of Wojcik (1999) and Perrin (1999) supports the observations wrt bloom density and index.

Applications of boron through solubor or boric acid did not show any

improvement in pollen viability contrary to the findings of Usenik and Stampar (2002) who in sweet cherry reported improvement in pollen viability by B application. Boron application in the form of solubor (B₃ and B₄) registered significantly higher values of pollen germination which might be due to increased sugar translocation and pollen integrity. Results are in accordance with Askin et al (1990) who found enhanced pollen germination in sweet cherry through foliar spray of B (boric acid) @ 40 ppm. Interaction influence on bloom density and bloom index was not influenced by C and B combination during 2010 (Table 3) which could be due to the fact that flower initiation takes place during preceding year. However Shukla (2011) reported that combinations of boron and calcium in the form of calcium carbonate and borax enhanced the bloom index and density. It is possible that supply of B and Ca in autumn was too late to influence the formation of flower buds because the development of flower buds mainly takes place 7-8 weeks after full bloom as outlined by Mika (1974) in sweet cherry. Pollen viability was found unaffected by different treatment combinations of C and B which is in consonance with Nyomora et al (2000) who observed that pollen viability remained unaffected by foliar application of boron and calcium combinations. However pollen germination was recorded

Calcium, boron effect on sweet cherry

Table 1. Foliar spray of boron and calcium applied on cherry

Chemical	Source	Concentration used
Boron	Boric acid (H_3BO_3)	$B_0 = 0\% B$
		$B_1 = 0.01\% B$
		$B_2 = 0.02\% B$
Calcium	Solubor/Disodium octaborate tetra-hydrate ($Na_2B_8O_{13} \cdot 4H_2O$) Calcium nitrate [$Ca(NO_3)_2$]	$B_3 = 0.01\% B$
		$B_4 = 0.02\% B$
		$C_0 = 0\% Ca$
	Chelated calcium (Ca-EDTA)	$C_1 = 0.05\% Ca$
		$C_2 = 0.10\% Ca$
		$C_3 = 0.05\% Ca$ $C_4 = 0.10\% Ca$

Treatment combinations (25)

Calcium	Boron				
	B_0	B_1	B_2	B_3	B_4
C_0	C_0B_0	C_0B_1	C_0B_2	C_0B_3	C_0B_4
C_1	C_1B_0	C_1B_1	C_1B_2	C_1B_3	C_1B_4
C_2	C_2B_0	C_2B_1	C_2B_2	C_2B_3	C_2B_4
C_3	C_3B_0	C_3B_1	C_3B_2	C_3B_3	C_3B_4
C_4	C_4B_0	C_4B_1	C_4B_2	C_4B_3	C_4B_4

Table 2. Bloom and pollen attributes of cherry under the influence of calcium and boron

Calcium	Bloom density (flower buds/cm ² BCSA)		Bloom index		Pollen viability (%)		Pollen germination (%)	
	2010	2011	2010	2011	2010	2011	2010	2011
C_0	16.10	17.83	0.65	0.70	87.95	88.20	58.88	58.28
C_1	15.98	19.12	0.66	0.70	88.03	88.43	60.58	61.61
C_2	16.21	19.21	0.65	0.71	87.65	89.44	60.17	60.62
C_3	16.00	12.90	0.66	0.66	88.45	87.75	59.23	43.16
C_4	15.86	12.41	0.65	0.66	87.75	87.58	58.70	41.17
$CD_{0.05}$	NS	1.45	NS	0.01	NS	NS	NS	0.41
Boron								
B_0	48.52	15.26	0.65	0.67	88.14	88.50	55.21	50.12
B_1	48.18	15.67	0.65	0.67	87.54	88.31	56.11	50.85
B_2	48.06	15.60	0.66	0.67	87.74	87.80	56.23	50.79
B_3	48.20	16.73	0.67	0.70	88.51	88.87	62.13	54.58
B_4	47.67	18.21	0.65	0.72	87.91	87.92	68.07	57.48
$CD_{0.05}$	NS	1.45	NS	0.01	NS	NS	1.52	0.41

Table 3. Interaction effect of calcium and boron on bloom and pollen attributes of cherry

Treatment	Bloom density (flower buds/ cm ² BCSA)		Bloom index		Pollen viability (%)		Pollen germination (%)	
	2010	2011	2010	2011	2010	2011	2010	2011
C ₀ B ₀	16.56	16.77	0.67	0.69	88.32	89.21	55.50	54.40
C ₀ B ₁	16.30	17.52	0.65	0.69	87.23	88.33	57.32	56.15
C ₀ B ₂	15.92	17.65	0.65	0.67	86.74	87.14	57.54	56.76
C ₀ B ₃	15.93	18.31	0.68	0.71	89.34	88.97	58.33	58.74
C ₀ B ₄	15.79	18.88	0.64	0.75	88.15	87.34	66.73	65.35
C ₁ B ₀	16.47	17.10	0.63	0.68	87.53	89.18	56.32	55.82
C ₁ B ₁	15.71	17.76	0.66	0.68	86.93	87.69	57.15	56.34
C ₁ B ₂	16.02	17.96	0.66	0.68	88.26	87.24	57.67	57.10
C ₁ B ₃	16.10	19.66	0.67	0.72	89.66	89.72	64.67	64.68
C ₁ B ₄	15.59	23.13	0.68	0.77	87.77	88.33	68.03	69.11
C ₂ B ₀	16.29	16.72	0.65	0.68	87.86	90.24	55.54	55.31
C ₂ B ₁	16.14	17.26	0.64	0.69	86.93	90.11	56.71	55.94
C ₂ B ₂	16.20	17.42	0.65	0.67	87.40	90.06	56.55	56.41
C ₂ B ₃	16.12	20.83	0.65	0.71	87.81	89.13	62.76	66.11
C ₂ B ₄	16.29	23.84	0.67	0.81	88.28	87.68	69.28	69.33
C ₃ B ₀	16.43	13.27	0.67	0.68	89.46	87.73	54.87	43.66
C ₃ B ₁	15.76	12.92	0.65	0.65	89.77	88.22	54.98	42.94
C ₃ B ₂	15.84	12.81	0.67	0.66	87.01	87.33	54.93	42.73
C ₃ B ₃	16.06	12.66	0.69	0.69	88.36	88.33	62.78	43.66
C ₃ B ₄	15.92	12.84	0.62	0.64	87.65	87.16	68.59	42.81
C ₄ B ₀	15.12	12.45	0.63	0.66	87.54	86.15	53.82	41.45
C ₄ B ₁	16.40	12.90	0.65	0.66	86.87	87.19	54.37	42.88
C ₄ B ₂	16.13	12.14	0.68	0.67	89.28	87.24	54.50	40.97
C ₄ B ₃	16.13	12.21	0.66	0.67	87.39	88.21	62.11	39.73
C ₄ B ₄	15.52	12.37	0.65	0.66	87.70	89.11	68.72	40.83
CD _{0.05}	NS	1.90	NS	0.02	NS	NS	3.04	0.82

to have been remarkably influenced by various Ca and B treatment combinations. This is due to the fact that Ca and B induced

pollen germination slightly (Jutamane et al 2002).

CONCLUSION

Flowering characteristics like bloom density and index, pollen viability and germination were noted to be positively affected by calcium nitrate at higher concentration that is 0.10 per cent Ca through $\text{Ca}(\text{NO}_3)_2$. The influence of solubor was striking with respect to flowering characteristics. Higher dosage of boron (0.02% B through solubor) recorded better values.

REFERENCES

- Anonymous 2011. A report on fruit area and production 2010-2011. Directorate of Horticulture, Kashmir, J&K, pp 1-2.
- Askin A, Hepaksoy S and Ozcagiran R 1990. Investigations on effects of atonic (sodium mono-nitro quaiacol), GA and boric acid on germination power of some sweet cherry pollens. *Ege-Universitesi-Ziratt-Fakultesi-Dergisi* **27(3)**: 105-116.
- Callan NW, Thompson MM and Westwood MN 1978. Effects on the fruit set of Italian prune following foliar spring B sprays. *Journal of American Society of Horticultural Sciences* **103**: 253-257.
- Drake SR, Proebsting SL and Spayd SE 1982. Maturity index for the colour grade of canned dark sweet cherries. *Journal of American Society of Horticultural Sciences* **107**: 180-183.
- Gupta UC 1979. Boron nutrition of crops. *Advances in Agronomy* **19**: 157-209.
- Hanson EJ and Breen PJ 1985. Effect of fall boron sprays and environmental factors on fruit set and boron accumulation in 'Italian' prune flowers. *Applied Journal of American Society for Horticultural Sciences* **110(3)**: 389-392.
- Jeremy C 2007. Apple and pear nutrition. *Prime Facts* **85**: 1-12
- Jutamane K, Eoomkhan S, Pichakum A and Krisanapook K 2002. Effect of calcium, boron and sorbitol on pollination and fruit set in mango cv Namdokmai. *Acta Horticulturae* **575**: 829-834.
- Kadir SA 2004. Fruit quality at harvest of Jonathan apple treated with fatally applied calcium chloride. *Journal of Plant Nutrition* **27(11)**: 197-200.
- Lee S, Kim W and Han T 2009. Effect of postharvest foliar B and Ca applications on subsequent seasons pollen germination and pollen tube growth of pear (*Pyrus pyrifolia*). *Scientia Horticulturae* **122**: 77-82.
- Mika A 1974. Studia and zaleznoscia miedzy wzrosterm an owocowaniem mlodych jabloni. *Prace Inst Sadown* **4(2)**: 1-100.
- Nyomora AMS, Brown PH and Krueger B 1999. Rate and time of boron application increase almond productivity and tissue boron concentration. *Hortscience* **34(2)**: 242-245.
- Perrin GD 1999. Main and interactive effects of B on lowbush blue berry (*Vaccinium angustifolium* Ait) nutrition, growth, development and yield. Thesis, Dalhousie University, Halifax, Nova Scotia.
- Saure MC 2005. Calcium translocation to fleshy fruits: its mechanism and endogenous control. *Scientia Horticulture* **105**: 65-89.
- Shorrocks VM 1997. The occurrence and correction of boron deficiency. *Plant and Soil* **193**: 121-148.
- Shukla AK 2011. Effect of foliar application of calcium and B on growth, productivity and quality of Indian gooseberry (*Emblica officinalis* L). *Indian Journal of Agricultural Sciences* **81(7)**: 628-632.
- Stampar F, Hudina M, Dolenc K and Usenik V 1999. Influence of foliar fertilization on yield quality and quantity of apple (*Malus x domestica* Bork). In: Improved crop quality by nutrient management. Khrwer Academic Publishers, Dordrecht, The Netherlands, pp 91-94.

- Stampar F, Sturm K and Usenik V 2000. Influence of foliar fertilization on yield quantity and quality of apple (*Malus x domestica* Borkh). In: Improved crop quality by nutrient management (D Anac and P Martin-Prevel eds). Kluwer Academic Publishers, Dordrecht, The Netherlands, pp 91.
- Usenik V and Stampar F 2002. Effect of foliar application of zinc plus B on sweet cherry fruit set and yield. *Acta Horticulturae* **594**: 30-40.
- Warington K 1923. The effect of boric acid and borax on the broad bean and certain other plants. *Annals of Botany* **37**: 629-672.
- Wojcik P 1999. Effect of boron fertilization of Dabrowicka prune trees on growth, yield and fruit quality. *Journal of Plant Nutrition* **22(10)**: 1651-1664.
- Wojcik P and Szwonek E 2002. The efficiency of different foliar applied calcium materials in improving apple quality. *Acta Horticulturae* **594**: 553-556.
- Zatylnyl AM and St-Pierre RG 2006. Development of standard concentrations of foliar nutrients for Saskatoon. *Journal of Plant Nutrition* **29**: 195-207.
- Zude M, Alexander A and Ludders P 1998. Influence of boron spray in autumn or spring on flower boron concentration, fruit set and yield in apple cv Elstar. *Erwerbsobstbau* **40**: 18-21.

Received: 2.6.2015

Accepted: 19.2.2016