Pure Appl. Biol., 5(3): 464-470, September, 2016
http://dx.doi.org/10.19045/bspab.2016.50060

Research Article

Effect of three Ca-sources applications on fruit quality attributes of three peach cultivars in Pakistan

Muhammad Wahab[1*], Zia Ullah[2], Muhammad Usman[3], Sadaf Nayab[4], Murad Ullah[1], Muhammad Sajid[1] and Kamran Sohail[5]

1. Department of Horticulture, University of Agriculture, Peshawar, Pakistan
2. Floriculture Section, Agricultural Research Institute Tarnab Farm, Peshawar, Pakistan
3. Department of Entomology, Bacha Khan University, Charsada, Pakistan
4. Department of Plant Breeding and Genetics, University of Agriculture, Peshawar, Pakistan
5. Department of Entomology, University of Agriculture, Peshawar, Pakistan

**Corresponding author's email*: *Muhammadwahab111@gmail.com*

Citation
Muhammad Wahab, Zia Ullah, Muhammad Usman, Sadaf Nayab, Murad Ullah, Muhammad Sajid and Kamran Sohail. Effect of three Ca- sources applications on fruit quality attributes of three peach cultivars in Pakistan. Pure and Applied Biology. Vol. 5, Issue 3, pp464-470. http://dx.doi.org/10.19045/bspab.2016.50060

Received: 15/12/2015 Revised: 13/05/2016 Accepted: 20/05/2016 Online First: 28/05/2016

Abstract

A research to investigate the "effect of three ca- sources applications on fruit quality attributes of three peach cultivars in Pakistan" was carried out at Peach orchard, Horticulture section research farm, The University of Agriculture Peshawar, Pakistan during the spring, 2013. Three Ca-sources (calcium chloride, calcium nitrate, calcium oxide) at 1.5% were sprayed on Peach cultivars (Early Grand, Florida King, Tex.A.69) and control were untreated plants. The experiment was presented in Randomized Complete Block Design with split plot arrangements having three replications. The Ca-sources kept in main plot and cultivars were kept in sub plot. In the experiment all the studied parameters were significantly affected by Calcium Sources and peach cultivars. Among Ca-sources, the highest Vitamin C Content (7.03 mg 100 ml^{-1}), TSS (6.31 ^{0}Brix), fruit pH (3.70) and fruit firmness (7.65 $Kg.cm^{-2}$) with lowest Number of fruits drop (15.33) and percent acidity (0.60%) was recorded in fruits that were sprayed with calcium chloride. Among cultivars highest TSS (6.26 ^{0}Brix), fruit pH (3.67) and fruit firmness (6.88 $Kg.cm^{-2}$) with the lowest number of fruits drop (17.75) was observed in fruits of peach Tex.A.69 cultivar. It is therefore concluded that peach grower should grow peach cultivar Tex.A.69 and calcium chloride should be used as foliar application to improve the quality attributes of peach cultivars.

Key words: Ca-Sources; Peach quality; Peach cultivars

Introduction

Peach, *(Prunus persica* L.*)* belongs to family Rosaceae and is one of the most important stone fruit of the temperate nature. Peach is looked as native to China and was probably developed in Persian. Two peach verities i.e. cling to party and free stone mostly used worldwide. It is one of the important fruit of Pakistan, especially in areas of Peshawar

and Swat. Early Grand, Florida King, 6-A and 8-A are the most popular cultivars. In Baluchistan primarily shah Pasand, Golden Early, and Shireen are cultivated [1]. In Pakistan peaches are cultivated on an area of 15.2 thousand hectares with the production of 52.6 thousand tons. In Khyber pakhtunkhwa peach is grown on 5.6 thousand hectares area with a complete production of 30.8 thousand tons [2]. Quetta, Kalat. Peshawar and swat valley are the main peach producing areas of Pakistan [1]. Peach is delicious in taste and attractive in aroma. It contains sugar of 10-14%, protein of 2% and rich in ascorbic acid, vitamins A and B except iron, phosphorus and calcium [3]. Peach is classified as of climacteric fruit because of increasing respiration during ripening. The peach fruit is drupe, with epidermis (skin) fuzzy (pubescence) as in normal peach or glabrous (smooth) as in nectarine. Skin and flesh colour may be white or yellow (some cultivars red). The endocarp (stone) is lignified, the outer surface being deeply furrowed and pitted. Peach fruit weight varies, but mostly 228g depending upon cultivar [4]. Calcium is a major constituent of cell walls and membranes and plays a role in their proper functioning. It also play important role in pollen germination, cell division, environmental signaling and protecting cells from toxins [5]. Calcium deficiency symptoms to appear are a reduction in root growth [5]. Subsequent roots that develop are often swollen and stubby. Early leaf symptoms of Calcium deficiency includes marginal leaf chlorosis, which develops into necrosis and eventually leads to defoliation. Fruits on Ca deficient trees are smaller, lower in sugar and have poorer colour and flavor [5]. As Ca is found in cell walls, it has been associated with cell rigidity and fruit firmness. Addition of Ca has successfully delayed softening of various fruits [6] and reduced decay [7]. Pre harvest applications of Ca spray have reduced fruit rot, maintained firmness and improved flavor, aroma and appearance of peaches [8, 9]. This study aimed to find out the best Ca-Sources as foliar application for agro climatic condition of Peshawar for improving the quality attributes of peach cultivars.

Materials and methods

To investigate the effect of three ca- sources applications on fruit quality attributes of three peach cultivars in Pakistan was carried out at Peach orchard, Horticulture section research farm, The University of Agriculture Peshawar, Pakistan during the spring, 2013.

Following two factors were examined. Factor A, three Ca-sources ($CaCl_2$, $Ca(NO_3)_2$, CaO) at 1.5% along with control. Factor B, different peach cultivars (Early Grand, Florida King, Tex. A.69). The study was laid out in Randomized Complete Block Design (RCBD) with split plot arrangement. The experiment comprises of twelve treatments and each treatment was replicated three times. The Ca-Sources (1.5%) as pre harvest spray applied at Berry stage of fruit. A total of 72 trees were selected and 2 trees per treatment per replication were selected for foliar application.

Number of fruits drop

From two randomly selected trees all the dropped fruits were collected in each replication. The numbers of fallen fruits were then counted and their means were recorded.

Fruit firmness ($Kg.cm^{-2}$)

Fruit firmness were calculated by Penetrometer (hand held with 8mm) plunger.

Total soluble solids (^{0}Brix)

TSS was determined with the help of Refract meter prisms represented in The Association of official Analytical Chemist [26].

Fruit pH

pH meter was used to determined the fruits pH of randomly taken fruits.

Percent acidity

Acid base titration procedure was used to calculate percent acidity as described in The Association of official Analytical Chemist [26].

Vitamin C content (mg 100 ml^{-1})

Vitamin C Content was calculated by the Titramitric method (Redox titration) as represented in The Association of official Analytical Chemist [26].

Statistical procedure

The experiment was laid out in Randomized Complete Block design with split plot arrangement and means were separated using (LSD) test [10].

Results and discussions

Number of fruits drop

Data obtained for number of fruits drop as effected by Ca-sources revealed that maximum number of fruits drops (26.61) was recorded in control treatment followed by number of fruits drops i.e. 20.00 and 18.88 recorded in trees with calcium nitrate and calcium oxide, respectively. Whereas the minimum number of fruits drops (15.33) recorded in plants sprayed with $CaCl_2$. **(**Table 1)

Data obtained for peach cultivars showed that maximum number of fruits drop (21.65) was observed in Florida King while the minimum number of fruits drops (17.75) was recorded in Tex.A.69. **(**Table 1)

Calcium chloride helped in flowering, pollination and fertilization [11] and its application helped to improve the cellulose and lignin formation and these materials are required for building plant structure and prevent abscission layer formation hence, pre harvest fruit drop was significantly reduce[12]. The number of fruit drops was more in calcium nitrate and calcium oxide treatment as compare to calcium chloride treatment. The foliar application of $CaCl_2$ significantly increased the fruit set and reduced the pre harvest fruit drop [13,14].

Fruit firmness (Kg.cm^{-2})

Data obtained for fruit firmness revealed that highest fruit firmness (7.65) in $CaCl_2$ treatment whereas the lowest (5.31) was recorded in control. The fruit firmness recorded in calcium chloride and calcium oxide treatments were 6.71 and 6.29, respectively. **(**Table 1)

Data obtained for peach cultivars also revealed that more fruit firmness 6.88 Kg.cm^{-2} was found in Tex.A.69 cultivar, whereas the minimum fruit firmness 6.14 Kg.cm^{-2} was recorded in Early Grand cultivar. **(**Table 1)

The determination of fruit reduction of peaches is because of classification of fermental degrading in un soluble proto pectin's to more simple tractable pectin, solubilizing contents of cells and wall of cells owing to increase in pectin esterase activity[15]. Sources of Calcium could reduce hardness of fruit as it is an essential part of structure of a cell and it also influences integrity of cell membrane [16]. The source of Calcium can also detain glacto lipid breakdown, increase norm of sterol conjugation and creates effects on the post harvests life of a fruit [17]. The pre harvest-application of the calcium chloride in peaches was effective in improving the fruit firmness [18]. These results are in conformity with the findings of [19-21], they concluded that application of sources of calcium helped in reducing the loss of fruit determination during the storage, and calcium chloride reduce the internal depression which helped in reducing the respiration and fruit determination.

Table 1. Numbers of fruit drop (F.D) and fruit firmness (Kg.cm^{-2}) (F.F) of three peach cultivars as affected by the three foliar applications of Ca-Sources at 1.5%

	Control		$CaCl_2$ (1.5%)		$Ca(NO_3)_2$(1.5%)		CaO (1.5%)		Means	
Cultivars	F.D	F.F	F.D	F.F	F.D	F.F	F.D	F.F	F.D	F.F
Early Grand	31.00	4.90	18.00	7.20	18.67	6.50	18.83	5.96	21.62a	6.14c
Florida King	26.83	5.13	14.83	7.76	21.33	6.70	22.00	6.20	21.25b	6.44b
Tex.A.69	22.00	5.90	13.11	8.00	16.67	6.93	19.17	6.70	17.74c	6.75a
Means	26.61a	5.31d	15.33c	7.65a	20.00b	6.71b	18.88b	6.29c		

LSD value for Ca-Source (Ca) at 5% level of probability = (F.D) 3.43 (F.F) 1.86
LSD value for cultivars (Cv.) at 5% level of probability = (F.D) 0.32 (F.F) 0.10

Total soluble solids (^{0}Brix)

Data obtained for total soluble solid (^{0}Brix) for Calcium Sources showed that more TSS 6.31 was recorded in fruits of plants treated with Calcium chloride followed by (6.20 & 6.03 ^{0}Brix) TSS noted in fruits of plants sprayed with $Ca(NO_3)_2$ and CaO, respectively while the minimum TSS (5.82 ^{0}Brix) was recorded in control treatment **(**Table 2).

Data obtained for peach cultivars indicated that highest (6.26) was recorded in Tex.A.69 cultivar, whereas the lowest 5.99 TSS observed in Early Grand cultivar **(**Table 2).

Taste and flavor of the fruit is due to TSS in combination with acidity. Total soluble solids increase with the application of calcium sources at pre harvest stage [13]. The respiration rate and ripening process reduce with foliar application of $CaCl_2$ converting some acid into sugars [22].

Fruit pH

Data obtained for Ca-Sources showed that maximum fruit pH (3.70) was observed in $CaCl_2$ treatment followed by fruit pH (3.67 & 3.65) observed in fruits treated with $Ca(NO_3)_2$ and CaO respectively, while the minimum fruit pH (3.6) was noted in fruit trees in untreated fruits **(**Table 2).

Data obtained for cultivars indicated that the highest fruit pH (3.67) was recorded in fruits of Tex.A.69 cultivar, while the lowest fruit pH (3.53) was recorded in fruits of Florida King cultivar **(**Table 2).

$CaCl_2$ as foliar application increase fruit pH and decrease percent acidity in peach fruit [21] and also affect the fruit quality because it cause change in the normal cellular functions and as a result, it lower the cell acidity [7]. The pre harvest application of Calcium slows down the respiration process and delay ripening of fruit. Acids utilization is reduced due to low respiration and some acids change into sugars. Hence pH become high and acidity becomes low [22].

Table 2. Total soluble solids (^{0}Brix) (TSS) and fruit pH of three peach cultivars as affected by the three foliar applications of Ca-Sources at 1.5%

	Control		$CaCl_2$ (1.5%)		$Ca(NO_3)_2$(1.5%)		CaO (1.5%)		Means	
Cultivars	TSS	pH	TSS	pH	TSS	pH	TSS	pH	TSS	pH
Early Grand	5.93	3.60	6.03	3.70	6.03	3.67	5.96	3.65	5.98c	3.65c
Florida King	5.63	3.59	6.20	3.69	6.16	3.67	6.06	3.64	6.01b	3.64b
Tex.A.69	5.90	3.62	6.70	3.71	6.40	3.69	6.07	3.70	6.26a	3.68a
Means	5.82d	3.60d	6.31a	3.70a	6.20b	3.67b	6.03c	3.65c		

LSD value for Ca-Source (Ca) at 5% level of probability = (TSS) 0.10 (pH) 0.02
LSD value for cultivars (Cv.) at 5% level of probability = (TSS) 0.07 (pH) 0.01

Percent acidity

Data obtained for percent acidity for calcium sources indicated that highest percent acidity (0.74%) was observed in fruits of untreated plants whereas the lowest percent acidity (0.60%) was observed in fruits of trees treated with $CaCl_2$. The percent acidity of 0.70 and 0.63% recorded in fruits of plants treated by CaO and $Ca(NO_3)_2$ respectively. **(**Table 3).

Data obtained for peach cultivars revealed that highest (0.77%) percent acidity was observed in fruits of Early Grand cultivar, whereas the lowest (0.70%) percent acidity was recorded in fruits of Florida King Cultivar. **(**Table 3).

Calcium chloride dealing with their prospective effect on improving fruit flavor, enhancing fruit quality and reduce percent acidity [19]. Percent acidity is responsible for maintaining the fruit quality that depends on the organic concentration [23]. Acid contents of the fruits may also affect the cellular processes [7]. Foliar application reduced the percent acidity of calcium chloride that negatively affect the rate of respiration, delay in fruit ripening ultimately affecting the acid utilization processes leads to change of acids into sugar contents [21, 22]. Fruit quality was improved by the application of calcium in the pre harvest [24].

Vitamin C content (mg $100ml^{-1}$)

Data obtained for Ca-Sources indicated that maximum (7.03) Vitamin C Content was observed in fruit plants treated with Calcium chloride followed by (6.20 & 6.03) Vitamin C Content recoded in fruit plants sprayed with Calcium nitrate and Calcium oxide respectively. Whereas the minimum (5.47) Vitamin C Content was observed in control treatment **(**Table 3).

Data obtained for cultivars showed that more (6.3) Vitamin C Content was recorded in fruits of Early Grand cultivar, whereas the less (6.11) Vitamin C Content was observed in fruits of peach cultivar Tex.A.69. **(**Table 3)

Maintains of fruit quality can be achieved by pre harvest application of Ca-sources as it internally reduced the break down processes [25]. Calcium application may also affect the fruit quality as by changing in total acid contents (Conway, 1987). The research of other scientists also supported our results [18].

Table 3. Percent Acidity (P.A) and vitamin C content (mg $100ml^{-1}$) (Vit.C) of three peach cultivars as affected by three the foliar applications of Ca-Sources at 1.5%

	Control		**$CaCl_2$ (1.5%)**		**$Ca(NO_3)_2$(1.5%)**		**CaO (1.5%)**		**Means**	
Cultivars	P.A	Vit C	P.A	Vit C	P.A	Vit C	P.A	Vit C	P.A	Vit C
Early Grand	0.85	5.74	0.70	7.14	0.72	6.47	0.81	6.07	0.77a	6.35a
Florida King	0.78	5.47	0.62	6.91	0.61	6.07	0.78	5.98	0.69a	6.10b
Tex.A.69	0.59	5.20	0.48	7.03	0.56	6.26	0.51	6.08	0.53a	6.14b
Means	0.74a	5.47c	0.60b	7.03a	0.63b	6.27b	0.70a	6.04b		

LSD value for Ca-Source (Ca) at 5% level of probability = (P.A) 0.27 (Vit C) 0.37
LSD value for cultivars (Cv.) at 5% level of probability = (P.A) 0.29 (Vit C) 0.14

Conclusion and recommendations

On the basis of results it was concluded that the fruits of peach trees sprayed with $CaCl_2$ at 1.5% indicated maximum Vitamin C Content (mg 100 ml^{-1}), TSS (^{0}Brix), fruit pH and fruit firmness ($Kg.cm^{-2}$) with lowest percent acidity and number of fruits drops. Cultivar Tex.A.69 showed more TSS (^{0}Brix), fruit pH, fruit firmness ($kg.cm^{-2}$) with less number of fruits drops and percent acidity. The present study recommends that foliar application of $CaCl_2$ at 1.5% could be used to improve the fruit quality attributes of peach cultivars also peach growers should used cultivar "Tex.A.69" for better qualitative attributes of peach fruit for the agro climatic condition of Peshawar.

Authors' contributions

Conceived and designed the experiments: M Wahab & Z Ullah, Performed the experiments: M Wahab, S Nayab & M Ullah, Analyzed the data: M Usman & K Sohail, Contributed reagents/ materials/ analysis tools: M Sajid & Z Ullah, Wrote the paper: M Wahab, S Nayab & M Ullah.

References

1. Chaudhary MA **(**1994). Fruit Crops. In: Bashir E & R Bantel, editors. Horticulture. National Book Foundation. Islamabad. 476-477
2. Agricultural Statistics of Pakistan (2010–2011). Peach production and area. Table 51, page 95. Retrieved from: http://www.pbs.gov.pk/content/agricultural-statistics-pakistan-2010
3. USDA Nutrient Database (2011). Nutrient data for 09236, Peaches, raw. Retrieved from:http://ndb.nal.usda.gov/ndb/foods/show/2327?fg=&man=&lfacet=&format=&count=&max=25&offset=&sort=&qlookup=peach.
4. Bassi D & Monet R (2008). Botany and Taxonomy. In: Lyne D R & Bassi D, editors. The Peach Botany. Production and Uses: *CAB International UK*. pp. 1-30
5. Johnson RS (2008). Nutrient and water requirements of peach trees. In: Lyne D R & D Bassi, editors. The Peach Botany. Production and Uses: *CAB International UK*. pp. 310-311.
6. Pooviah BW, Glenn GM & Reddy ASN (1988). Calcium and fruit softening physiology and biochemistry. *Horti Revi* 10: 107–152.
7. Conway WS **(**1982). Effect of postharvest calcium treatment on decay of 'Delicious' apples. *Plant Disease* 66: 402–403.
8. Adaskaveg JE, Ogawa JM & Feliciano AJ (1992). Comparisons of calcium-based and film-forming materials for control of brown rot of peach caused by *Monilinia fructicola. Phytopathol* 82: 1158.
9. Biggs AR, El-Kholi MM, El- Neshawy S & Nickerson R **(**1997). Effects of calcium salts on growth, polygalacturonase activity and infection of peach fruit by *Moniliniafructicola*. *Plant Disease* 81: 399-403.
10. Steel R & Torri J (1997). Principles and Procedures of Statistics A Biometrical Approach 178.
11. Rasool M & Khan FU (2012). Effect of calcium, boron and zinc on growth, flowering and bulb (*Tulipa gesneriana* L.) cv. Apeldoorn. PhD dissertation, Sher-E-Kashmir *Uni Of Agri Sci* (Srinagar). Retrieved from: http://dspaces.uok.edu.in/jspui//handle/1/1065.
12. Nijjar GS (1985). Nutrition of Fruit, Published by Mrsusha Rajkumer for Kalyeni publishers New Delhi pp: 10-270.
13. Sarrwy SMA, Gadalla EG & Mostafa EAM (2012). Effect of calcium nitrate and boric acid sprays on fruit set, yield and fruit quality of cv. Amhat Date

Palm. *World J of Agriculture Sci* 8: 506-515.
14. Ge LL, Tian Q & Russell SD (2007). Calcium function and distribution during fertilization in angiosperms. *Amer J of Botany* 94: 1046–1060.
15. Deshpande PB & DK Salunkhe (1964). Effect of maturity and storage on certain biochemical changes in apricots and peaches. *Food Technol* 18(18): 85-88.
16. Fallahi E, Conway WS, Hickey KD & Sams CE (1997). The role of calcium and nitrogen in postharvest quality and disease resistance of apple. *Hort Sci* 32(5): 831-835.
17. Picchioni GA, Watada EA, Conway WS, Whitaker BD & Sams CE (1995). Phospholipid, galactolipid and steryl lipid composition of apple fruit cortical tissue following postharvest CaCl2 infiltration. *Phytochem* 39 (4): 763-769.
18. El-Alakmy HA **(**2012). Effect of Calcium Application and Wrapping Treatments on Fruit Quality of Early Grand Peach Trees (*Prunus persica* L.). *J of Appli Sci* 8: 3845-3849.
19. Brar SS, Simnani SSA & Kaundal GS (1997). Effect of pre-harvest sprays of calcium nitrate on the storage life of Shan-I-Punjab peach. *J Res Punjab Agric Univ* 34(2): 174-180.
20. Guarinoni A, Ferenczi A, Silvera A & Mori R (2000). Evaluation of post-harvest fruit quality of flavor crest peach growing under an integrated production system. *IIR Conference Murcia Spain* 69: 81.
21. Mahmoud MM (2008). Influence of gamma rays and some pre and post harvest treatments on behavior of some fruits during cold storage. M.Sc. Thesis. Deptt Environmental Sci. Institute of Environmental Studies and Research. Ain Shams Univ of Egypt.
22. Raese JT & Drake SR (1993). Effect of pre-harvest calcium sprays on apple and pear quality. *J of Plant Nutrit* 16: 1807-1918.
23. Kazemi M, Aran M & Zamani S (2011). Effect of calcium chloride and salicylic acid treatments on quality characteristics of kiwifruit (*Actinidia deliciosa* cv.) during storage. *American J Plant Physiol* 6(3): 183-189.
24. Serrano M, Romero DM, Castillo S, Guillén F & Valero D (2004). Effect of preharvest sprays containing calcium, magnesium and titanium on the quality of peaches and nectarines at harvest and during postharvest storage. *J Sci Food & Agric* 84(11): 1270-1276.
25. Bangerth F, Dilley DR & Dewey DH (1972). Effect of postharvest calcium treatment on internal breakdown and respiration of apple fruits. *J Amer Soc Hort Sci* 97: 679-682.
26. AOAC **(**1990). Official Methods of Analysis. The Association of official Analytical Chemist, 17thEdn. Chap17.