academicJournals

Vol. 10(11), pp. 376-380, 15 June, 2015
DOI: 10.5897/SRE2015.6246
Article Number:2BFBED353458
ISSN 1992-2248

http://www.academicjournals.org/SRE

Scientific Research and Essays

Full Length Research Paper

Effect of pre-harvest foliar spray of calcium and potassium on fruit quality of Pear cv. Pathernakh

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Received 1 May, 2015; Accepted 2 June, 2015

Growing costs of fertilizers and increasing concern about ground water pollution has resulted indiscriminate or excessive soil fertilization problem that may be solved by more efficient fertilizer application technologies. The availability of new promising oriental pear or Japanese pear [*Pyrus pyrifolia* (Burm) Nakai] cultivar like 'Patharnakh', pave an opportunity for extending its cultivation under tarai region of Uttarakhand. Even though the cultivar 'Patharnakh' is good for tarai region but the quality is not much good to attract consumer acceptance. An experiment was conducted in 2013 to 2014 to study the effect of foliar spray of micronutrients on Pear. Fifteen year old pear trees were treated with three concentrations (1.0, 1.5 and 2.0%) of calcium and potassium nutrients *viz.,* calcium chloride, calcium nitrate, potassium sulphate and potassium nitrate; and water spray as a control at 30 days intervals starting from fruit set, that is, 20th March 2013, 20th April 2013 and 20th May, 2013. Each treatment was replicated thrice, in which one tree serving as a unit treatment. The experiment was conducted in Factorial Randomized Block Design. The observations were recorded on the basis of biochemical characters *viz.,* total soluble solids, acidity, ascorbic acid contents, total sugars, reducing sugar and non reducing sugar. Fruits treated with potassium nitrate at 1.5% showed the highest total soluble solids (11.72 ºBrix), total sugars (7.62%), reducing sugars (6.10%) and non reducing sugars (1.51%). However, titratable acidity (0.46 %), and ascorbic acid (6.42 mg/100 g) were found maximum with calcium chloride at 2.0% concentration. Therefore on the basis of economic point of view reducing the excessive cost of applied inputs by use of micronutrients can be an alternative to get quality produce. So, these treatments may be recommended for adaptation of Patharnakh pear in *tarai* region.

Key words: Pear, calcium and potassium spray, fruit quality.

INTRODUCTION

Pear (*Pyrus pyrifolia* Burm Nakai) is one of the important fruit of temperate region of the world. It can be grown in a wide range of climatic conditions and tolerate as low as -26°C temperature when dormant and as high as 45°C during growing period. A large number of pear cultivars require about 1200 h below 7°C during winter to meet their chilling requirements to flower and fruit satisfactorily. It belongs to the family Rosaceae, subfamily Pomoideae

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and genus *Pyrus,* having basic chromosome number 17 (2n=34). It ranks second, only next to apple in many aspects *viz.,* global importance, diversity of existence, acreage and production. About 1711.50 MT of pears are produced around the world, of which 20 MT are produced in India (FA0, 2014). The area under pear cultivation in the state of Uttrakhand is around 15.0 Thousand hectare, with annual production and productivity of 1.08 lack MT and 7.16 MT/ha, respectively (Anonymous, 2014). Macro and micronutrients play an important role in physiological characteristics and quality of pear. Amiri et al. (2008) claimed that foliar application of nutrients is more efficient to improve quality of pear, as foliar sprays can supply essential elements directly to the foliage and fruits. Improving marketable fruit with good quality has always been a challenge for scientists and pear growers. Growing costs of fertilizers and increasing concern about ground water pollution resulting from indiscriminate or excessive soil fertilization are problem that may be solved by more efficient fertilizer application technologies. The easiest way to maximize quality level by foliar spray is an alternative approach. Foliar application may be one technique which could possibly minimize the environmental hazard. Calcium plays an important role in maintaining the quality and storability of pear fruits. By applying calcium nutrition, the respiration rate was reduced, delaying ripening and there was increase in fruit firmness and the storage life was extended (Faust, 1979). Among various nutrients, foliar application of potassium is also considered to have profound effect on fruit quality that is colour, total soluble solids, acidity and vitamins contents (Bhargava et al., 1993). Gill et al. (2012) reported that under sub-tropical conditions of north-western India, pear cultivation is primarily focused to a single variety 'Patharnakh' due to its wider adaptability, low chilling requirement and higher yield potential. Therefore, the present study was carried out in order to study the effect of pre-harvest spray of calcium and potassium nutrients on fruit quality.

MATERIALS AND METHODS

The present investigation was carried out at Horticulture Research Centre Patharchatta, Govind Ballabh Pant University of Agiculture and Technolgy, Pantnagar (Uttarakhand) during the year 2013-2014. Fifteen year old pear trees were treated at three concentrations (1.0, 1.5 and 2.0%) of calcium and potassium nutrients sources from calcium chloride, calcium nitrate, potassium sulphate and potassium nitrate; and water as control at 30 days intervals' starting from fruit set then on 20th March 2013, 20th April 2013 and 20th May, 2013. Each treatment was replicated thrice with one tree serving as a treatment unit. Control plants received only water sprays. Applications were made with foot sprayer using 10 L of water per plant. The experiment was conducted as Factorial Randomized Block Design (FRBD). Trees were maintained under uniform management practices and supplied with good quality tube well water for irrigation. The observations were recorded on the basis of various quality characters viz., total soluble solids, acidity, ascorbic acid contents, total sugars , reducing sugar and non reducing sugar. A random sample of 20 fruits from each replication was taken for physicochemical analysis. Pear fruits were harvested at their proper maturity on 15 July, 2013. Total soluble solid in fruits was recorded at room temperature using hand refractometer (Erma,Tokyo, Japan) and expressed in term of °Brix. A small amount of fruit pulp was taken in muslin cloth and crushed to obtain the juice of crushed pulp which was taken on the refractometer and the value was read against light. For acidity, fruit juice was titrated with 0.1 N NaOH and the results were expressed in terms of percentage of maleic acid as described by Rangana (1996). The Ascorbic acid was estimated by 2, 6-dichlorphenol-indophenol visual titration method as described by Ranggana (1996) and it was expressed in terms of mg per 100 g pulp. Sugars were estimated as per standard method Ranggana (1996). The observations were subjected to statistical analysis by using Factorial Randomized Block Design (FRBD) for various physicochemical attributes. Mean differences were tested by 'F' test at 5% level of significance (LOS). Critical difference (CD) at 5% level of significance was used for comparison among treatments.

RESULTS AND DISCUSSION

The data on total soluble solids presented in Table 1 reveal that all treatments were found to be significant except calcium chloride (T1) in terms of TSS. In the study, the highest total soluble solid content was recorded under potassium nitrate (11.72 °Brix), followed by potassium sulphate (11.11 °Brix) and calcium nitrate (11.03 °Brix) whereas, the minimum total soluble solid contents was recorded under control (10.42 °Brix). The mean TSS at various concentrations also differs significantly, the highest being recorded at 1.5% that is, 11.66 °Brix which is found statistically significant with C1 and C3. The interaction between treatment at their various concentrations (T × C) was found to be non significant. The possible reason of increase in TSS is adequate scope of nutrients to the plant, which hydrolyzed starch into sugar and helpful to increase the TSS of fruit. A higher increase in TSS content with foliar application of potassium is related with role of potassium in translocation of sugar from leaves to fruits, which results better quality fruits in term of total soluble solid. A marked influence in total soluble solid by these nutrients in current study is supported by Shirzadeh and Kazemi (2011) in Apple, Dhatt and Mahajan (2005) in Pear cv. Pathernakh, and Mahajan et al. (2008) in plum cv. Satluj Purple and Siddiqui et al. (1989) in ber cv. Umran.

The data presented in Table 1 manifests that spray of nutrients had a significant effect on titratable acidity over control. The highest mean titratable acidity was recorded under the calcium chloride (0.46%) followed by calcium nitrate (0.45%) and control (0.45%), while the minimum under potassium nitrate (0.41%). The mean acidity at various concentrations also differs significantly among themselves, the highest being recorded at 2.0% that is, 0.45% which is found statistically significant with C1 and C3. The interaction between treatments at various concentrations (T × C) was found to be non significant. The decrease in the acidity might be due to reduction in

Table 1. Effect of pre harvest spray of calcium and potassium on TSS (˚Brix) and Titrable acidity of pear cv. Pathernakh.

Treatments	Fruit TSS (˚Brix)				Titratable acidity (%)			
	Concentrations			Mean	Concentrations			Mean
	1.0% (C_1)	1.5 % (C_2)	2.0 % (C_3)		1.0 % (C_1)	1.5%(C_2)	2.0 % (C_3)	
Calcium Chloride (T_1)	10.63	10.91	11.07	10.87	0.47	0.45	0.44	0.46
Calcium Nitrate (T_2)	10.63	11.27	11.20	11.03	0.46	0.43	0.47	0.45
Potassium Sulphate (T_3)	11.21	11.41	10.70	11.11	0.43	0.42	0.45	0.43
Potassium Nitrate (T_4)	11.52	11.94	11.70	11.72	0.42	0.40	0.41	0.41
Mean	10.99	11.66	10.92		0.44	0.43	0.45	
	(T)	**(C)**	**(T × C)**		**(T)**	**(C)**	**(T × C)**	
C D at 5% or (p=0.005)	0.50	0.43	NS		0.013	0.011	NS	
	Control: 10.42 ± 0.33 (Mean ± SE)				**Control: 0.45 ± 0.011 (Mean ± SE)**			

the activities of enzyme by foliar application of these nutrients. Calcium and potassium nitrate being the source of nitrogen might have modified the vegetative growth, which in turn increase sugar metabolism and consequently decrease the acidity due to conversion of acid into sugar which resulted decrease in the acidity of fruits. The reduction in the acidity under potassium treatment might be owing to increased TSS of the fruits. Titratable acidity is directly related to the concentration of organic acids present in the fruit, which are an important parameter in maintaining the quality of fruits. These results also elucidate the finding of Gill et al. (2012) in pear cv. Pathernakh.

The significant differences were observed for mean values of ascorbic acid content for pear with the foliar application of calcium and potassium nutrients (Table 2). The range of variation for ascorbic acid content was from 6.15 to 6.42 mg/100 g of pulp. The maximum ascorbic acid (6.42 mg/100 g) was recorded with calcium chloride followed by 6.29 mg/100 g of pulp with calcium nitrate and 6.21 mg/100 g of pulp with potassium sulphate. At the same, minimum value (6.15 mg/100 g) for this trait was observed with water spray (control).The mean value of ascorbic acid content at various concentrations also differ significantly, the highest being recorded at 1.5%, that is, 6.39 mg/100 g of pulp (C_2) followed by 2.0%, that is, 6.35 mg/100 g of pulp (C_3), while the minimum ascorbic acid was recorded at 1.0% concentration, that is, 6.13 mg/100 g of pulp (C_1). The interaction between treatments at various concentrations (T × C) was further found to be significant, the highest (6.46 mg/100 g of pulp) being recorded with calcium chloride at 1.5% concentration ($T_1 \times C_2$) however, the lowest (5.96 mg/100 g) with potassium nitrate at 1.0% concentration ($T_4 \times C_1$). The increase in ascorbic acid content might be speculated due to increased activity of enzymes responsible for the synthesis of the ascorbic acid precursor and also the reduction in the rate of respiration by these chemicals. Bhat et al. (2009) reported the maximum ascorbic acid content with foliar application of calcium chloride (6.02 mg/100 g) and minimum under control (4.14 mg/100 g) in cherry cv. Makhmali, and suggested that the increases in ascorbic acid content might be attributed to higher synthesis of some metabolites and intermediate substances which promoted the synthesis of precursor of ascorbic acid and resulted the improvement in ascorbic acid content. However increase of ascorbic acid with foliar application of calcium and potassium nutrients are contradictory with the findings of Raese (1998) in Apple and Bhat et al. (2011) in pear cv. Bartlett.

Significant variation was observed with respect to data obtained from total sugar content in pear among all the nutrients applied over control (Table 2). The mean value of total sugar ranged from 7.15 to 7.62%. Among all the treatments under study, potassium nitrate recorded significantly highest total sugars (7.62%) followed by potassium sulphate (7.48%) and calcium nitrate (7.28%). The mean value of total sugar content at various concentration also differ significantly, the highest being recorded at 1.5%, that is, 7.63% (C_2) followed by 2.0%, that is, 7.38% (C_3) while the lowest was recorded at 1.0% concentration, that is, 7.15%. The interaction between treatment at various concentrations (T × C) was found also found to be significant however, the highest (7.76%) being recorded with potassium sulphate at 1.5% ($T_3 \times C_2$) and the lowest with calcium nitrate (7.07%) at 2.0% concentration ($T_2 \times C_3$). Singh et al. (2002) also reported that pre harvest sprays of nutrients have a marketed influence on increasing total sugar content of fruits over control, when applied at balloon bud stage and 15 days prior to maturity in peach cv. Flordasun. The effect of these nutrients on increase in total sugar contents could be attributed to the balance in nutrition status of the tree which advanced fruit maturity and ripening. The possible reason for increase in total sugar content may be due to hydrolysis of starch yielding mono and disaccharide, which owned a simplest form of sugar, and it could be one of the important reasons for the increase in total sugar content of fruits. Further higher levels of calcium do

Table 2. Effect of pre harvest spray of calcium and potassium on ascorbic acid content (mg/100 g) and total sugar (%) of pear cv. Pathernakh.

Treatments	Ascorbic acid (mg/100 g of pulp)				Total sugars (%)			
	Concentrations			Mean	Concentrations			Mean
	1.0% (C_1)	1.5% (C_2)	2.0% (C_3)		1.0% (C_1)	1.5% (C_2)	2.0% (C_3)	
Calcium Chloride (T_1)	6.36	6.46	6.43	6.42	7.21	7.53	7.36	7.36
Calcium Nitrate (T_2)	6.25	6.41	6.22	6.29	7.26	7.52	7.07	7.28
Potassium Sulphate (T_3)	5.94	6.36	6.34	6.21	7.23	7.76	7.45	7.48
Potassium Nitrate (T_4)	5.96	6.33	6.42	6.24	7.48	7.73	7.64	7.62
Mean	6.13	6.39	6.35		7.30	7.63	7.38	
CD at 5% or (p=0.005)	(T) 0.10	(C) 0.089	(T × C) 0.17		(T) 0.080	(C) 0.069	(T ×C) 0.14	
	Control: 6.15 ± 0.09 (Mean ± SE)				**Control: 7.15 ± 0.12 (Mean ± SE)**			

not showed improvement in total sugar (Table 2) reason being increased level of calcium in fruits which can retard ripening and senescence process resulting in slower hydrolysis of polysaccharides into monosaccharide and ultimately no further increase in sugar content of fruit. Our results are also in line with the finding of Raese (1998) in Apple.

A perusal of data presented in Table 3 revealed significance effects among all the treatments and concentrations in relation to reducing sugar in pear fruit. The highest mean reducing sugar was recorded under the potassium nitrate spray (6.10%) followed by potassium sulphate (6.06%) and calcium chloride (5.84%), while the minimum with control (5.78%). It also reveals from the Table 3 that mean reducing sugar at various concentrations differs significantly over control and themselves, the highest (6.15%) being recorded under 1.5% concentration (C_2), which was found significant with 1.0 and 2.0% concentration, while the lowest value of reducing sugar (5.86%) was recorded at 1.0% concentration (C_1). The interaction between treatments at various concentrations (T × C) was also found to be significant, the highest (6.24%) being recorded with potassium sulphate at 1.5% concentration ($T_3 \times C_2$) however, the lowest (5.70%) with calcium nitrate at 2.0% concentration ($T_2 \times C_3$). In agreement with our present findings Gill et al. (2005) reported that pre harvest spray of nutrients have a marked effect on non reducing sugar content of Kinnow Mandarin. Foliar spray of nutrients is helpful to increase the reducing sugar level, which could be due to translocation of carbohydrate as a result of maintenance of better assimilating power of laves over a longer period. An increase in reducing sugar with these nutrients may be due to the enhancement of photophosphorylation and dark reaction of photosynthesis by potassium and hence resulted in accumulation of more carbohydrates to the fruits, which results the better accessibility of nutrition for developing fruits and at long last increases the reducing sugar level of fruits. Similar observations have been reported by Bhat et al. (2012) in pear fruit cv. Bartlett, and Singh et al. (2002) in peach cv. Flordasun.

The data regarding the influence of various nutrients spray on non reducing sugars are presented in Table 3. It clearly indicates that various treatments have a significant effect on non reducing sugar content of fruit. The maximum mean value of non reducing sugar (1.51%) was observed with the potassium nitrate treatment (T_4), which was found significant with T_1, T_2 and T_3. The minimum non reducing sugars was reported under calcium chloride spray (T_1), that is, 1.38%, the interaction between treatment at various concentrations (T × C) was found to be non significant. The possible reason for increase in non reducing sugar content of fruits with the application of nutrients may be ascribed to hydrolysis of polysaccharides to simpler form, that is, mono and disaccharides and better transportation of nutrients to plant by potassium due to it important role in the transport of assimilates and nutrients to the plant from leaves to their place of utilization, which helps to increase availability of nutrition and conclusively better quality evolution in term of non reducing sugar content of fruits. These results corroborate the earlier records of Kumar et al. (1990) in grape cv. Delight, Bhat et al. (2009) in pear cv. Bartlett, Kaur and Dhillon (2006) in guava cv. Allahabad Safeda and Elham et al. (2007) in apricot cv. Canino. The results of present investigations revealed that pre harvest sprays of calcium and potassium nutrients at 1.5% were highly effective in improving total soluble solids, acidity, ascorbic acid, total sugars reducing sugars and non reducing sugar in Pathernakh pear.

Conclusion

Present studies clearly showed that different pre-harvest treatments of calcium and potassium at 1.5% had positive effect on quality of pear. Thus it can be concluded that potassium nitrate and calcium chloride

Table 3. Effect of pre harvest spray of calcium and potassium on reducing sugar (%) and non reducing sugar (%) of pear cv. Pathernakh.

Treatments	Reducing sugar (%)				Non reducing sugar (%)			
	Concentrations			Mean	Concentrations			Mean
	1.0% (C_1)	1.5% (C_2)	2.0% (C_3)		1.0% (C_1)	1.5% (C_2)	2.0% (C_3)	
Calcium Chloride (T_1)	5.75	6.15	6.04	5.98	1.46	1.38	1.32	1.38
Calcium Nitrate (T_2)	5.78	6.06	5.70	5.84	1.48	1.46	1.37	1.44
Potassium Sulphate (T_3)	5.91	6.24	6.03	6.06	1.32	1.51	1.42	1.42
Potassium Nitrate (T_4)	6.00	6.13	6.16	6.10	1.47	1.60	1.47	1.51
Mean	5.86	6.15	5.98		1.43	1.49	1.44	
	(T)	**(C)**	**(T × C)**		**(T)**	**(C)**	**(T ×C)**	
C D at 5% or (p=0.005)	0.043	0.037	0.074		0.076	0.066	NS	
	Control:5.78 ± 0.98 (Mean ± SE)				**Control:1.37 ± 0.046 (Mean ± SE)**			

improved the quality attributes of pear fruits cv. Pathernakh. Therefore in order to maintain the quality of the produce pre-harvest foliar spray of calcium and potassium with 1.5% can be recommended for the pear in *tarai* regions.

Conflict of Interest

The authors have not declared any conflict of interest.

ACKNOWLEDGEMENT

This paper forms a part of the M.Sc. Ag (Hort.) thesis of the first author submitted to the G.B. Pant University of Agriculture and Technology, Pantnagar, 2014.

REFERENCES

Amiri ME, Fallahi E, Golchin A (2008). Influence of foliar and ground fertilization on yield, fruit quality, and soil, leaf and fruit mineral nutrients in apple. J. Plant Nutr. 31:515-525.

Anonymous (2014). Indian Horticulture Database. National Horticulture Board, Gurgaon, Haryana.

Bhargava BS, Singh HP, Chadha L (1993). Role of potassium in development of fruit quality. In. Advances in Horticulture. (Eds. Chadha KL, Pareek OP) Malhotra. Publishing House, New Delhi, pp. 947-60.

Bhat MY, Hafiza A, Banday FA, Dar MA, Khan FA (2011). Effect of calcium chloride and storage period at ambient temperature on physico-chemical characteristics of pear cv. Bartlett. Indian J. Hortic. 68(3):444-447.

Bhat MY, Hafiza A, Banday FA, Dar MA, Wani AI, Hassan GI, Khajwall MH (2009). Effect of harvest dates, pre harvest calcium sprays and storage period on physico-chemical characteristics of pear cv. Bartlett. Appl. Biol. Sci. Res. 11(1):31-35.

Bhatt AR, Sofi AG, Mir MA, Gani MR (1997). Effect of pre- harvest sprays of calcium and potassium on some quality characteristics of cherry cv. Makhmali. Indian J. Hortic. 54(1):19-24.

Bhat MY, Hafiza A, Banday FA, Dar MA, Wani AI, Hassan GI (2012). Effect of harvest dates, pre harvest calcium sprays and storage period on physico-chemical characteristics of pear cv. Bartlett. J. Agric. Res. Dev. 2(4):101-106.

Dhatt AS, Mahajan BVC (2005). Effect of pre harvest calcium treatments on the storage life of Asian pear. Acta Hortic. 696:696-698.

Fallahi E, Conway WS, Hickey KD, Sams CE (1997). The role of calcium and nitrogen in postharvest quality and disease resistance of apple. Hortic. Sci. 32:831-835.

Faust M (1979). Evolution of fruit nutrition during the 20th century. Hortic. Sci. 14:321-324.

Gill J, Dhillon WS, Gill PPS, Singh NP (2012). Fruit set and quality improvement studies on semi-soft pear cv. Punjab Beauty. Indian J. Hortic. 69:39-44.

Kaur G, Dhillon WS (2006). Effect of foliar application of chemicals on physicochemical characters of variety Allahabad Safeda of guava during winter. Res. Punjab Agri. Univ. 43 (2):114-116.

Elham Z, Motty A., Mohamed HE, Mohamed FM, Shahin MIFF (2007). Effect of pre harvest spray of calcium and boric acid treatment on characteristics and storability of “Canino” apricot fruit. Res. J. Agric. Biol. Sci. 2(5):330-339.

Kumar R, Singh SP, Chandra AS (1990). Effect of preharvest application of different chemicals on the quality of grape cv. Delight during storage. Haryana .J. Hortic. Sci. 19(1-2):62-70.

Mahajan BVC, Randhawa JS, Kaur H, Dhatt AS (2008). Effect of post-harvest application of calcium nitrate and gibberellic acid on the storage life of plum. Indian J Hortic. 65:94-96.

Raese JT (1998). Responce of apple and pear tree to N, P and K fertilizer. J. Plant. Nutri. 21(12):2671-2696.

Shirzadeh E, Kazemi M (2011). Effect of malic acid and calcium treatment on quality charactristics of apple fruit during storage. Am. J. Plant Physiol. 6(3):176-182.

Siddiqui S, Gupta OP, Yamdayni R (1989). Effect of pre harvest application of chemical on flesh firmness and cell wall composition of Apples influence fruit size. J. Hortic. Sci. 70(2):263-269.

Singh SK, Arora RL, Sharma AK (2002). Effect of pre-harvest spray of calcium nitrate on flowering, fruiting, yield and quality of Peach cv. Flordasan. Prog. Hortic. 34(1):83-87.