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Influence of prohexadione-calcium and paclobutrazol on growth, yield and mineral content of pear cv. Clapp's favourite

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Abstract

Present investigation was carried out to study the influence of growth retardants viz., prohexadione-calcium and paclobutrazol on mineral content of pear cv. 'Clapp's Favourite' during the year 2015-2016. The experiment was laid out with thirteen treatments, replicated thrice on 12 year-old-pear tree with uniform vigor and health under uniform cultural practices. The treatment comprised of single and double spray of growth retardants i.e., prohexadione-calcium (100 ppm, 200 ppm and 300 ppm) and paclobutrazol (100 ppm, 200 ppm and 300 ppm). The first spray of these growth retardants was given at complete petal fall stage and second at four weeks after first spray. The orchard soil was moderately deep with good fertility status. Results revealed that both the growth retardants had showed a significant influence on the studied characters. The plants sprayed twice with prohexadione-calcium @ 200 ppm (T₉S₂) recorded minimum annual shoot extension growth of 16.92 cm and leaf area (22.20 cm²) alongwith increase in fruit yield (51.24 kg). Highest value for calcium (Ca) in leaves and fruits of pear (574.00 mg & 71.24 mg, respectively) was recorded when plants were sprayed twice with prohexadione-calcium at 300 ppm. Results also revealed that application of prohexadione-calcium application at 200 ppm sprayed twice (T₉S₂) resulted in significant increased in potassium content of the pear leaves and fruits i.e. 98.40 mg and 22.78 mg, respectively. However minimum value for potassium content was recorded in control (T₁S₀). Double spray of prohexadione-calcium @ 200 ppm was effective in reducing the annual extension growth, leaf area and increasing the fruit yield and calcium and potassium content in leaves and fruit.

Keywords: Pear, prohexadione-calcium, paclobutrazol, calcium and potassium

Introduction

Among temperate fruits pear is next to apple in importance, acreage and production with high degree of adaptability under different climatic conditions and temperate areas like apple and pear suffers from many problems like canopy volume, shoot elongation, abortion of fruit lets which reduces the fruit size and fruit firmness as well as its mineral content. An excessive shoot growth in pear that directly competes with the fruit growth for assimilates, particularly during the early stages of fruit development when shoot and fruit growth are optimal and leads to reduction of number of fruit cells, thereby, limiting fruits from reaching their potential size and quality. Although many growth retardants are used to overcome these problems like adenile benzyl amine, GA₁₂ aldehyde, chloroqemutat and ethephon but it has been found that application of prohexadione-calcium and paclobutrazol can significantly reduce these problems when applied at appropriate time and in proper quantity (Yoder *et al.*, 1999; Rademacher and Kober, 2003) [16, 12]. Prohexadione-calcium now's day is considering a new plant growth retardant especially for pome fruit crops. A number of reports have confirmed that it is an effective plant growth retardant that retards shoot growth (Greene, 2007 and Medjdoub *et al.*, 2005) [6, 10]. Application of prohexadione-calcium causes in reduction of number of shoots, transforming trees into more desirable, spur type growth habit and as the vegetative sink was reduced the transport of nutrients including calcium towards leaves and fruits was enhanced (Kim, 2008) [9]. Paclobutrazol (PBZ) also called 'cultur' is a potent gibberellin synthesis inhibitor that effectively controls vegetative growth (Curry, 1988 and Sanchez *et al.*, 1988) [4, 13] and fruit development and hence, increases the amount of mineral nutrition including calcium in fruits that increases the fruit firmness (Sherif and Assad, 2014) [14]. Keeping in view the importance of calcium and potassium for fruit crops the present experiment was conducted with two plant growth retardants to examine their effect on mineral content of Clapp's favourite pear.

Material and Methods

Experimental site and material involved

The present study was conducted on 12-year-old-pear trees cv. 'Clapp's Favourite' grown on seedling rootstock at private orchard during the year 2015-2016 near SKUAST-Kashmir, Shalimar, Srinagar (J&K). The experimental orchard was situated at an altitude of 1685 m amsl which is lying between 34°75'N latitude and 74°50'E longitude. The orchard had proper soil drainage and good fertility status. Trees of similar vigor and size were selected, marked and maintained under uniform cultural practices and trained as modified leader system at spacing of 5 x 5 meter.

Treatment Details

The experiment was laid out in a completely randomized block design (RCBD) with three trees representing a treatment. There are thirty nine healthy trees grouped into three replications and thirteen treatments including a control (Water spray) were marked as per the treatments. Three concentrations (100, 200, 300 ppm) each of prohexadione calcium and paclobutrazol with their active ingredients 10 and 23, respectively were sprayed (details given in Table 1). The first spray of these plant growth retardants was given at petal fall stage and second at four weeks after first spray.

Table 1: Treatment details

Treatments	Chemicals concentrations	Treatments	Chemicals concentrations
T ₁ S ₀		Water spray	
Single spray (S₁)		Double spray (S₂)	
T ₂ S ₁	Prohexadione Ca 100 ppm	T ₈ S ₂	Prohexadione Ca 100 ppm
T ₃ S ₁	Prohexadione Ca 200 ppm	T ₉ S ₂	Prohexadione Ca 200 ppm
T ₄ S ₁	Prohexadione Ca 300 ppm	T ₁₀ S ₂	Prohexadione Ca 300 ppm
T ₅ S ₁	Paclobutrazol 100 ppm	T ₁₁ S ₂	Paclobutrazol 100 ppm
T ₆ S ₁	Paclobutrazol 200 ppm	T ₁₂ S ₂	Paclobutrazol 200 ppm
T ₇ S ₁	Paclobutrazol 300 ppm	T ₁₃ S ₂	Paclobutrazol 300 ppm

Observations recorded

Observations on annual extension growth was worked out by selecting four branches per plant randomly and marked and annual shoot extension growth (cm) was worked out with the help of measuring tape. Leaf area (cm²) was calculated with help of automatic leaf area meter (221 Systronics). Yield per plant (kg) was calculated by weighing whole fruits from a single plant. Calcium and potassium in leaves and fruits were estimated by taking one gram of crushed sample (fruit as well as leaves) was taken in 100 ml conical flask and 20 ml of di-acid (HNO₃+ perchloric acid in the ratio of 9:4) was added to it. Then the flask was placed on hot plate using gas stove till sample changed to clear solution. 10-15 ml of distilled water was added after cooling down and it was filtrated the filtrate was diluted to 50 ml (stock sample) with distilled water for the estimation of different nutrients. Potassium (K) was estimated by flame photometer method using flame photometer 130 (systronics). Calcium (Ca) were analysed with the help of atomic absorption spectrophotometer (AAS 4141 of electronic corporation of India). (Fazli and Fazli, 2014) [5]. Data collected on various parameters were statistically analyzed as per the procedure given by Snedecor and Cochran (1994).

Results and Discussion

Vegetative and yield characters

The effect of growth retardants on the vegetative growth parameters on the Clapp's Favourite pear are given in Fig 1. The effect of Prohexadione-Ca and paclobutrazol dosage on all the shoot extension growth and leaf area were statistically significant. Minimum annual shoot extension growth (16.92) was obtained in the treatment prohexadione-calcium @ 200 ppm sprayed twice (T₉S₂) which was statistically at par with

treatment T₁₀S₂ (17.01 cm) i.e. prohexadione-calcium @ 300 ppm sprayed twice and treatment T₁₂S₂ (17.09 cm) i.e. paclobutrazol @ 200 ppm sprayed twice (17.09 cm) whereas maximum shoot extension growth (21.44 cm) was recorded under control (T₁S₀). Reduction in vegetative growth is attributed to the reason that prohexadione-calcium inhibits biosynthesis of active gibberellic acid isomers in plant tissues (Pasa *et al.*, 2014) [11]. Prohexadione-calcium reduces the shoot elongation in fruit trees due to inhibition in the biosynthesis of gibberellic acid as it stops the formation of GA₁ (active form) from GA₂₀ (Basak and Rademacher, 2000) [1]. Double spray of prohexadione-calcium applied @ 200 ppm registered minimum leaf area (22.20 cm²) closely followed and statistically at par with other double spray of Pro-calcium and paclobutrazol concentrations except double spray of both the growth retardants @ 100 ppm whereas maximum leaf area (24.63 cm²) was measured in control (T₁S₀). Cares *et al.*, (2014) observed that prohexadione-calcium is a plant bio regulator that inhibits gibberellic acid biosynthesis and hence causes reduction in annual extension growth and leaf area of sweet cherry cv. Lappins and Sweet heart.

Fruit yield was also influenced by the prohexadione-calcium and paclobutrazol application (Fig 1). Prohexadione-calcium 200 ppm sprayed twice (T₉S₂) had scored highest values for fruit yield (52.24 kg) which was statistically superior among all the treatments, however, minimum values was registered under control for fruit yield (33.59 kg). The increase in yield may be attributed to the reason that prohexadione-calcium inhibits gibberellic acid biosynthesis, which changes the source sink relationship by recollecting the carbohydrates source toward fruits (Costa *et al.*, 2001) [3].

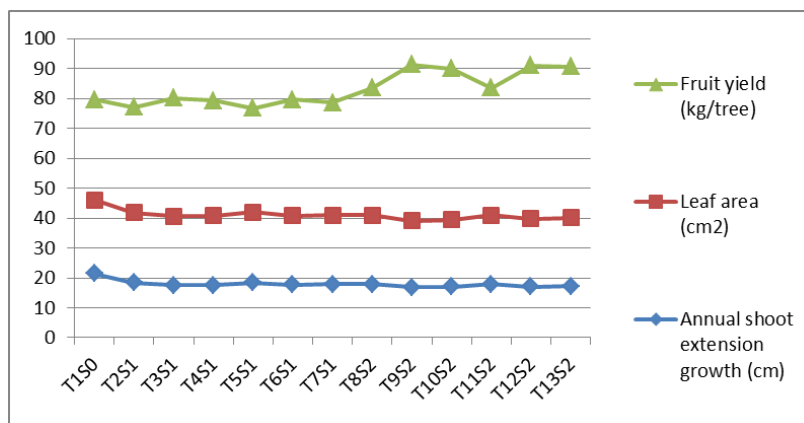


Fig. 1: Vegetative and yield characters of 'Clapp's Favourite' pear affected by prohexadione-calcium and paclobutrazol

Calcium in leaves and fruits

The significant result of plant growth retardants on calcium content of Clapp's Favourite pear are given in Table 2. Calcium content of pear leaves and fruits was most obviously affected by Prohexadione-Ca and paclobutrazol applications. Maximum value for calcium content in pear leaves (574.00 mg) was recorded in (T₁₀S₂) i.e. prohexadione-calcium @ 300 ppm sprayed twice which was statistically at par with treatment T₉S₂(572.28 mg), T₁₃S₂(524.33 mg) and T₁₂S₂(523.67 mg) whereas minimum (342.33 mg) was recorded in control (T₁S₀). The application of prohexadione-calcium @ 300 ppm also showed the significant influence on calcium content of pear fruits. Maximum calcium in pear fruit

was recorded in T₁₀S₂ (71.24 mg) i.e. prohexadione-calcium @ 300 ppm which was statistically at par with T₉S₂ (69.92 mg) i.e. prohexadione-calcium @ 200 ppm and T₁₃S₂ (63.22 mg) i.e. paclobutrazol @ 300 ppm. However, minimum calcium (40.63 mg) was recorded in control (T₁S₀). The linear increase in calcium content in leaves were also recorded by Smith *et al.* (2005) [15] in pear and Mesa *et al.* (2012) in apricot cv. 'Castlebrite' and reported that application of prohexadione-calcium, the number of shoots were reduced, transforming trees into more desirable, spur type growth habit and as the vegetative sink was reduced and transport of nutrients including calcium towards leaves and fruits was enhanced (Kim, 2008) [9].

Table 2: Effect of prohexadione-calcium and paclobutrazol on calcium and potassium content in leaves and fruits of 'Clapp's Favourite' pear

Treatments	Calcium in leaves (mg)	Calcium in fruit (mg)	Potassium in leaves (mg)	Potassium in fruit (mg)
T ₁ S ₀	342.33	40.63	24.45	10.12
T ₂ S ₁	404.67	48.09	56.63	11.50
T ₃ S ₁	500.24	60.12	76.86	12.57
T ₄ S ₁	502.00	62.56	69.95	12.00
T ₅ S ₁	398.67	44.61	45.66	11.00
T ₆ S ₁	472.33	54.62	70.84	11.68
T ₇ S ₁	474.33	56.62	65.07	11.21
T ₈ S ₂	464.67	54.33	89.96	15.86
T ₉ S ₂	572.28	69.92	98.40	22.78
T ₁₀ S ₂	574.00	71.24	92.44	18.36
T ₁₁ S ₂	458.73	53.31	67.77	12.78
T ₁₂ S ₂	524.33	63.08	73.83	18.36
T ₁₃ S ₂	523.67	63.22	69.36	16.53
CD _{0.05}	63.49	7.63	11.37	4.35

Potassium in leaves and fruits

Application of prohexadione-calcium and paclobutrazol showed a significant effect on potassium content in pear leaves as well as fruits. Maximum increased value for potassium in leaves was recorded in T₉S₂ (98.40 mg) i.e. prohexadione-calcium @ 200 ppm sprayed twice which was statistically at par with T₁₀S₂ (92.44 mg) i.e. prohexadione-calcium @ 300 ppm sprayed twice and T₈S₂ (89.96 mg) i.e. prohexadione-calcium @ 100 ppm sprayed twice and minimum (24.45 mg) in control (T₁S₀). On the other hand it was also recorded that maximum value (22.78 mg) for potassium in fruits was recorded in T₉S₂ i.e. prohexadione-calcium at 200 ppm sprayed twice which was statistically superior among all other treatments. However, minimum potassium (10.12 mg) in fruits was recorded in control (T₁S₀). Our results are in conformity with Guak *et al.* (2013) [8] in apple cv. 'Golden Delicious'. Similar results were also found by Kim *et al.* (2008) [9] in apple cv. 'Gamhong'. Increased in

potassium content in pear leaves as well as fruits was due to the fact that prohexadione-calcium is basically the growth retardant that retards vegetative growth in plants, thus reduces the competition between shoot growth and fruit development that leads to more translocation of minerals toward developing leaves and fruits and thus, increased the potassium levels along with the other nutrients in developing leaves and fruits (Guak *et al.*, 2001) [7].

Conclusion

Foliar application of prohexadione-calcium at 300 ppm and 200 ppm resulted in increased in calcium and potassium level in leaves as well as fruits of pear. Application of prohexadione-calcium causes reduction in vegetative growth and thus reduces competition between shoot growth and plant leaves as well as fruits for available calcium and potassium that increases minerals level in them.

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