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Effect of Growth Retardants on Floral Biology, Fruit Set and Fruit Quality of Cape Gooseberry (*Physalis peruviana* L.)

L.P. Yadava
Central Institute for Sub-tropical Horticulture, Rehmankhera, Kakori, Lucknow-227107 (U.P.), India

ABSTRACT

Various doses of paclobutrazol (12.5, 25, 50 and 100 ppm) and ethephon (100, 200, 400 and 800 ppm) on flowering, fruit characters and quality of cape gooseberry (*Physalis peruviana* L.) were observed. Results indicated that ethephon 800 ppm delayed flowering but prolonged duration of fruit set and early ripening by 30.25, 2.5 and 10.13 days, respectively over control. 400 ppm of ethephon was more effective than 800 ppm in respect of fruit weight and quality constituents. In the same trend by 17.5, 2.37 and 5.85 days delay in flowering, prolonged duration of fruit set and early ripening, respectively were recorded with paclobutrazol 100 ppm. However, ethephon 400 ppm and paclobutrazol 50 ppm significantly influenced the fruit set, growth rate, cumulative growth, volume, density and TSS/acidity ratio of the fruit as compared to control and other concentrations of the retardants.

Key words: Cape gooseberry, paclobutrazol, ethephon, fruit growth rate, fruit set

INTRODUCTION

Cape gooseberry, diploid species with 2n = 48 (Menzel, 1951), was known to the Incas but their origins are not clear, after Christopher Columbus the cape gooseberry was introduced into India and Africa (Popenoe *et al.*, 1990). Among the minor fruit crops, it occupies an important position as quick growing fruit crop in India as well as other parts of the world. However, it is well known as for its flavor and tasty jams but unexploited fruit crop and required more attention for higher yield and quality (Yadava, 2001). The commercial interest in this fruit has grown due to its nutritional properties related to high vitamins content, minerals and antioxidants as well as its anti-inflammatory, anti-cancer and other medicinal properties (Martinez *et al.*, 2010; Yen *et al.*, 2010; Wu *et al.*, 2009; Pinto Mda *et al.*, 2009; Franco *et al.*, 2007; Ramadan and Morsel, 2003).

The effect of PP333 (paclobutrazol) and/or Ethrel (ethephon) on flowering and fruit set in 10 year old Litchi cv. Lanzhu, growing on sand red soil, was investigated and found that 600 mg L^{-1} 15% PP333 and 450 mg L^{-1}15% PP333+32 mg L^{-1} 40% Ethrel, applied after 20-30% of the staminate flowers had opened, reduced the length of flowering to 4 days in length, delayed pistilate flowering for 5-8 days, increased the percentage of pistilate flowers by 10.3-15.9% and increased fruit set by 53.9-54.5% (Zhang *et al.*, 2002). The use of growth regulators particularly paclobutrazol and ethephon have proved very effective in modifying growth, development, flowering, fruit setting and yield in several tropical and sub-tropical fruit crops. Maiko and Musat (1977) observed that ethephon has strong and long-lasting inhibitory effect on GA activity in peach. Paclobutrazol (PBZ) is reported to be effective on a wide range of plant species where its principle mode of action is the inhibition of gibberellin biosynthesis (Anonymous, 1983).

Therefore, attempts have been made to investigate the response of ethephon and Paclobutrazol (PBZ) on flowering, fruiting and quality constituents of cape gooseberry (*P. peruviana* L.) plants extensively grown in sub-tropical conditions.

MATERIALS AND METHODS

Plant material: Seeds of *P. peruviana* native to India were collected in April 2009 from fruits grown in the farmer's field at Bharwari, Kaushambhi (UP), India. For raising the seedlings, a 15 cm raised nursery bed was prepared and seeds were sown in the line. One day before sowing, seeds were wetted in water for 12 h. The bed was hand watered as needed and two inter culture programme was used during the growing period. Thirty five days old seedlings were transplanted in the experimental plot in randomized block design. Healthy uniform seedlings 8-10 cm tall were used for planting. The row to row distance 50 cm and plant to plant 50 m was kept. Immediately after transplanting a light irrigation was given to seedlings as when required irrigation up to 25 days. In order to maintain uniform stand of crop in each plot the dead diseased seedlings were removed and replaced by filling during both year, to get uniform stand of seedlings.

Paclobutrazol and ethephon application: The chemicals were prepared fresh before use during both years. Stock solutions of 100 PBZ and 800 ppm Ethephon were made by dissolving the 0.4 mL of PBZ (a.i. 250 g L^{-1}) in one litre of water and 1.67 mL ethephon (a.i. 480 g L^{-1}) in one litre of water, respectively, then required rates of each chemical were prepared by dilution method. A few drop of 'Teapol' were added to solution as a wetting agent. The chemicals were applied as a foliar spray after 21 days of transplanting the seedlings. Spraying was done in the evening using a hand compressor sprayer for each treatment.

Data collections: Each tagged plant was closely watched and as soon as anthesis started in first flower, days required for anthesis of first flower was calculated from the date of transplanting. The period required for fruit set was worked out from the date of anthesis to fruit set. Days required for harvest maturity of fruit was calculated from the date of fruit set to harvest. Fruit growth rate was recorded by weighing the fruit at 10 days interval from fruit set to fruit maturity and with help of fruit weight a graph was plotted to determine the growth curve.

RESULTS AND DISCUSSION

Pooled data on observations indicated that paclobutrazol (PBZ) and ethephon at 50 and 400 ppm, respectively had marked effect on flowering, fruiting, fruit growth rate and fruit quality (Table 1). The delay in flowering was noticed with ethephon 800 ppm followed by paclobutrazol

Table 1: Effect of PBZ and ethephon on flowering, fruiting and fruit quality of *Physalis peruviana* L.

Treatments	Days to flower	Duration of fruit set	Fruit set (%)	Fruit maturity days	Fruit weight (g)	Calyx weight (g)	Fruit volume (cc)	Fruit density (g cc^{-1})	TSS/acidity ratio
Control	91.88	5.88	89.75	49.63	4.81	0.216	4.34	1.047	6.44
PBZ 12.5 ppm	98.13	6.88	91.50	48.25	5.01	0.186	4.52	1.045	6.53
PBZ 25 ppm	109.13	7.50	93.25	45.88	5.08	0.172	4.72	1.043	7.69
PBZ 50 ppm	109.63	7.75	98.00	44.63	5.77	0.119	5.50	1.046	9.26
PBZ 100 ppm	111.75	8.25	93.88	43.75	5.12	0.167	4.83	1.042	7.48
Ethephon 100 ppm	96.00	6.75	92.13	46.88	5.07	0.186	4.69	1.044	6.68
Ethephon 200 ppm	102.25	7.13	93.75	43.88	5.14	0.170	4.77	1.042	7.81
Ethephon 400 ppm	119.50	7.75	98.38	40.25	6.40	0.124	6.03	1.042	9.06
Ethephon 800 ppm	122.13	8.38	93.38	39.50	5.20	0.191	4.81	1.042	7.17
SD	4.97	0.842	2.80	2.15	0.48	0.049	0.38	0.003	0.23

TSS: Total soluble solids

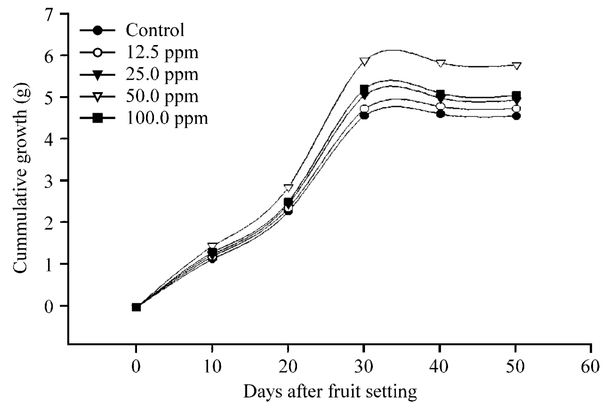

Fig. 1: Response of cape gooseberry to PBZ

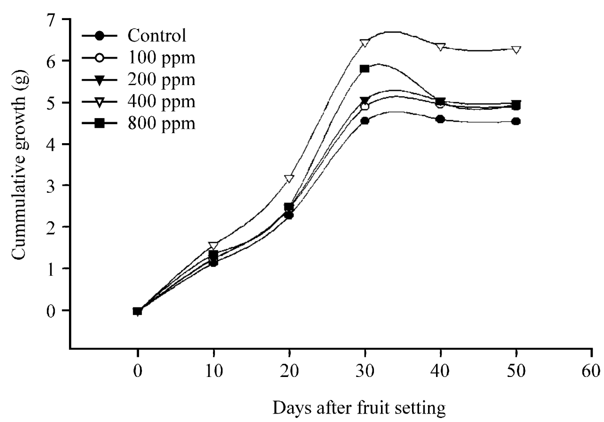

Fig. 2: Response of ethephon on the cumulative growth of fruit

100 ppm. The delay in flowering may be attributed to suppression of plant growth. The delays in flowering by ethephon and paclobutrazol have been reported in many crops viz. poinsettia (Faust *et al.*, 2001; Zhang *et al.*, 2002), almond (Grijalva-Contreras *et al.*, 2011), Pistachio (Askari *et al.*, 2011). Moghadam and Mokhtarian (2006) reported that 100 mg L^{-1} of ethephon applied at the end of October delayed full bloom approximately 3 days (2000) and 7 days (2001). In this study, duration of fruit set was prolonged by ethephon 800 ppm and paclobutrazol 100 ppm application. Prolonged fruit set period may, probably, be due to disturbed carbohydrate and mineral metabolism.

In the meantime, ethephon at 400 ppm as well as paclobutrazol 50 ppm recorded the highest percentage of fruit set. The highest fruit set may be linked with delicate balance between C: N ratio along with auxins. Similar findings have been Faizan *et al.* (2000) with paclobutrazol in litchi.

The growth curves obtained by plotting the average cumulative fresh weight of berry against time with various treatments showed an increase up to 30 days after fruit setting while control and lower concentration of chemicals (paclobutrazol 12.5, 25 and ethephon 100 ppm) up to 40 days after fruit setting, thereafter, the growth start declining. Thus the fruit development of cape gooseberry deserve a single sigmoid growth curve (Fig. 1, 2).

Ethephon at 400 ppm and paclobutrazol at 50 ppm improved the growth rate of fruit significantly over control (Fig. 3, 4). The higher growth rate of fruit was noticed between

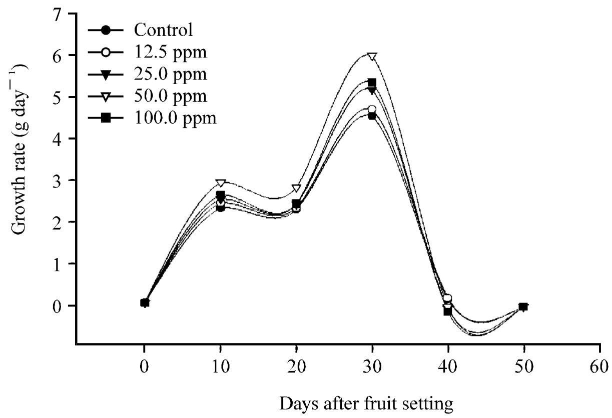

Fig. 3: Response of cape gooseberry to PBZ

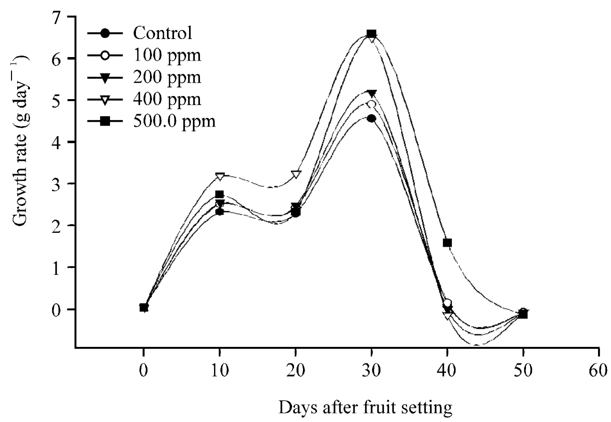

Fig. 4: Response of ethephon on growth rate (g day^{-1}) of fruit

20-30 days after fruit set. It seems to be the grand growth period of the fruits. The faster rate of fruit growth (Fig. 3, 4) during this period may be due to more rapid increase in the number of cells during the period.

The fruit ripening was enhanced significantly by ethephon 800 ppm and paclobutrazol 50 ppm. The early ripening may be attributed to an increase in ethylene production. The treatment of plant led to marked increase in rates of ethylene production leaves, stem and apices (Abdallah *et al.*, 1986). Ethephon increases the endogenous level of ethylene in plant by autocatalytic stimulation (Coombe and Hale, 1973). Similarly, Luo *et al.* (1989) reported that foliage application of paclobutrazol influences ethylene production and the time course of fruit ripening. Early maturity of the fruits was noticed by the study of Ebel *et al.* (1999) with ethephon in peach and Singh (2000) observed with paclobutrazol in amaranth.

The berry weight was highest with ethephon 400 ppm and paclobutrazol 50 ppm over control. The increased berry weight may be due to increase in size and diameter of fruit. Increased berry weight with paclobutrazol has been reported by Rawash *et al.* (2002) and with ethephon by Verma *et al.* (1984). It is worthwhile to mention here that paclobutrazol and ethephon at 50 and 400 ppm, respectively increased the berry weight but reduced the calyx weight in the same trend.

Coneva and Cline (2009) observed that Ethrel delays blossoming, reduces fruit set and increases fruit size of 'Baby Gold 5' peaches.

A significantly enhanced volume of fruits with 400 ppm ethephon and 50 ppm paclobutrazol was observed over control. It may be due to increase in cell number and volume of intercellular spaces in the flesh. Fruit density significantly reduced as compared to control with ethephon 400 ppm and paclobutrazol 100 ppm. At ripening, the rate of respiration increases thereby increasing the hydrolysis in the fruits which may result in reduction of its density. The said rate of chemicals might have increased the rate of these processes, taking place at ripening and hence would have decreased the density to a great extent.

Maximum increase in TSS: acidity ratio was recorded in 50 ppm of paclobutrazol and ethephon 400 ppm. Similar results were reported by Godara *et al.* (2002) and Hutton (1989) in grapes. Taghipour and Rahemi (2010) found that total soluble solids/total acidity ratio significantly increased with ethephon at 50 and 100 mg L^{-1}. It is quite remarkable and acceptable fact as the TSS was increased and acidity decreased. Thus, TSS: Acidity ratio is mostly increased by paclobutrazol and ethephon levels.

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