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Effect of plant biostimulants on fruit cracking and quality attributes of pomegranate cv. Kandhari kabuli

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The present experiment was laid out in the experimental orchard of the Department of Fruit Science, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during the year 2008 to 2009. The experiment consisted of 19 treatments with three replications. The pomegranate trees cv. kandhari kabuli under investigation were subjected to foliar spray of biostimulants viz. vipul, spic cytozyme, homobrassinolides, biozyme crop plus, vipul + homobrassinolides and control. The study was conducted to determine the effect of plant biostimulants on cracking and quality of fruits. Cracking is a disorder where fruit surface cracks mainly due to heavy irrigation or rain after long dry spell. This may occur due to varietal characters, orchard soil management, inappropriate levels of water at maturity stage, light, temperature and micro-nutrient deficiency. The results revealed that the highest fruit length, diameter, weight, volume and minimum fruit cracking were recorded in trees treated with spic cytozyme (4 ml/l). The highest intensity in ground and over colour were observed with the application of Vipul 15 ml/l.

Key words: Quality, fruit cracking, pomegranate, biostimulants.

INTRODUCTION

Pomegranate (*Punica granatum* L.) is one of the oldest known edible fruits and is capable of growing in different agro-climatic conditions ranging from the tropical to sub-tropical (Levin, 2006; Jalikop, 2007). Though, it is native of Iran but cultivated extensively in Mediterranean and central Asian countries. It is highly suitable for growing under arid and semiarid regions due to its versatile adaptability, hardy nature, low cost maintenance and high returns. India is the largest producer of pomegranate in the world with production around 0.8 MT and area 0.13 MH (Anonymous, 2009). In recent past its wide significance in health, nutrition and livelihood security has been recognized which resulted in heavy demand for fruit consumption not only in India but throughout the globe. In India, pomegranate is commercially cultivated in Maharashtra, Karnataka and Andhra Pradesh and the most important cultivar in this pomegranate belt is 'Bhagwa' which covers around 80% area under pomegranate in Maharashtra. Since last two decades, its cultivation has popularized in arid and semi-arid regions of India, not only because of its sweet acidic taste, precocious bearing and better self-life but as a remunerative crop as well. Among various arid fruits, pomegranate occupies second largest area after ber (*Ziziphus mauritiana*).

In Himachal Pradesh, pomegranate is mainly cultivated under rainfed conditions, therefore, its yield and quality is adversely affected during drought and rainfall conditions. Fruit cracking is a serious problem in pomegranate which hinders its cultivation to a large extent. Cracking varies

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from 10 to 70% depending upon the prevailing environmental conditions. Various factors are responsible for fruit cracking which include fluctuation in soil moisture regimes, climate, tree nutrition, cultivars (Kumar et al., 2010). It may also occur due to micronutrient deficiency in young fruits, while in mature fruits it might be due to moisture imbalance or due to extreme variations in day and night temperatures (Abd El-Rhman, 2010). At the time of fruit ripening, if the soils become too dry followed by heavy irrigation or rains, cracking may occur (Mars, 2000). It is due to the hardening of the skin of the fruit during long dry period and then sudden expansion in the volume of inner part of the fruit after rain or heavy irrigation. Delay in harvesting of fully ripened fruits for a long time or severe attack of pest and disease also leads to cracking of the fruits (Hoda and Hoda, 2013). Cracked fruits lose their value for the fresh market and are used for processing only (especially for fruit juice) if not affected by fungi. Cracked fruits are susceptible to storage disease and have a shorter storage as well as shelf-life. It is revealed that the shape of the fruit plays an important role in fruit cracking. It is generally found in apricot, litchi, cherry, apple, pomegranate, citrus, and nectarine etc.

Plant growth and development, as well as the responses to environmental factors, are highly regulated by complex and coordinated action of the endogenous hormones and plant biostimulants. They have the potential of increasing plant productivity and quality through influence on various metabolic processes. They have the potential of increasing plant productivity and quality through influence on various metabolic processes. Plant biostimulants are also known to improve fruit size, appearance and aril quality by having direct effects on fruit growth and development or indirectly by regulating crop load, tree vigour and canopy architecture (Looney, 1993). Vipul is a commercial formulation of triacontanol (TRIA) which is a long chain 30 carbon primary alcohol (CH_3 $(CH_2)_{28}$ CH_2OH) and occurs in nature as a natural constituent of bee wax and plant waxes.

Biozyme crop plus is a commercial formulation of seaweed extract (*Ascophyllum nodosum*), enzymes and hydrolyzed proteins whereas, spic cytozyme contains gibberellic acid, auxins, cytokinins, seaweed extract (*A. nodosum*), hydrolysed proteins and trace elements. Gibberellic acid (GA_3) sprays have been evaluated in many fruit growing regions to reduce the risk of crop loss by making fruit more resistant to cracking. Gibberrellic acid is used widely in various horticultural crops for improving fruit set and also to control cracking of pomegranate fruit (Sepahi, 1986) and litchi (Sharma and Dhillon, 1986) and to inhibit flowering of *Prunus* species (Coneva and Cline, 2006; Lenahan et al., 2006). GA_3 sprays have also been observed to improve fruit quality in sweet cherries (Clayton et al., 2006). Godrej Double is a commercial formulation having Homobrassinolides and belongs to brassinosteroids group of plant hormones. Brassinosteroids are relatively new endogenous phytohormones which were first isolated from pollen grains of *Brassica napus* and they participate with other plant hormones in the regulation of numerous aspects of plant development, including shoot and root growth, vascular differentiation, fertility, and seed germination. So, in order to achieve optimum fruit quality biostimulants need to be supplied to the plant in small and frequent applications.

MATERIALS AND METHODS

The experiment was laid out at an elevation of 1250 m above mean sea level at 30° 51N latitude and 76° 11E longitude, representing mid hill zone of state, in the pomegranate experimental block of the Department of Fruit Science, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2008 to 2009. The climate of the area is typically sub-temperate. The annual rainfall ranges between 800 to 1300 mm. The orchard soil was sandy in texture with pH 6.55, 0.59 dS/m electrical conductivity (EC) and 0.61% organic carbon content. The experiment consisted of 19 treatments with three replications in randomized block design. The biostimulants applied were vipul (5, 10 and 15 ml/l), spic cytozyme (1, 2 and 4 ml/l), homobrassinolides (0.5, 1 and 1.5 ml/l), biozyme crop plus (1, 2 and 3 ml/l), Vipul + homobrassinolides (0.5 + 5, 1 + 5, 1.5 + 5, 5 + 0.5, 5 + 1 and 5 + 1.5 ml/l) and control with no foliar application. Seven years old pomegranate trees cv. Kandhari Kabuli with uniform vigour and size, planted at a spacing of 3 x 3m were selected for the study. The biostimulants were applied 45 days after bud burst and repeated 10 days after fruit set. The solutions of biostimulants were prepared by dissolving them in water directly. Before spraying, 0.5 ml of wetting agent (Indtron-AE) per litre of solution was added as surfactant to reduce surface tension and to facilitate the absorption of solution. The treatments were applied with a foot sprayer. Spraying was done in a clear and calm day during the morning hours to increase efficiency. The application was performed until run off. The observation in respect of fruit cracking was recorded by counting the number of fruits, which were labeled, periodically at the end of each month and expressed in percentage. The size of five randomly taken fruits per tree was measured with a digital vernier calliper and the average size expressed as length and diameter in millimeter (mm). The weight of fruits was recorded at harvest time with a top pan balance and the average fruit weight was expressed in grams (g). The volume of five fruits was measured with the water displacement method and the data expressed in cubic centimeter (cc). Fruit colour was determined using the RHS (royal horticultural society) horticultural colour chart. The data was analyzed using data analyzing statistical software. The final data was presented in the table for interpretation of the result.

RESULTS AND DISCUSSION

Fruit cracking

All the biostimulants significantly reduced fruit cracking (Table 1). A significant decrease in fruit cracking percentage was obtained by using all sprayed substances compared to control. Higher concentrations of biostimulants were found more effective in reducing fruit cracking. The minimum fruit cracking (11.33%) was recorded with spic cytozyme (4 ml/l) which was statistically similar to the biozyme crop plus (3 ml/l)

Table 1. Effect of biostimulants on fruit cracking, fruit size, fruit weight and fruit volume of pomegranate cv. Kandhari kabuli.

Treatment		Concentration (ml/l)	Fruit cracking (%)	Fruit length (mm)	Fruit diameter (mm)	Fruit weight (g)	Fruit volume (cc)
T_1	Vipul	5	17.67	81.55	82.08	301.30	282.41
T_2	Vipul	10	16.33	81.92	84.13	302.60	283.55
T_3	Vipul	15	16.00	84.93	85.76	306.60	285.61
T_4	Cytozyme	1	15.67	80.81	82.95	301.10	282.31
T_5	Cytozyme	2	14.00	82.83	83.09	302.80	283.82
T_6	Cytozyme	4	11.33	91.16	88.68	316.30	293.57
T_7	HBRs	0.5	19.00	81.17	82.00	300.10	281.68
T_8	HBRs	1	17.33	81.94	83.28	301.60	282.93
T_9	HBRs	1.5	16.00	82.26	83.93	303.90	284.44
T_{10}	Biozyme	1	16.67	81.89	84.07	303.70	284.20
T_{11}	Biozyme	2	14.17	82.96	84.11	304.30	285.00
T_{12}	Biozyme	3	12.67	84.65	85.37	305.90	285.48
T_{13}	Vipul+HBRs	0.5 +5	15.00	83.03	86.41	305.20	285.27
T_{14}	Vipul+HBRs	1 +5	14.67	84.01	87.08	307.20	285.91
T_{15}	Vipul+ HBRs	1.5 +5	13.67	86.49	87.53	309.80	287.69
T_{16}	Vipul+HBRs	5 +0.5	16.67	83.51	86.26	305.70	285.29
T_{17}	Vipul+HBRs	5 +1	15.33	83.67	86.45	306.10	285.57
T_{18}	Vipul+HBRs	5 +1.5	14.33	85.45	87.24	307.50	286.75
T_{19}	Control	Water Spray	20.00	79.24	79.72	296.50	279.03
	$CD_{0.05}$		1.90	2.00	2.08	2.49	2.87

treatment (12.67%). These treatments were closely followed by the vipul+HBRs (1.5 + 5 ml/l) treatment (13.67%). This reduced fruit cracking could be due the effect of auxins, gibberellins and enzymes which influenced hydrolytic activity and increased plasticity of cell walls (Taiz and Zeiger, 2006). Such physiological effect of these biostimulants may possibly result in preventing the cracking (Anand et al., 2003). Sekse et al. (2005) reported that GA_3 influences fruit cracking indirectly by influencing the permeability or elasticity of the fruit cuticle.

In addition, Byers et al. (1990) also observed that GA_3 may be influencing cell wall strength or elasticity. Moreover, spic cytozyme may have increased the resistance of the rind to punctures by the pressure of the aril growth (Duarte and Guardiola, 1995). These results are also in agreement with the findings of Singh (2008) with 20 ppm 2, 4-D in pomegranate cv. G-137 and with gibberellic acid (Mohamed, 2004). Usenik et al. (2005) found that application of GA_3 reduced cracking in cherry. Cline and Trought (2007) also reported that gibberellic acid reduced cracking in cherry. Lal et al. (2012) observed that application of GA_3 40 ppm in pomegranate reduced fruit cracking. However, the maximum fruit cracking (20.00%) was observed in control.

Fruit quality

Fruit size, weight and volume

Treatments with biostimulants resulted in significantly higher lengths, diameters, weights and volumes in fruits in comparison to the control (Table 1). The maximum fruit length (91.16 mm), diameter (88.68 mm), weight (316.30 g) and volume (293.57 cc) was observed with spic cytozyme (4ml/l). This increase in fruit size, weight and volume with the application of spic cytozyme could be due to nature of auxins (NAA) to stimulate cell division and cell enlargement and increased sink strength of the fruits (Taiz and Zeiger, 2006; Chaudhary et al., 2006). Increased fruit size is in corroboration with the findings of (Singh, 2008) and (Hoang, 2003) who reported that application of NAA increased fruit size, weight and volume of pomegranate. NAA + Carbaryl improved average fruit weight in pomegranate (Desai et al., 1993; Pawar et al., 2005). Sprays of GA_3 have been widely adopted in commercial cherry orchards because they have consistently been shown to increase fruit size and firmness (Choi et al., 2002; Kappel and MacDonald, 2002; Horvitz et al., 2003; Clayton et al., 2006; Ozkaya et al., 2006). Gibberellins are involved in cell division and cell elongation. They are known to influence fruit size (Zhang and Whiting, 2011). Gibberellic acid is also reported to promote growth by increasing plasticity of the cell wall followed by the hydrolysis of starch into sugars which reduces the cell water potential, resulting in the entry of water into the cell and causing elongation (Richard, 2006).

Fruit colour

The biostimulant treatments improved fruit colour in

Table 2. Effect of biostimulants on fruit colour of pomegranate cv. Kandhari kabuli.

Treatment		Concentration (ml/l)	Fruit ground colour	Fruit over colour
T_1	Vipul	5	RED GROUP 41 C	RED GROUP 45 A
T_2	Vipul	10	RED GROUP 44 C	RED GROUP 45 A
T_3	Vipul	15	RED GROUP 46 C	RED GROUP 46 A
T_4	Cytozyme	1	RED GROUP 41 D	RED GROUP 45 A
T_5	Cytozyme	2	RED GROUP 41 C	RED GROUP 45 A
T_6	Cytozyme	4	RED GROUP 41 B	RED GROUP 45 A
T_7	HBRs	0.5	RED GROUP 42 C	RED GROUP 45 B
T_8	HBRs	1	RED GROUP 42 C	RED GROUP 45 B
T_9	HBRs	1.5	RED GROUP 42 C	RED GROUP 45 B
T_{10}	Biozyme	1	RED GROUP 41 D	RED GROUP 45 A
T_{11}	Biozyme	2	RED GROUP 41 C	RED GROUP 45 A
T_{12}	Biozyme	3	RED GROUP 42 B	RED GROUP 45 A
T_{13}	Vipul+HBRs	0.5 +5	RED GROUP 42 B	RED GROUP 45 A
T_{14}	Vipul+HBRs	1 +5	RED GROUP 42 B	RED GROUP 45 A
T_{15}	Vipul+HBRs	1.5 +5	RED GROUP 42 A	RED GROUP 44 A
T_{16}	Vipul+HBRs	5 +0.5	RED GROUP 42 C	RED GROUP 45 A
T_{17}	Vipul+HBRs	5 +1	RED GROUP 42 B	RED GROUP 45 A
T_{18}	Vipul+HBRs	5 +1.5	RED GROUP 42 B	RED GROUP 45 A
T_{19}	Control	Water spray	RED GROUP 40 C	RED GROUP 45 D
	$CD_{0.05}$			

comparison to control (Table 2). Fruits with best ground (RED GROUP 46 C) and over colour (RED GROUP 46 A) were observed with vipul (15 ml/l) (Table 2). Triacontanol is also known to increase anthocyanin content in plum (Chandel and Jindal, 1991), deep colour and even ripening of grape berries after Mixtalol application (Gupta et al., 1987). Carbohydrates play a vital role in the development of fruit colour, an indicator of maturity (Roper et al., 1987). Further, increase in the fruit colour is due to increase in the anthocyanin content which was due to greater accumulation of carbohydrates under the influence of bioregulators. The increase in the colour intensity is in agreement with the work of Fornes et al. (1995) and Koo and Mayo (1995) who observed accelerated colour break and pigmentation in citrus after application of triacontanol.

Conclusion

The results revealed that the plant biostimulants significantly improved fruit quality and reduced fruit cracking. The highest fruit length, diameter, weight, volume and minimum fruit cracking were recorded in trees treated with spic cytozyme 4 ml/l. The highest intensity in ground and over colour were observed with the application of vipul 15 ml/l. Hence, it can be recommended that spic cytozyme (4 ml/l) and (vipul 15 ml/l) should be applied 45 days after bud burst and repeated 10 days after fruit set to improve fruit quality and reduce fruit cracking of pomegranate cv. kandhari kabuli.

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