Indian J. Plant Physiol., Vol. 16, No. 3&4, (N.S.) pp. 326-330 (July-Dec., 2011)

SHORT COMMUNICATION

EFFECT OF DIFFERENT CHEMICALS ON FRUIT CRACKING IN POMEGRANATE UNDER KAREWA CONDITION OF KASHMIR VALLEY

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Received on 9th December, 2010; Revised and accepted on 3rd Aug., 2011

The present research study was accomplished on five varieties of pomegranate (Dholka, Bedana, Kandhari, Jyoti and G-137) during 2008-09 and 2009-10 to investigate the effect of nutrients and growth regulator on fruit cracking. Treatments comprises of calcium sulphate (2000, 3000, 4000 ppm), GA_3 (40, 80, 120 ppm), borax (25, 50, 75 ppm) and control (water) were applied as foliar application on 15th May (fruit set) and 15th June (fruit active development stage). The minimum fruit cracking was observed in $CaSO_4$ 3000 ppm followed by $CaSO_4$ 2000 ppm, GA_3 40 ppm and borax 50 ppm as compared to control in both seasons. Among selected varieties, minimum fruit cracking was recorded in Jyoti followed by G-137 and maximum in Kandhari. There were significant differences noticed in treatment varietal interaction means and minimum fruit cracking was recorded with the treatment of $CaSO_4$ 2000 ppm in Jyoti, Dholka and Kandhari however in Bedana and G-137 was recorded with $CaSO_4$ 3000 ppm as compared to control. Fruit yield per tree was recorded to be highest in GA_3 80 ppm followed borax 75 ppm, borax 50 ppm, borax 25 ppm as compared to control, regardless of the varieties. In addition to that correlation among the fruit morphological parameter and fruit cracking also estimated in Dholka variety and found that fruit cracking was positively associated with fruit diameter, fruit L/D ratio, fruit weight, fruit volume, rind weight and grain moisture where as negetively with rind thickness, fruit firmness index and rind moisture.

***Key words*: Cracking, growth regulators, nutrients, physiological disorders**

Pomegranate (*Punica granatum* L.) is a favorite fruit in temperate, tropical and sub tropical regions of world. In India, it consists area of 125 (000 ha), 820 MT production and 6.6 MT/ha productivity ((NHB 2009), mostly grown in subtropical, tropical regions and limited extent to temperate regions (H.P, Uttarakhand and J&K). Fruit cracking is one of the major physiological disorders wherever pomegranate trees are grown. In temperate region, in past several years it is observed that almost all the cultivars in the region are sensitive to fruit cracking resulting huge economic loss to the growers. It may be due to moisture imbalances (Kumar 1990**)** as this fruit is very sensitive to variation in soil moisture prolonged drought causes hardening of peel and if this is followed by heavy irrigation, the pulp grows then peel expand and crack develops. Fruit cracking caused huge loss to farmers by reducing total yield up to 30-50% (Bankar and Prasad 1992, Singh and Kingsly 2006). It also deteriorates fruit quality significantly and fruit become unfit for marketing. Several chemical substances were tried to control fruit cracking. (Singh *et al.* 1990) noted that application of macro-nutrients such as $MgSO_4$ 1% and KNO_3 1% reduced fruit cracking in pomegranate with regular irrigation at weekly intervals. Calcium is a nutritional element that differs from others by being imported into fleshy fruit only in small amounts,

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much less than into leaves. Calcium uptake and distribution in the plant is influenced by water movement to transpiring organs and relative rate of Ca use along the transport pathway (Saure 2005). Although Ca is sufficiently available in the soil of most of the orchards, localized Ca deficiency may become a problem in several fruit crops, with the risk of large economic losses. Some authors postulated a competition for Ca between low-transpiring fruit and vigorously growing, highly transpiring leafy shoots (Montanaro *et al*. 2006). Calcium plays an important role in regulating absorption of water by plant roots. Calcium solution treatments have been reported to reduce the cracking in pomegranate (Sharma 2011). Boron is another important nutrient for plants. It plays major role in cell walls membrane function, cell wall strength and development, cell division, fruit and seed development, sugar transport. Response of borax was effective in managing fruit cracking and increasing yield of pomegranate plants (Soni *et al.* 2000). Likewise, micronutrients and growth regulator (Gibberalic acid) were also found effective in controlling premature and mature cracking of pomegranate var. Jodhpur Red (Kuldeepet *et al*. 2001). Keeping well documented results of growth hormones and plant nutrient on fruit cracking in view, the present project emphasis has been given on to reduce cracking in fruit by application of different types of chemical and growth hormones under Karewa area of Kashmir valley which is characterized by low rainfall and high evapo-transpiration. In addition to that correlation studies among fruit morphological characteristics and fruit cracking of pomegranate varieties helps in finding out the degree of inter-relationship among various characters and in evolving selection criteria for improvement and development of fruit cracking resistant varieties.

The present study was carried out at Central Institute of Temperate Horticulture, Srinagar during 2008-09 and 2009-10 on 8-years old five pomegranate varieties viz. Dholka, Bedana, Kandhari, Jyoti and G-137. The trees were planted at 2.5m ×2.5m and irrigation supplied by drip method @ 4 liter/hour at 4 days interval. Sixteen trees nearly uniform in shape and size and received the same pruning, training, weeding, intercultural operation etc. including the control. The experiment was conducted under factorial randomized block design replicated three times and pooled data of two years were analyzed as per the method suggested by Gomez and Gomez (1984). Calcium sulphate (2000, 3000, 4000 ppm), GA_3 (40, 80, 120 ppm) and Borax (25, 50, 75 ppm) and control (water) was applied as foliar application on 15th May (fruit set) and 15th June (fruit active development stage). At harvesting, fruit samples were taken from all trees in both seasons and the number of fruits per tree in each treatment was counted and the percentage of cracked fruits was recorded, also the fruit yield (kg) per tree was calculated. Twenty fruits of each variety were individually analyzed for physical characteristics. Fruits were weighted in the air on a Sartorius balance of accuracy of 0.001 g. Fruit volume was calculated by a liquid displacement method. The length and diameter of the fruit and calyx were measured with a digital vernier caliper. The measurement of fruit length was made on the polar axis, i.e. between the apex and the end of stem. The maximum width of the fruit, as measured in the direction perpendicular to the polar axis, is defined as the diameter. The measurements of the peel thickness were made using the digital vernier caliper. Fruit firmness index has been measured with digital firmness meter. The peel moisture content and grain moisture content was also estimated using oven dry method. To determine interrelationship among the fruit morphological traits and fruit cracking, samples were taken from untreated (control) tree of Dholka variety and correlation coefficients were worked out as method suggested by Al-Jibouri *et al.* (1958).

All tested treatments reduced the percentage of cracked fruits in Dholka, Bedana, Kandhari, Jyoti and G-137 pomegranate varieties as compared to control in both studied seasons, 2008-09 and 2009-10. The minimum fruit cracking (23.01%) was observed in the treatment $CaSO_4$ 3000 ppm followed by $CaSO_4$ 2000 ppm (23.73 %), GA_3 40 ppm (25.36%) and in control (39.18%) (Table 1). The results were at par in both the treatments i.e. $CaSO_4$ 3000 ppm and $CaSO_4$ 2000 ppm. Results were according to findings of Yamamoto *et al*. (1992) who reported that spraying with 0.5% calcium solution significantly reduced the cracking index of 'Napolean' sweet cherries. Calcium ion, which have strong effect in preventing fruit cracking are thought to have a strong precipitation or crosslinking effect on pectin (Bangerth 1973). This also suggests that the calcium in the cell wall, especially that in the middle lamella, play

Table 1. Different chemicals and varietal interaction effect on percent fruit cracking in Jyoti, Dholka, Kandhari, Bedana and G-137 pomegranate varieties grown under Karewa condition of Kashmir valley

Treatments	Fruit cracking percentage					(Average of 2 years)
	Jyoti	Dholka	Kandhari	Bedana	G-137	Pooled means
$CaSO_4$ 2000 ppm	17.40	19.6	23.49	28.56	29.58	23.72
$CaSO_4$ 3000 ppm	27.08	26.28	26.35	20.10	15.28	23.01
$CaSO_4$ 4000 ppm	26.23	32.28	33.06	30.14	28.08	29.95
GA_3 40 ppm	25.10	26.56	27.54	24.02	23.62	25.36
GA_3 80 ppm	22.52	29.28	30.46	25.33	25.65	26.64
GA_3 120 ppm	22.04	27.53	38.62	27.43	28.46	28.81
Borax 25 ppm	27.35	27.49	33.24	26.36	25.41	27.97
Borax 50 ppm	23.32	27.50	31.14	26.42	18.70	25.41
Borax 75 ppm	27.38	30.24	33.33	30.52	27.30	29.75
Water (control)	33.19	40.30	46.35	39.57	36.52	39.18
Mean	25.16	28.70	32.35	27.84	25.86	-
Factor	CD at 5%		SE(d)		SD(m)	
Treatment	1.45		0.73		0.51	
Variety	1.02		0.51		0.36	
Treatment × variety	3.25		1.63		1.15	

an important role in the fruit cracking process. The percentage of fruit cracking also varies with the types of varieties and among selected varieties minimum fruit cracking % recorded in Jyoti (25.16%) followed by G-137 (25.86%), Bedana (27.84%), Dholka (28.70%) and maximum in Kandhari (32.35%) this might be due to difference in genetic behavior among the varieties (Table 1).

There were significant difference noticed in treatment varietal interaction means (Table 1) and minimum fruit cracking was recorded with in treatment $CaSO_4$ 2000 ppm in Jyoti, Dholka and Kandhari whereas in Bedana and G-137 was recorded with $CaSO_4$ 3000 ppm as compared to control.

Fruit yield per tree recorded highest in both the years of investigation (Table 2) with foliar application of GA_3 80 ppm followed by Borax 75 ppm, Borax 50 ppm and Borax 25 ppm as compared to control regardless of the varieties. Among varieties maximum yield per tree was recorded in G-137 and had non-significant difference with Jyoti. However, minimum yield was recorded in Bedana variety. Plant growth regulators and varieties interaction means was found significant and maximum yield recorded in treatment GA_3 80 ppm in G-137, Jyoti, Dholka, Bedana and Kandhari respectively followed by treatment $CaSO_4$ 4000 ppm in Dholka, Borax 75 ppm in Jyoti, Kandhari, and Bedana respectively as compared to control in Bedana, Kandhari, Jyoti, Dholka, G-137 (Table 2). Similar results was also reported by Pawar *et al.* (2005) they recorded highest yield in cv. Mridula of pomegranate in Maharashtra with 75 ppm GA_3, while Mohamed (2004) from Assiut (Egypt) recommended 150 ppm of GA_3 for getting higher fruit yield.

Correlation study revealed (Table 3) that fruit diameter, fruit length, fruit L/D ratio, fruit weight, fruit volume and grain moisture are positively but not significantly associated whereas rind weight exhibit significantly association with fruit cracking . Result indicates that bigger size fruit with less thick rind having high seed moisture are more prone to fruit cracking as compared to medium size, thick fruit rind with low seed moisture content. That might be due the exertion of high pressure by high moisture seeds towards the thin rind

Table 2. Different chemicals and varietal interaction effect on fruit yield per plant in Jyoti, Dholka, Kandhari, Bedana and G-137 pomegranate varieties grown under Karewa condition of Kashmir valley

Treatment	Yield/tree (kg)					(Average of 2 years)
	Bedana	Kandhari	Jyoti	Dholka	G-137	Pooled means
$CaSO_4$ 2000 ppm	4.25	4.96	6.13	5.73	6.23	5.46
$CaSO_4$ 3000 ppm	4.23	4.83	6.63	5.60	6.56	5.57
$CaSO_4$ 4000 ppm	3.63	5.16	6.66	7.16	7.00	5.92
GA_3 40 ppm	3.83	4.46	6.20	5.80	6.00	5.26
GA_3 80 ppm	6.36	6.16	8.00	7.83	8.13	7.30
GA_3 120 ppm	3.86	4.06	5.86	5.56	6.86	5.24
Borax 25 ppm	4.60	5.23	6.93	6.66	7.03	6.09
Borax 50 ppm	5.26	5.20	6.96	7.00	6.70	6.22
Borax 75 ppm	5.46	5.36	7.13	7.13	6.26	6.27
Control (Water)	3.70	4.43	5.10	5.40	6.30	4.98
Mean	4.52	4.99	6.56	6.39	6.71	-
Factor	CD at 5%		SE(d)		SD(m)	
Treatment	0.20		0.10		0.07	
Variety	0.14		0.07		0.05	
Treatment × cultivar	0.46		0.23		0.16	

Table 3. Correlation among fruit morphological attributes and fruit cracking Cv. Dholka (Average of 2 years)

Characters	Fruit diameter (mm)	Fruit length (mm)	Fruit L/D ratio	Fruit weight (gm)	Fruit volume (ml)	Rind weight (gm)	Rind thickness (mm)	Rind moisture (%)	Grain moisture (%)	Fresh fruit firmness index	Fruit cracking (%)
Fruit diameter (mm)	1.000	0.994	0.943	0.962	0.854	0.972	-0.276	-0.852	0.883	-0.093	0.984
Fruit length (mm)		1.000	0.972	0.928	0.794	0.941	-0.173	-0.792	0.828	0.012	0.960
Fruit L/D ratio			1.000	0.816	0.630	0.837	0.062	-0.627	0.675	0.245	0.868
Fruit weight (g)				1.000	0.963	0.999*	-0.526	-0.962	0.977	-0.360	0.995
Fruit volume (ml)					1.000	0.952	-0.736	-1.000**	0.998*	-0.598	0.933
Rind weight (g)						1.000	-0.495	-0.951	0.969	-0.325	0.998*
Rind thickness (mm)							1.000	0.739	-0.695	0.983	-0.443
Rind moisture (%)								1.000	-0.998*	0.601	-0.932
Grain Moisture (%)									1.000	-0.550	0.952
Fresh fruit /firmness index										1.000	-.270
Fruit cracking (%)											1.000

*Correlation is significant at the 0.05 level (2-tailed)., **Correlation is significant at the 0.01 level (2-tailed).

of fruit resulting cracks. Similar results also reported by (Mir *et al.* 2007). Rind moisture, fruit firmness index and rind thickness are negatively but non significantly related with fruit cracking and this statement also supported by the Gharesheikhbayat (2006) who reported that weakness of epiderm, formation of sclereid clusters and air cavity in ground tissue causes cracking in pomegranate.

It can be concluded that fruit cracking in pomegranate cultivars grown under Karewa condition of Kashmir valley could be minimized by a pre-harvest foliar application of calcium sulpahte 3000 ppm and calcium sulpahte 2000 ppm at fruit set and fruit active development stages. Maximum yield per tree in cultivars Dholka, Bedana, Kandhari, Jyoti and G-137 could be achieved by foliar application of GA_3 80 ppm. Fruit morphological characters like fruit diameter, fruit length, fruit shape, fruit weight, fruit volume and rind weight were positively and rind thickness, grain moisture and rind moisture were found to be negatively associated with fruit cracking. In future this aspect can be further investigated and tested in screening for crack or drought resistance varieties for the Karewa region of Kashmir valley.

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