Indian Journal of Agricultural Sciences **79** (8): 592–4, August 2009

Effect of chemicals and pruning on russeting, yield and quality of 'Golden Delicious' apple (*Malus domestica*)

M K SHARMA[1], S R SINGH[2], A S SUNDOURI[3], K K SRIVASTAVA[4] and F A BANDAY[5]

Received: 15 March 2009

Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar 191 121

ABSTRACT

A study was conducted during 2005-06 on the influence of chemical treatments and light pruning on russeting and yield and quality of 'Golden Delicious' apples (*Malus domestica* L.) The treatments were, 0.2% wettable sulphur (T_1), 3% $Ca(OH)_2$ (T_2), 0.4% $MnSO_4$ (T_3), 0.1% Boric acid (T_4), 0.2% wettable sulphur + Ca $(OH)_2$ @ 3% (T_5), $MnSO_4$ @ 0.4% + Ca $(OH)_2$ @ 3% (T_6), wettable sulphur (0.2%) + 0.4% $MnSO_4$ + 0.1% boric acid (T_7), 0.2% wettable sulphur + 3% Ca $(OH)_2$ + 0.4% $MnSO_4$ (T_8), light pruning 15 days after petal fall (T_9) and no treatment (control) (T_{10}). Chemical treatments were repeated thrice at weekly interval starting from the petal fall as foliar sprays and the observations were recorded on russeting percentage, extent of russeting, fruit yield and physico-chemical characteristics of 'Golden Delicious' apples. Spray of 0.2% wettable sulphur + 0.4% $MnSO_4$ + 0.1% boric acid (T_7) significantly reduced fruit russeting, followed by spray of 0.2% wettable sulphur. The extent of russeting was also lower with these treatments. Yield as well as weight, length, diameter, TSS and total sugars of fruits were significantly higher in T_7, followed by T_5 and T_4. The frequency and extent of russeting was higher in control plants. All the treatments improved yield and quality of 'Golden Delicious' apples over control.

Key words: Russeting, Yield, Quality, 'Golden Delicious' apples

Russeting manifested as suberin patches on different parts of the fruit epidermis in different shapes and intensities in the 'Golden Delicious' (*Malus domestica* L.) is a great problem for apple growers all over the world in marketing fresh fruits because it decreases consumption and commercial value (Byers *et al* 1983). This is considered to be due to untimely divisions of cells in the epidermis of the fruit initiated by various reasons including cool wet weather, frost, pesticides, viruses, fungi (powdery mildew, *Aureobasidium pullulans* and *Rhodotorula glutinis*) and bacteria (*Erwinia herbicola* and *Pseudomonas* sp.) (Curry 1990). Many spray materials (including surfactants), especially emulsifiable concentrates and materials containing copper, zinc, or calcium, if not evenly distributed by spray equipment can produce a russet on apples. Stress can be important in relation to such blemishes. The disorder was correlated with weather parameters, particularly with humidity and net precipitation. For the development of russeting, the fruits were especially sensitive to weather conditions for a short period which occurred between 16 and 20 days after full bloom (Creasy 1980). Some workers believe that there is a strong correlation between nutrition and russeting and optimal orchard management (pruning and manuring) may contribute to a reduction in fruit russeting. Therefore the investigation was carried out to find out a method to reduce fruit russeting in 'Golden Delicious' apples.

[1,3]Assistant Professors, [5]Professor and Head, Division of Pomology

[2,4] Senior Scientists, CITH, Srinagar

MATERIALS AND METHODS

The study was conducted in the experimental orchard of the university, Shalimar, Srinagar district of Jammu and Kashmir during 2005 and 2006 on 15-year old trees of 'Golden Delicious' apple raised on seedling rootstock having uniform size and vigour. The orchard is situated at an elevation of 1 458 m above mean sea level and the climate is temperate. Fertilizer was applied to the soil a fortnight before flowering as: urea 533, diammonium phosphate 650 and muriate of potash 1 500 g/tree to the experimental trees (recommended for the area). A 532 g of urea was applied 3–weeks after fruit set. The treatments were, T_1 (0.2% wettable sulphur), T_2 (3%$Ca(OH)_2$), T_3 (0.4% $MnSO_4$), T_4 (0.1% boric acid), T_5 (0.2% wettable sulphur) + (3% Ca $(OH)_2$, T_6 (0.4% $MnSO_4$) + (3% Ca $(OH)_2$, T_7 (0.2% wettable sulphur) + (0.4% $MnSO_4$) + (0.1% boric acid), T_8 (0.2% wettable sulphur) + (3% Ca $(OH)_2$) + (0.4% $MnSO_4$), T_9 light pruning

15 days after petal fall and T_{10}–no treatment (control). Chemical treatments were applied as foliar sprays thrice at weekly interval starting from the petal fall the crucial period for the development of russeting (Meador and Taylor 1987). For the cultivar the date of full bloom was 23 and 12 April during 2005 and 2006, respectively. The experimental design was random block with three replicates.

When the fruits reached commercial maturity (21 September during 2005 and 25 September during 2006), 20 random fruits were collected/tree for russeting and physico-chemical analysis. The percentage of the number of fruits with russeting were counted, the per cent of surface area of fruits covered with russet was estimated and fruit yield (kg)/tree, length and diameter of 20 randomly selected fruits and individual fruit weight (g) were recorded.

Fruit TSS was measured with Ermma hand refractrometer. Titrable acidity and total sugars were following the methods of Rangana (1986) and A O A C (1980), respectively. Rainfall and other meteorological informations were taken from Meteorological observatory of the university situated near the experimental orchard area.

RESULTS AND DISCUSSION

It is evident from Table 1 that different treatments significantly reduced russeting during both the years under study. Plants treated with T_7 had the lowest number of russeted fruits, followed by the plants treated with T_1 and T_6. However the control plants had highest number of russeted fruits during both the years. Different treatments appreciably reduced the extent of fruit russeting. The plants treated with T_5 had fruits with less than 5% of the russeted surface during 2005 though the effect was less pronounced during 2006 with more russeted fruit surface than the previous year. The precipitation was quite high during the first five weeks after full bloom (sensitive period) during 2005 (98.60 mm) than 2006 (58.50 mm). Day and Crisosto (1994) also established moisture as the major cause of weather-induced russeting. Weather was cooler during the sensitive period in 2005 (max. temp. 21.50–22.18°C) than 2006 (max. temp. 26.92–27 °C). However, humidity was also high during 2005 (76.64%) than 2006 (69.93%). These congenial conditions might have favoured the development of more russeting during 2005 than 2006. Reduced russseting with the application of wettable sulphur may probably be due to the thickening of cuticle (Curry 1990). The cuticle thickness is highly important in diminishing or augmenting russeting damage (Adler 1994) and thus, the most susceptible apples are those with thin skins. Basak *et al.* (1983) and Steenkamp *et al.* (1984) demonstrated that sulphur-based products applied at the onset of flowering and in six weekly applications diminished russeting by 30–80%. Jobin-Lawler *et al.* (2001) observed a significant decrease in cuticle cracking with individual as well as combined foliar application of Ca and B. High Ca might have increased tissue plasticity (integrity) and resulted in low russeting. Mn is also reported to increase the elasticity of the cells hence can contribute to the reduction in the occurrence of russeting. Sanchez *et al.* (2001) also reported that the treatments reduced the russeting in 'Golden Delicious' apples by increasing Mn levels in fruit skin. Light pruning at fifteen days after full bloom might have direct effect on auxin biosynthesis as shoot tips are the site of auxin synthesis, hence reduced russeting in comparison to control (Roberts 2008). This treatment might also have encouraged the air flow through the tree canopy as high humidity within the tree or orchard tends to increase russeting (Day and Crisosto 1994).

Fruit yield in all the treatments was superior to control during both the years (Table 1). Maximum fruit yield (72.59 and 32.18 kg/tree) was obtained from the trees treated with T_7, followed by the plants treated with T_5 (69.71 and 28.88 kg/tree) during 2005 and 2006, respectively. Lower fruit yield during 2006 in comparison to 2005 was due the inherent character of 'Golden Delicious' which is an intermediate bearer. Plants treated with T_7 resulted in highest fruit weight (195.47 and 199.16 g), followed by T_5 (170.81 and 195.82). However the fruit weight was lowest in control plants (116.11

Table 1 Effect of different treatments on frequency and extent of russeting and yield and fruit weight of apple cv. 'Golden Delicious'

Treatment	Russeting (%)		Extent of russeting		Fruit yield (kg/tree)		Fruit weight (g)	
	2005	2006	2005	2006	2005	2006	2005	2006
T_1	26.00	14.33	<5	<5	64.18	27.52	150.76	193.33
T_2	34.67	31.00	<10	<10	63.39	27.36	146.19	190.06
T_3	30.67	22.33	<10	<10	61.29	25.39	145.08	185.31
T_4	46.33	26.67	<10	<10	65.66	28.76	143.39	194.96
T_5	25.33	20.67	<5	<10	69.71	28.88	170.81	195.82
T_6	22.67	18.67	<15	<15	61.19	24.19	151.56	170.69
T_7	8.00	10.67	<5	<5	72.59	32.18	195.47	199.16
T_8	31.33	18.33	<10	<10	62.23	26.11	164.59	188.21
T_9	62.00	43.67	<20	<15	58.39	23.08	148.67	161.43
T_{10}	76.00	62.33	<25	<20	55.51	18.51	116.11	135.36
CD (*P*=0.05)	5.30	3.45			2.93	0.60	6.08	1.13

Table 2 Effect of different treatments on fruit quality of apple cv. 'Golden Delicious'

Treatment	Fruit length (mm)		Fruit diameter (mm)		TSS (°B)		Total sugars (%)	
	2005	2006	2005	2006	2005	2006	2005	2006
T_1								
T_1	63.11	66.18	71.49	74.33	13.7	13.8	8.16	8.27
T_2	63.24	65.45	69.81	73.81	13.9	13.9	8.23	8.38
T_3	65.86	64.36	66.39	72.29	13.8	13.8	8.21	8.31
T_4	61.65	66.31	70.41	74.88	14.0	14.0	8.43	8.41
T_5	65.34	66.81	74.49	75.73	14.0	13.8	8.54	8.32
T_6	61.74	63.25	71.11	71.34	13.2	13.3	7.99	7.94
T_7	66.49	68.39	75.88	76.61	14.4	14.4	9.16	9.08
T_8	65.34	65.17	71.36	73.44	13.3	13.2	8.08	7.91
T_9	65.29	64.13	71.06	70.36	13.5	13.4	8.16	7.98
T_{10}	57.81	62.56	67.12	68.27	13.0	13.1	7.76	7.71
CD (*P*=0.05)	2.14	1.09	3.73	0.41	0.19	0.21	0.42	0.09

and 135.36 g) during 2005 and 2006 respectively. All other treatments had intermediate effect on fruit weight. Fruit length and diameter were also highest with T_7 and lowest in control (T_{10}) during both the years of study (Table 2). Higher fruit yield and other physical parameters with T_7 may probably be due to higher amino-acid and protein synthesis with sulphur and enhanced carbohydrates metabolism and photosynthesis with Mn and boron application (Chundawat 1997). The results corroborate with the findings of Pathak and Mitra (2008). Plants treated with T_7 resulted in higher fruit TSS and total sugars during both the years in comparison to other treatment under study. However these chemical parameters were lowest in control plants. These results are in conformity with those of Usha and Singh (2005).

From the above results it is concluded that application of 2% wettable sulphur + (0.4%) $MnsO_4$ + (0.1%) boric acid thrice at weekly interval starting from petal fall not only reduced fruit russeting but also improved the yield and quality of 'Golden Delicious' apples.

REFERENCES

A O A C. 1980. *Official Methods of Analysis of Analytical Chemist*. Benjamin Franklin Station, Washington D C.

Alder S J. 1994. Russeting control takes knowledge of various causes. *Good Fruit Grower* **3**: 38–9.

Basak A, Soczek Z, Cisek B and Karolczak W. 1983. Control of russeting of 'Golden delicious' apples with Golclair. *Fruit Science Reports* **10**(2): 67–72.

Byers R E, Yoder K S and Matus G E. 1983. Reduction in russeting of Golden Delicious apples with 2,4,5–TP and other compounds. *Hort Science* **18**(1): 63–65.

Chundawat B S. 1997. *Nutrient Management in Fruit Crops*, pp 256. Agrotech Publishing Academy, Udaipur.

Creasy L L. 1980. The correlation of weather parameters with russet of Golden Delicious apples under orchard conditions. *Journal of American Society of Horticultural Sciences* **105**(5): 735–8.

Curry A E. 1990. Causes of russeting in fruit. (*in*) *Proccedings of 87th Annual Meeting. Washington State Horticultural Association,* pp 157–160. Seattle, WA.

Day K R and Crisosto C H. 1994. Apple russeting. *Central Valley Post Harvest News* **3**(2): 4–6.

Day K. 1994. Russeting control takes knowledge of various causes. *Good Fruit Grower* **3**: 38–9.

Jobin-Lawler F, Simard K, Gosselin A and Papadopoulos A P. 2001. The influence of solar radiation and boron-calcium fruit application on cuticle cracking of a winter tomato crop grown under supplemental lighting. *Acta Horticulturae* **580**: 49–54.

Meador D B and Taylor B H. 1987. Effect of early season foliar sprays of GA_{4+7} on russeting and return bloom of 'Golden Delicious' apples. *Hort Science* **22**(3): 412–15.

Pathak P K and Mitra S K. 2008. Effect of phosphorus, potassium, sulphur and boron on litchi. Indian *Journal of Horticulture* **65**(2): 137–40.

Rangana S. 1986. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd edn, pp 190–210. Tata McGraw Hill Publishing Co., New Delhi.

Roberts Keith. 2008. *Handbook of Plant Science*. John Wiley and Sons Ltd, New York.

Sanchez E, Soto J M, Ruiz U H and Romero J M. 2001. Chemical treatments in Golden Delicious spur fruits in relation to russeting and nutritional status. *Journal of Plant Nutrition* **24**(1): 191–202.

Steenkamp J, Zyl-Van H J and Westraad I. 1984. A preliminary evaluation of various chemical substances for the control of calyx-end russeting in 'Golden Delicious' apples. *Journal of Horticultural Sciences* **59**(4): 501–5.

Usha K and Singh B. 2005. Effect of macro and micro-nutrient spray on fruit yield and quality of grape (*Vitis vinifera* L.) cv. Perlette. *Acta Horticulturae* **594**: 154–7.