Phyl-Gold: a product to diminish russeting of 'Golden Delicious' apples

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INTERNATIONAL JOURNAL OF HORTICULTURAL SCIENCE

AGROINFORM Publishing House, Hungary

Key words: fruit quality gibberellins GA_{4+7}, Golden Delicious, russeting

Summary: Producing high quality apples in mature trees of the cv. 'Golden Delicious' is rather difficult because of the russeting of it's fruits, especially in seasons of high relative humidity and/or wetness.
Earlier experiments proved the possibility to decrease russeting by treatments of GA_{4+7} during a period after petal fall.
Phyl-Gold, a product of Phylaxia Co. (ai. 10 gl^{-1} GA_{4+7}) was applied to inhibit russet formation in fruit skin of 'Golden Delicious' apples. Four consecutive sprays were carried out (with 10 ppm a.i.) in weekly intervals, starting at petal fall and tank-mixed with the current pesticides of the plant protection program.
Due to the GA_{4+7} application the russet formation decreased at a rate of economical importance. As for the side-effects of treatments, fruit set was reduced slightly in trees treated, however, there was no consequent influence on return bloom.

Introduction

Fresh fruits are not always considered the most important commodities by consumers doing their weekly shopping so the decision to buy is often spontaneous and highly dependent on product attractiveness. For example fruit appearance can influence competitiveness and a substantial premium is paid for 'Golden Delicious' apples free of surface russet.

Some of the factors associated with the development of russet were discovered hundred years ago, these and many others revealed later on were reviewed in a comprehensive paper (*Faust & Shear* 1972) as follow.

Russeting originates in the epidermis and russet formation occurs in the tissues subjacent to small cuticular cracks. It was found that epidermal cells undergo tangential division shortly after bloom (about 30 days after anthesis). Soon after this an active cork cambium (phellogen) is initiated in the innermost epidermal cells which divide rapidly giving rise to cork cells (periderm). The cracking of the cuticle is perhaps the earliest step in the etiology of russet. Cultivars with thin cuticles, or areas of fruit having thin cuticle are most subject to russet. The structure of the cuticle may also be important. 'Golden Delicious', a cultivar having an amorphous cuticle in which the wax platelets are embedded in a structureless matrix, is more subject to russet than are cultivars which have their cuticle arranged in free platelets. It has also been reported that some cultivars with thin, but "oily" cuticles are resistant to russet. Fruit enlarges during the night, which is influenced by temperature. Russet is more likely to develop in areas where night temperature is high (15–20 °C), than in places where night temperature is low (4–10 °C). Treatments with high N, which increase cell enlargement, enhance the formation of russet. Spraying materials that are toxic to cells can also cause russet.

Many environmental conditions, such as frost, certain pesticides, and, especially, exposure of the fruit to prolonged periods of high relative humidity or wetness, are associated with the occurrence of russet (*Faust & Shear* 1972, *Walter* 1967, cit. *Meador & Taylor* 1987). The effect of water may not be confined to a single action. Apples in a humid environment develop a thin or almost no cuticle (*Tomana* 1963, *Tukey* 1960, 1969, cit. *Faust & Shear* 1972). Also water as rain or dew may diffuse into the epidermal cells through the cuticular cracks creating high turgor pressure within, which may lead to the rupture and death of some cells.

Gibberellins GA_{4+7} are the most frequently used and the most effective substances to improve the appearance of skin of 'Golden Delicious' fruits (*Dijke & Kester* 1983, *Benati & Cobianchi* 1984, *McLaughlin & Greene* 1984, *Bootsma* 1985, *Taylor & Knight* 1985, *Maffi & Rocca* 1986, *Hallama* 1985, *Meador & Taylor* 1987, *Fankhauser* et al. 1986, *Elfving & Allen* 1987). The cited authors used the commercial products called Berelex or Regulex, containing GA_{4+7}. The treatments were carried out as successive sprayings within some weeks after bloom and they proved to be more efficient than other substances which have been used for this purpose, for example sulphur (*Eccher & Maffi*, 1986), finely dispersed A1203 (*Byers* et al. 1983) or dimethoate (*Skene*, 1980).

Gibberellin treatments increase the plasticity of the fruitlet skin and causes enlargement of epidermal and hypodermal cells, and cuticular morphology is also affected

(*Taylor & Knight*, 1986). Treatments can cause slight thinning effect and decrease flower-bud formation (*Wertheim* 1982, *Hallama* 1985, *Meador & Taylor* 1987, *Taylor & Knight* 1985).

Improved (i.e. properly elongated) fruit shape of Delicious apples, as another function of GA_{4+7} treatments had been discussed earlier (*Bubán* et al., 1993).

Materials and methods

Gibberellins GA_{4+7} as experimental substances were used during the years from 1987 to 1995. For the time being the Phyl-Gold, a product of Phylaxia Co. (Budapest) is available. It's most important ingredients are GA_{4+7} (10 gl^{-1}) and contains small amounts of other gibberellins and the intermediers of gibberellin biosynthesis. The product was registered in 1996.

Treatments were carried out four times, starting at petal fall and then three times again (about weekly). Gibberellins were sprayed at a concentration of 5 ppm (a.i.) as an aqueous solution but mostly 10 ppm combined i.e. tank-mixed with the current pesticides of the plant protection program. The treatments were evaluated by investigating 5 to 6 times 100 apples, or 10 times 50 pieces of fruits based on the percentage of the russeted area of their skin (see bottom row of apples on *Fig. 2*: 1 – no russet, 2 – less than 30%, 3–31 to 60%, 4 – more than 61%, 5 – confluent, severe russeting). This paper is presenting results of two experiments as examples (in *Rakamaz* 1991, and *Újfehértó* 1993).

Results and discussion

Russeting of the treated 'Golden Delicious' apples decreased markedly. The proportion of the first class fruits (the sum of grade 1 and 2) of the treated trees was 105% higher compared to the controll in 1991, and 41% higher in 1993 (*Table 1*). The percentage of the low quality fruits

Table 1 Percentage of fruits according to the russeting

Years Treatments	No russet	Grade of russeting			
	1	2	3	4	5
Rakamaz, 1991 [1]					
GA_{4+7} 10 ppm	38	42	16	2	2
Untreated	6	33	34	12	15
Újfehértó, 1993 [2]					
GA_{4+7} 10 ppm	54	29	12	5	0
Untreated	26	33	22	15	4
	***	n.s.	**	**	**

[1] farm experiment, statistically not evaluated
[2] T-test of Student ** = $p<0.01$; *** = $p<0.001$; n.s. = not significant

(grade 4 and 5, suitable only for processing) decreased significantly: in 1991 the proportion of these severely russeted fruits was 6.8 times higher on the untreated trees, and 3.8 times higher in 1993 (*Table 1.*, see *Fig. 1* and 2, too).

Fruit set was slightly reduced in trees treated *(Table 2)*. It is mentioning, too, that the average fruit set of 5 years (1987 to 1991) was 81% on one-year-old shoots and 88% on spurs, if it is considered as 100% in untreated trees (*Bubán* et al., 1991, not published). A moderate fruit thinning in trees with extremely high fruit set is, however, a really favourable side-effect of these treatments. Nevertheless, treatments in orchards and/or years of poor flowering should be neglected.

Table 2 Fruit set in trees of the cv. 'Golden Delicious' (Újfehértó) (Bubán et al., 1995)

Years Treatments	No. of fruits/ 100 flower clusters	
	on 1-year-old shoot	on spurs
1990.		
GA_{4+7} 5 ppm	47	51
GA_{4+7} 5 ppm + pesticides	32	73
Untreated	68	78
1991.		
GA_{4+7} 5 ppm	77	92
GA_{4+7} 10 ppm + pesticides	119	96
Untreated	117	110
1993.		
GA_{4+7} 10 PPM	124	104
Untreated	121	105

Table 3 Return bloom in trees of cv. 'Golden Delicious' (Újfehértó) (Takács, 1994)

Years Treatments	Return bloom	
	on 1-year-old shoot (pcs/m)	proportion of flowering spurs (%)
1992.		
GA_{4+7} 10 ppm	28.5	75.9
Untreated	16.5	58.5
1991.		
GA_{4+7} 5 ppm	17.6	84.2
GA_{4+7} 10 ppm	13.3	82.3
Untreated	21.5	87.1

Table 4 Percentage of fruits according to the russeting (cv. 'Golden Delicious') (Bubán et al., 1993)

Treatments	No russet	Grade of russeting				Income[2]
	1	2	3	4	5	%
GA_{4+7} 10 ppm	48	32	13	4	2	121
Untreated	16	34	24	12	14	100

[1] as an average of 9 experiments in 5 years (1987-1991)
[2] relative market value of the total yield in the field treated and untreated, resp., calculated from the rate of russeting and prices belonging to certain grades of russeting

There was no decrease in return bloom (*Table 3*), the restrained fruit thinning effect mentioned above may explain it. It can not be excluded, too, that the ratio of GA_4:GA_7 might be higher in the Phyl-Gold; other products of GA_{4+7} caused a certain reduction in flower bud formation (*McLaughlin & Greene* 1984, *Meador & Taylor* 1987). A relative higher ratio of GA_4 may counteract the flower initiation inhibiting effect of GA_7. Four to six weeks after bloom is a real critical period regarding success of plant protection against diseases, i.e. spraying of fungicides is needed nearly each week. Therefore, the cost of Phyl-Gold treatments combined with pesticides is not more than the

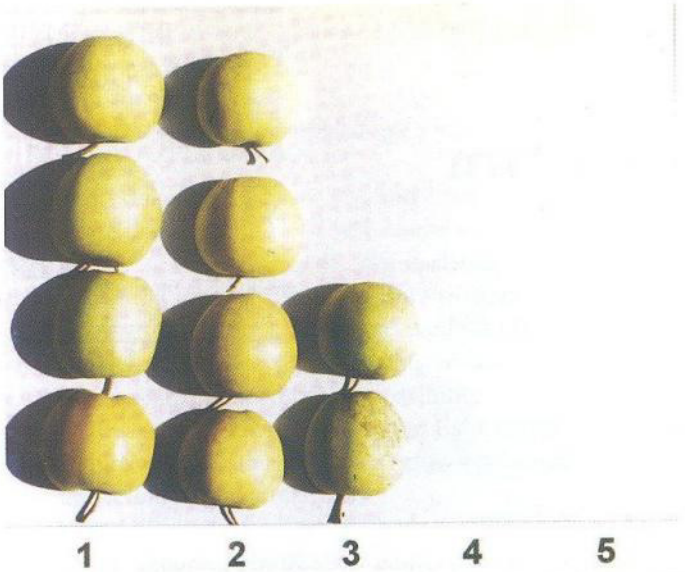

Figure 1 Russeting of 'Golden Delicious' fruits treated with GA_{4+7} 10 ppm
(each apple represents approx. 10%)

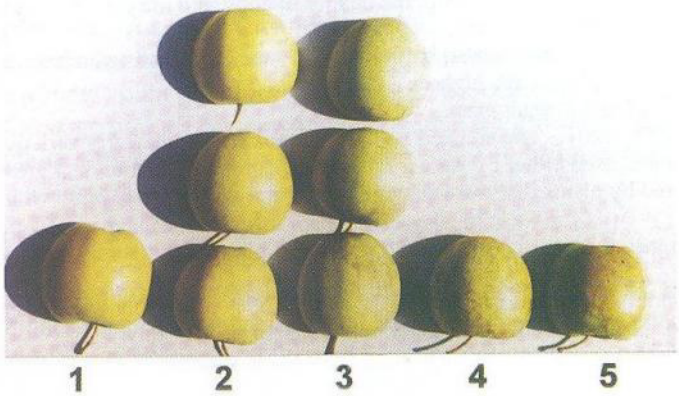

Figure 2 Russeting of untreated 'Golden Delicious' fruits
(each apple represents approx. 10%)

price of this product itself (which is about 50 USD for 4 sprayings per hectare). Taking into consideration the higher market value of the yield in the orchard treated (*Table 4*), there is no doubt concerning the usefulness of these treatments.

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