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Full Length Research Paper

The effect of gibberellins on russeting in golden delicious apples

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Russet on apples, *Malus domestica Borkh* and other fruits results in lowered fruit quality and substantial economic losses to growers. In this study we investigated the effect of GA_3 and GA_{4+7} on russeting. Russeting index of fruits were estimated at harvest. Apple trees, twenty years old Golden Delicious was sprayed with GA_3 at the concentrations10-20 mgL^{-1} and GA_{4+7} at 5-10 mgL^{-1} during petal-fall at 7-10 days 3 time again. All applied concentration of GA_3 and GA_{4+7} reduced russeting in Golden Delicious cultivar significantly and significant difference was found between GA_3 and GA_{4+7} actions. The application of GA_3 or GA_{4+7} caused fruits to shift to elongated shape due to increase of L/D ratio. The application of GA_3 or GA_{4+7} caused to increase the weight of Golden Delicious fruit significantly. When GA_3 or GA_{4+7} were separately sprayed on Golden Delicious, it resulted in considerable decrease in russeting neither return bloom nor were fruit set influenced by treatment.

Key words: Apple russeting, golden delicious, gibberellins, GA_3 and GA_{4+7}.

INTRODUCTION

Russet on apples, *Malus domestica Borkh* and other fruits results in lowered fruit quality and substantial eco-nomic losses to growers (Cummins et al., 1977). Tho-rough reviews have been written on the etiology of fruit russet (Eccher and Boffelli, 1981; Fuast and Shear, 1972). Factors associated with apple russet include in-fection by the powdery mildew pathogen (podosphaera Leucotricha) (Gildemacher et al., 2004; Matteson-Heiden-reich et al., 1997; Spotts, 2002) insects (Easterbrook and Fuller, 1986), cultural and environmental factors (Michail-ides, 1991), mechanical injuries (Walter, 1967) and pesti-cides (Taylor, 1978).

The use of some fungicides (Creasy and Swartz, 1981) silicon dioxides (Edgerton, 1976; Matteson-Heidenreich et al., 1997), antagonistic bacteria (Lindow, 1992) and gibberellic acid (Foulk and Hoover, 1994; Greene, 1993; Looney et al., 1992) was shown to reduce the incidence of apple russet. Microscopic observation of russeted areas of fruit shows breaks in the cuticule layer with underlying layers of dead epidermal cells (Ashizawa et al., 2005; Skene and Green, 1989).

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Fruit cultivars differ greatly in their susceptibility to russet (Kirby and Bennett, 1967). In this study we investigated the effect of application of GA_{4+7} and GA_3 on russeting of apple. We also investigated if the concentration of GA_{4+7} and GA_3 is sufficient to reduce russeting of apple. The aim of this study was to compare the effect of GA_{4+7} and GA_3 in control of russeting.

MATERIALS AND METHODS

The experiments were conducted in the experimental Orchad of Agricultural Institute of Iran, kahriz Orumia in 2007-2008. Apple trees of cultivar "Golden Delicious" were used as experimental materials. A complete randomized blocks design with 13 trees of same size, homogenous and medium growth were used. The distance between trees was 6 x6 m and age of the trees was 20 years. The concentrations of GA_{4+7} and GA_3 used were 5, 10, 10 and 20 mgL^{-1}. The concentrations were sprayed 3 times starting from petal-fall (P.F) stage and at intervals of 7-10 days. Single, whole selected tree were sprayed at petal- fall (22 may 2007) with a motorized air blast sprayer with GA_3 at a rate of 10 to 20 mgL^{-1} and GA_{4+7} at a rate of 5 to 10 mgL^{-1} separately. The GA_{4+7} and GA_3 treatment did not include a witting agent. Russeting of fruit was estimated at harvest using a scale of grading described by (Buban, 2001):

(1) No russet.
(2) Less than 30%.
(3) 31 to 60%.

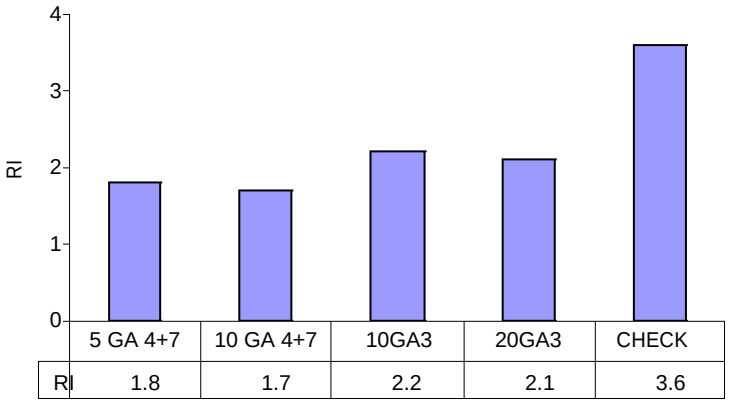

Figure 1. Russet index of GA4+7 and GA3 treated apples.

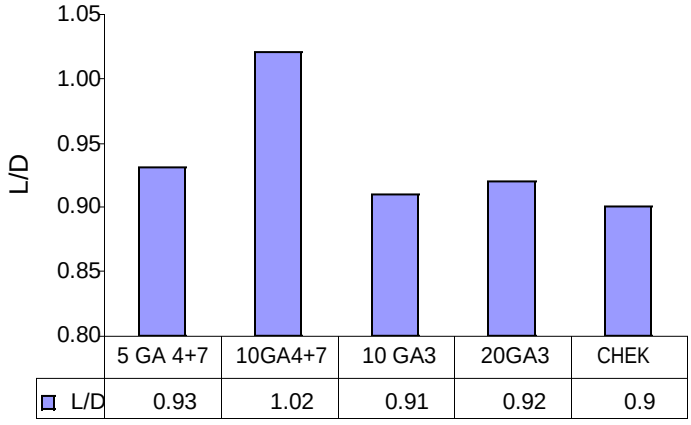

Figure 2. The effect of GA_{4+7} and GA_3 on fruit shape. Indicate error bars.

(4) More than 61% of the fruit surface with network-like russeting.
(5) Confluent sever russeting.

Mean fruit weight, seed number and fruit length: diameter ratio (L/D) was estimated on a random sample of 30 fruits/trees at harvest. The experiments were repeated 2 times. Data were subjected to statistical analysis of variance and LSD for mean comparisons at P=0.01 was used.

RESULTS

The effect of GA_{4+7} and GA_3 on russeting

This study has shown that GA_{4+7} and GA_3 reduced russet in apple but did not have the same effect. Figure 1 shows the effect of GA_{4+7} and GA_3 on russeting. Russeting Index indicated significance between control and case.

Although reduce russeting with increasing concentration and number of spray. The concentration of 10 mgL^{-1} of GA_{4+7} was significantly different with control.

The effect of GA_{4+7} and GA_3 on fruit shape

Both of GA_{4+7} and GA_3 elongated the fruit shape resulting in higher L/D ratios measured at harvest. There was a significant positive effect of GA_{4+7} and GA_3 concentration on the fruit L/D ratio ($P<0.01$). There was a markedly higher of elongated fruit (with L/D ratio of 0.91 or more). Figure 2 shows the effect of GA_{4+7} and GA_3 fruit shape.

The effect of GA_3 or GA_{4+7} treatments on fruit weight

Result of this study showed that GA_3 and GA_{4+7} treatments can increase fruit weight. The highest fruit weight was produced with concentration of 10 mgL^{-1} GA_{4+7} and lowest with the control (Figure 3). There was no relationship between number of seeds, firmness, color and GA_3 and GA_{4+7} treatments.

DISCUSSION

Treatments by GA_3 and GA_{4+7} proved to be useful to increase the market value of fruits likewise to earlier reports on improving fruit shape and decrease in russeting. Non-treatment trees of "Golden Delicious" in this study were russeted. Therefore, treated trees were free of rus-

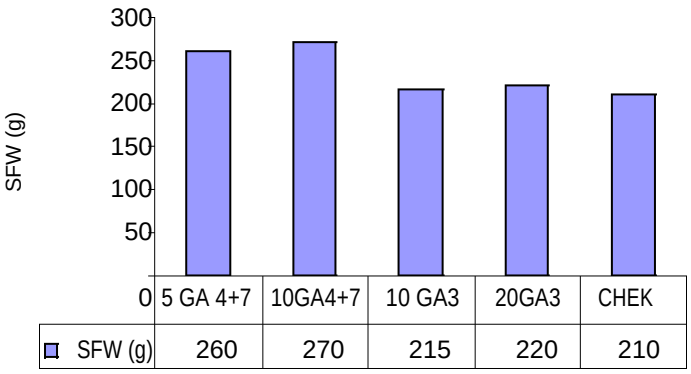

Figure 3. The effect of GA_3 and GA_{4+7} treatments on fruit weight.

seting. 10 mgL^{-1} GA_3 concentration has a few effect on reduction of russeting but caused increase L/D ratio, while 20 mgL^{-1} GA_3 concentration caused increasing of inhabitation of fruit set in the year after treatment and increased fruit size and weight not significantly. Both GA_{4+7} concentrations caused reduction of russeting and increase fruit size and weight significantly. When higher concentration of GA_3 or GA_{4+7} was applied on the trees, there was increasing of inhibitation of flower bud formation and reduction of fruit number in the year after treatment and increased of cost (Taylor and Knight, 1986). There was no influence on return bloom. However, GA_3 and GA_{4+7} treatment increased fruit weight because of thinning effect and decrease of fruit number.

In similar experiment in Australia on "Golden Delicious" influence on flower bud formation was found following the application of 24 mgL^{-1} of GA_{4+7} this effect while with app-lication 10 mgl^{-1} of GA_{4+7} was not found this effect. When the higher concentration of GA_3 and GA_{4+7} was used, the weight of "Golden Delicious" fruit was higher. These re-sults confirm the thesis of additional fruit growth after GA application (Looney et al., 1992).

Similar experiments on "Golden Delicious" and "COX Orange *Pippen*" with rate of GA_{4+7} 2.5- 10 mg/l (depending on cultivar) applied 3 or 4 times at 10 day intervals starting during the period of first-flower to petal-fall to achieved satisfactory control (Skene and Green, 1989).

While some authors found a positive influence of GA_3 and GA_{4+7} on return bloom (Jones et al., 2004) in other trial the application of GA_{4+7} 12 or 24 mgL^{-1} did not increase the return bloom of "Golden Delicious" trees (Taylor and Knight, 1986). In this study, best treatment was 10 mgl^{-1} GA_{4+7} in control of russeting on "Golden Delicious" and improved fruit shape, weight and increase quality of fruits and reduce economic losses and has not effect on return bloom.

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