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Effect of Jasmonic Acid on Yield and Quality of Two Strawberry Cultivars

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Abstract

A low concentration (0.10 mM) of jasmonic acid (JA) did not affect fruit ripening and development in 'Tufts' and 'Cruz' strawberries. However, high concentrations (0.25, 0.50 and 1.00 mM) caused fruits to ripen earlier than the control, significantly increased berry size in the first two weeks of harvest, and increased total yield per plant. No concentration of JA affected soluble solids concentration or total titratable acidity in either cultivar.

Jasmonic acid (JA) and its methyl ester, methyl jasmonate (MJ), are regarded as endogenous plant growth regulators with a wide range of physiological functions. Several researchers reported remarkable biological activities of jasmonates, such as inhibition of stem and root growth (12), prevention of chlorophyl and carotenoid formation (10), reduction of photosynthetic (9) and respiratory activity (9, 13), and promotion of senescence (14).

After jasmonates were shown to interact with ethylene in a variety of biological activities, there was a surge in research activity aimed at clarifying the effects of jasmonates on fruit growth and ripening because ethylene is known to accelerate ripening of fruits. These compounds stimulate ethylene production in ripening tomatoes (11), in immature strawberry fruits (8), and in preclimacteric apples (4), whereas they inhibit ethylene production in rice seedlings (14) and in postclimacteric fruits (11).

Fan et al. (3) concluded that methyl jasmonate participates in modulating initial events in apple ripening. There are reports on levels of jasmonic acid and methyl jasmonate in immature strawberry fruits (5, 7). Gansser et al. (5) reported that a high concentration of methyl jasmonate was found in immature 'Kent' strawberries; it steadily decreased during fruit development. The authors suggested that the high concentration of endogenous methyl jasmonate in unripe 'Kent' strawberries contributes to the initiation and modulation of ripening processes. In this work, the effects of different concentrations of JA on fruit ripening and development and some yield components were investigated in two cultivars of strawberry.

Materials and Methods

The experiment was carried out at Horticultural Research Station of Yuzuncu Yil University, Faculty of Agriculture, Van, Turkey. On 15 June 2000, cold stored plants (cvs. Tufts and Cruz) were established in slightly raised beds covered with black polyethylene sheeting 0.25 mm thick. A double row planting was used, with plant spacing at approximately 30 cm x 30 cm. Standard methods of fertilization and irrigation were used. On 25 April 2001 (first bloom date), JA at different concentrations (0.10 mM, 0.25 mM, 0.50 mM and 1.00 mM) was applied to flowering plants by spraying with an atomizer. Fruits were hand-picked every third day at marketable maturity. The berry weight, number of fruit per plant, total soluble solids concentration (SSC), and titratable acidity were determined at each harvest. The data of two harvest dates were combined to provide a weekly total. Using filtered juice, SSC was measured with a refractometer and total acidity was determined by titrating to pH 8.2 with 0.1 N NaOH and is reported as percentage of citric acid.

The experiment was arranged as a completely randomized design with three

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Table 1. Fruit weight (g/fruit) of 'Tufts' and 'Cruz' strawberry as affected by jasmonic acid of different concentrations.

Cultivar	Treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Average
Tufts	Control	—	10.0 b	11.6 a	9.8 a	8.6 a	7.2 a	9.4 a
	0.10 mM	—	10.9 b	12.0 a	9.9 a	7.8 a	6.5 a	9.4 a
	0.25 mM	14.1 a[1]	14.3 a	11.7 a	9.9 a	8.2 a	7.9 a	11.0 a
	0.50 mM	16.7 a	15.9 a	12.1 a	9.5 a	8.5 a	7.2 a	11.6 a
	1.00 mM	15.1 a	16.6 a	11.5 a	9.7 a	9.0 a	6.6 a	11.4 a
Cruz	Control	—	11.1 b	10.4 a	10.7 a	9.5 a	8.1 a	9.9 a
	0.10 mM	—	11.5 b	10.3 a	11.0 a	8.7 a	7.5 a	9.8 a
	0.25 mM	12.8 b	14.0 a	12.3 a	11.0 a	9.1 a	7.7 a	11.1 a
	0.50 mM	14.5 a	14.9 a	11.9 a	11.0 a	9.1 a	8.2 a	11.6 a
	1.00 mM	15.3 a	14.7 a	13.2 a	10.7 a	8.8 a	8.8 a	11.9 a

[1]Means followed by the same letter within cultivars and columns are not significantly different at ($P<0.05$), Duncan's multiple range test.

replications, each plot having 20 plants. Data were analyzed by analysis of variance and the mean values were established and compared by Duncan's Multiple Range Test at $p \leq 0.05$.

Results

The effect of JA was similar in both cultivars. No concentration of JA affected the fruit number per plant (data not shown). However, high concentrations (0.25, 0.50 and 1.00 mM) of JA caused fruits to ripen earlier than the control. In the first week of harvest, there were no ripe fruit from plants treated with 0.10 mM JA or the control plants, but the mean number of fruit per plant was 1.8, 5.3 and 4.9 in 'Tufts', and 2.7, 6.3 and 5.9 in 'Cruz' treated with 0.25, 0.50 and 1.00 mM JA, respectively.

The high concentrations (0.25, 0.50 and 1.00 mM) of JA significantly increased berry weight in the first two weeks of harvest in the both cultivars (Table 1). However this effect was not observed in fruits harvested in later periods. Also, JA increased total yield per plant by increasing berry size at the first two weeks of harvest in both cultivars. The total yield per plant

Table 2. Yield (g/plant) of 'Tufts' and 'Cruz' strawberry as affected by jasmonic acid of different concentrations.

Cultivar	Treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Total
Tufts	Control	—	51.0 d	73.1 a	57.5 a	26.7 a	10.1 a	218.4 b
	0.10 mM	—	57.8 cd	68.4 ab	63.0 a	25.7 a	7.7 ab	222.7 b
	0.25 mM	25.4 c[1]	60.1 c	71.1 ab	62.1 a	26.2 a	10.2 a	255.1 b
	0.50 mM	88.3 a	73.1 b	65.3 b	41.8 b	24.7 ab	5.8 b	299.0 a
	1.00 mM	74.0 b	89.4 a	48.3 c	57.2 a	19.8 b	5.9 b	294.6 a
Cruz	Control	—	73.3 b	65.2 c	82.0 a	52.0 a	25.0 ab	297.4 c
	0.10 mM	—	73.3 b	73.1 b	82.5 a	48.4 a	24.0 ab	301.4 c
	0.25 mM	34.6 b	81.2 a	82.4 a	76.7 ab	47.01 ab	23.7 ab	345.6 b
	0.50 mM	91.4 a	87.9 a	65.5 c	71.5 bc	40.7 c	20.5 b	377.4 a
	1.00 mM	90.3 a	80.9 a	66.0 c	66.3 c	41.4 bc	29.0 a	373.9 a

[1]Means followed by the same letter within cultivars and columns are not significantly different at ($P<0.05$), Duncan's multiple range test.

was increased in both cultivars by application of 0.50 mM JA compared with the control (Table 2).

In relation to quality, no significant differences ($p<0.05$) were found for SSC or titratable acidity in either cultivar (data not shown).

Discussion

In this study, the effect of JA applied to strawberry plants at bloom on fruit development was investigated. The application rate of 0.10 mM JA did not affect fruit development. However, 0.25, 0.50 and 1.00 mM JA application rates caused fruits of both cultivars to ripen approximately one week earlier than in control plants. There are few reports on physiological effects of exogenously applied jasmonates on fruits. Gansser et al. (5) reported high levels of MJ in immature 'Kent' strawberries, which steadily decreased during fruit development. The authors concluded that a high concentration of endogenous MJ in unripe strawberry fruit contributes to the initiation and modulation of ripening processes. In tomato fruits, Czapski and Saniewski (2) observed various effects of exogenously applied MJ, e.g., a great stimulation of ethylene-forming enzyme (ACC oxidase). Likewise, Fan et al. (3) reported that MJ stimulated ethylene production in preclimacteric apples. Therefore, jasmonates, by their influence on ethylene, could be a determinant of fruit ripening.

Perez et al. (8) reported that MJ increased *in vitro* fruit growth rate, expressed as cumulative weight gain of control, in strawberry. Similarly, in this study, JA increased the fruit size harvested during the first two weeks in both cultivars. On the other hand, strawberry growth and development have been related to increasing accumulation of sugar and abscisic acid (ABA) by fruit from mid-development to ripening (1). John and Yamaki (6) reported that ABA increased size and weight of fruit of strawberry. Staswick (12) claimed that physiological properties and activities of jasmonates were similar to ABA. However, in this study, no significant differences ($p<0.05$) were found for SSC and titratable acidity. These results are similar to the finding from the studies by Perez et al. (8) on the effect of MJ on *in vitro* strawberry ripening.

The results demonstrated that exogenously applied JA may stimulate ripening of fruit and increase fruit size in strawberry.

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'UFBeauty' and 'UFBlaze' Peaches

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'UFBeauty' and 'UFBlaze' peaches [*Prunus persica* (L.) Batsch] are released for grower trials by the Florida Agricultural Experiment Station. Trees of both cultivars produce attractive, sweet tasting, yellow and non-melting flesh (nmf) fruit intended for fresh use. As with most nmf fruit, these can be harvested "tree ripe", with full flavor and aroma, while retaining firmness for longer shelf life than fruit from melting flesh cultivars (8). Both cultivars originated from a 1995 cross of Fla.90-50cn x 'UFGold' (Fig. 1). Fla.90-50cn was a nmf nectarine selection with the nmf gene originating from two sources, one from a Brazilian genotype (3,5) and the other from old US cultivars and tracing back to 'Chinese Cling' (1). Fla.90-50cn originated as a full sib of 'UFGold' (3). 'UFBeauty' and 'UFBlaze' were selected in 1997 and 1998, and tested as Fla. 97-5c and Fla. 98-1c, respectively.

Standards and methods used in this program to evaluate genotypes have been described (6). Trees of 'UFBeauty' and 'UFBlaze' are estimated to require 200 and 300 chill units (cu), respectively, based on full bloom compared to the standards of 'Okinawa' (150cu), 'Sunred' (250cu) and 'Early Amber' (350cu) (4). The two cultivars bloom about 4 to 5 days apart ('UFBeauty' blooms earlier) in early February at Gainesville, and both have fruited well where the coldest month averages 15° and 17°C (2), respectively, and in colder locations in the absence of spring frost. Thus, we expect 'UFBeauty' and 'UFBlaze' to be grown successfully where 'UFGold' (200cu) and 'UF2000' (300cu) peaches, respectively, have been successful. Fruit of 'UFBeauty' ripen 2 to 3 days after 'UFGold', or near May 1 at Gainesville, about 85 to 90 days from full bloom. Fruit of 'UFBlaze' also ripen in the first week of May, about with 'Flordaking', or 80 days from full bloom. Trees of both cultivars are spreading and highly vigorous, and thus require summer pruning to permit light penetration for formation of strong fruiting wood in the lower half of the tree. Trees at Gainesville set a high number of flower buds, have few blind nodes (7), and exhibit little bud drop prior to bloom (8). Trees of both cultivars have high fruit set at Gainesville, and in the absence of thinning by spring frosts require fruit thinning to achieve optimum marketable size.

'UFBeauty' and 'UFBlaze' fruit have been observed at Gainesville for 3 successive years on top worked and budded trees on 'Flordaguard' rootstock (Tables 1 and 2) and are compared to cultivars ripening

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