Effects of Gibberellin Spray on Storage Quality of Kaki[1,2]

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Abstract. Gibberellic acid at 50, 100, and 200 ppm sprayed on leaves of bearing Kaki shoots 3 days before harvest greatly increased the storage life of fruit. In Hiratanenashi cultivar, GA sprayed fruits had more than double the storage life of unsprayed fruits. Sprayed fruits also remained firm on the tree, so period of harvest could be extended. Sprayed trees showed delay in defoliation. No injurious effects of the spray were observed.

The Kaki or Oriental persimmon (*Diospyros kaki*) keeps very poorly, especially Hiratanenashi which is considered to be the best of the astringent type cultivars. It softens within 2 or 3 days after the treatment to remove astringency and quickly becomes overripe. The rapid ripening characteristic of this fruit prevents it from becoming of first importance in the fruit industry.

Tarutani (4) stored non-astringent Kaki fruits successfully for several months in sealed 0.06mm polyethylene bags at 0°C. His results raised the question of whether it might be possible to increase the physiological life of this fruit in another manner. Stewart (3) reported 2, 4-D and 2, 4, 5-T markedly affected the retention of the buttons (calyxes) in a green condition in citrus fruits, thus preventing their undesirable blackening in storage. These results encouraged the authors to study possible methods for increasing the storage life of Kaki fruit.

The experiments were conducted at Kyoto University, Kyoto, Japan in 1962, 1963, and 1964. Two varieties, Hiratanenashi, an astringent type and Fuyu, a non-astringent type were used.

In 1962, 100 ppm each of 2, 4-D, 2, 4, 5-T, 2, 4, 5-TP, NAA, MH, PCPA, DNP, TIBA, Kinetin, and GA (gibberellic acid) were sprayed on bearing shoots of Hiratanenashi on Oct. 2 and to those of Fuyu on Oct. 9.

In 1963, 100 ppm of GA solution was sprayed only on fruits, only on leaves, and on both fruits and leaves of bearing shoots to determine the most effective method of GA treatment.

In 1963 and 1964, various concentrations of GA were sprayed on leaves of bearing shoots on many trees. Since the results of both years were similar, only the data for 1964 are presented. In 1964, 0 (unsprayed), 50, 100, and 200 ppm of GA solutions were sprayed on the leaves of approximately 20-year-old trees that were similar in respect to vigor of growth and fruit maturity. Hiratanenashi was sprayed on Oct. 10 and Fuyu on Oct. 26, on which dates the respective varieties were mature and ready to harvest. Fifty fruit samples of Hiratanenashi were harvested from sprayed trees on Oct. 13 (3 days after spraying), Oct. 20 (10 days after spraying), and Oct. 27 (17 days after spraying). A sample of 100 fruits of Fuyu was harvested on Oct. 29 (3 days after spraying) and again on Nov. 5 (10 days after spraying).

On the days of harvest, fruits of Fuyu were placed in wooden boxes for storage studies. Those of Hiratanenashi were treated with alcohol in air-tight casks for 7 days to remove astringency (2), then were removed and placed in wooden boxes for storage at a temperature of 7 to 15°C.

Fruit firmness was determined with a pressure tester every 2 days for Hiratanenashi and every 5 days for Fuyu. The average number of days required for firmness to decrease to 0.45 kg was compared between the GA treated and untreated fruits.

Screening of plant regulators: Results of screening sprays showed that fruits sprayed with 2,4-D matured early, while GA, 2,4,5-T, and DNP delayed maturity. 2,4,5-TP, NAA, MH, PCPA, TIBA, and Kinetin showed no effect on maturity. Of these materials, GA showed striking effects on fruit development. The sprayed fruits remained firm on the tree for 3 to 4 weeks longer than the non-sprayed fruits, and fruit enlargement and coloration were retarded. GA seemed to decrease the rate of development, maturation, ripening, and senescence of the fruit.

Effect of leaf or fruit application: When leaves only, or both fruits and leaves of bearing shoots were sprayed

Table 1. The effect of GA sprays on the storage life of Kaki fruits

Variety	Number of days to harvest after spraying [a]	Concentration in ppm	Average number of days fruit firmness decreased to 0.45 kg
Hiratanenashi	3	200	11.4 [b]
		100	10.1
		50	8.6
		0	3.5
	10	200	11.9
		100	10.0
		50	7.6
		0	2.9
	17	200	12.0
		100	9.2
		50	6.4
		0	0
Fuyu	3	200	56.3 [c]
		100	49.2
		50	41.5
		0	32.4
	10	200	61.4
		100	56.2
		50	46.8
		0	35.2

[a] Date of spraying: Hiratanenashi, Oct. 10; Fuyu, Oct. 26.
[b] Average number of days firmness decreased to 0.45 kg after removal of astringency.
[c] Average number of days firmness decreased to 0.45 kg after harvest.

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with GA, retardation in enlargement, coloration, and softening of fruits resulted. GA sprayed only on fruits showed very slight response. GA which was sprayed on leaves of bearing shoots apparently was absorbed and translocated to the fruits as was observed by Crane (1) in peaches. Therefore, spraying foliage seemed to be an appropriate method of GA application.

Time and effect of GA application: It was found that GA increased storage life of fruit when it was sprayed on leaves before harvest, but also retarded fruit development. Therefore, it was thought that GA should be applied as late as possible after fruits had attained their full size and mature color and were ready to harvest.

GA spray greatly increased the storage life of fruits of both varieties (Table 1). In Hiratanenashi, GA sprayed fruits showed more than double the storage life of the unsprayed (0 ppm). Unsprayed fruits harvested 3 days after date of spraying tested 0.45 kg in 3.5 days after removal of astringency. Fruits receiving 50, 100, and 200 ppm GA sprays tested 0.45 kg in 8.6, 10.1, and 11.4 days, respectively.

Unsprayed fruits harvested 17 days after the date of spraying overripened on the tree and became soft during the treatment for removal of astringency. On the first day after the treatment they tested less than 0.45 kg and were unmarketable. However, GA sprayed fruits remained firm and their storage life was almost the same as those harvested 3 days and 10 days after spraying. Therefore, GA spray not only increased the storage life of fruits after harvest but also extended the period of harvest on the tree.

Delay of autumn leaf fall by GA spray: GA sprays markedly delayed autumn leaf fall of the trees (Table 2). Heavy frost occurred on Dec. 2 and 3 causing all GA sprayed leaves to defoliate. However, in a non-frost region a greater delay in defoliation might have been expected.

Other effects of GA spray: The quality of sprayed fruits was not impaired by GA spray when the spray was applied after fruits had matured. Sprouting of sprayed shoots in the following spring was delayed 1 or 2 days by 200 ppm of GA. However, no injurious effects were observed.

Table 2. The effect of GA sprays on delay of autumn leaf fall.

Variety	Conc. (ppm)	Date of defoliation
Hiratanenashi	200	Dec. 3 [a]
	100	Dec. 3
	50	Dec. 2
	0	Nov. 10
Fuyu	200	Dec. 3
	100	Dec. 3
	50	Dec. 3
	0	Nov. 18

[a] Heavy frost occurred on Dec. 2 and 3.

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A Gravity Penetrometer for Measuring Flesh Firmness in Citrus Fruits

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Table 1. Comparison of the results obtained with the gravity penetrometer with those obtained with a whole-fruit compression tester[a].

	Flesh penetration (mm)	
	Normal	Variant
1.	4.47	7.80*
2.	7.36	12.83*
3.	6.34	11.21*
4.	6.65	11.46*
5.	7.61	12.43*
	Whole-fruit compression (mm)	
	Normal	Variant
1.	3.56	4.56
2.	4.23	4.34
3.	3.18	3.52

[a] Average of 10 fruits from each of ten trees of each type in each planting.
* = Difference significant at the 1% level.

Investigations on a widely distributed variant Navel orange led to the need for reproducible, quantitative measurements of flesh firmness of orange fruits. Previous work using pressure devices on the surface of transversely-cut citrus fruits had resulted in erratic results. Whole fruit compression tests failed to show significant differences between samples of the variant and normal fruits (Table 1). In preliminary trials, dropping a pointed rod a given distance through a guide tube onto the transversely-cut fruit gave reproducible results. On the basis of the preliminary results, the present instrument, Fig. 1, was constructed and used in subsequent tests comparing variant Navel oranges with normal Navel oranges. In all plantings tested, the variant trees could be identified by means of the differences in the penetrometer measurement. The absolute values varied from planting to planting and on different sampling dates, but the differences between the two fruit types were always

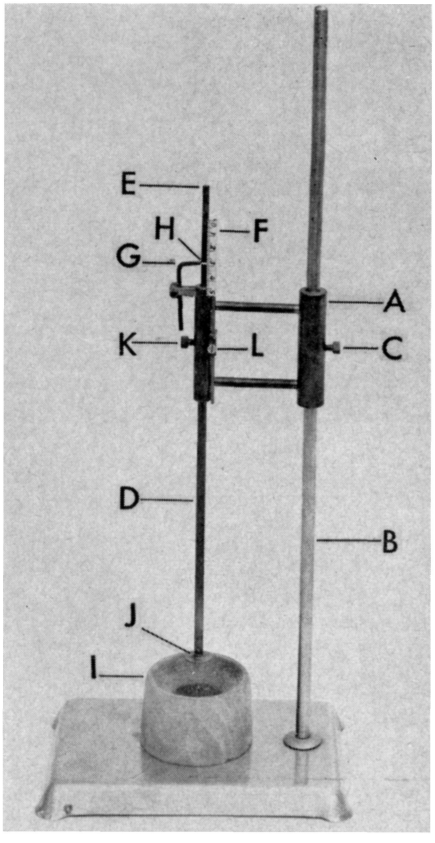

Fig. 1. Gravity penetrometer, side view.