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EFFECT OF PREHARVEST GIBBERELLIC ACID SPRAYS ON ELLENDALE MANDARIN FRUIT

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SUMMARY

Gibberellic Acid (GA) was applied at 10 and 20 ppm to mandarin fruit cv. Ellendale, at 18, 15 and 12 weeks prior to harvest. All sprays reduced rind puffiness, delayed the loss of green colour from the rind and reduced juice acidity. There was no difference in effect due to the GA rates used and little difference due to the timing of the sprays. Yield was not affected over two years of application.

I. INTRODUCTION

Gibberellic Acid (GA) is a naturally occurring plant growth regulator. It has been used successfully in California, South Africa and Australia to maintain fruit quality of late harvested Navel oranges.

With oranges, pre-harvest GA sprays have been shown to delay rind senescence (specifically to reduce puffing and creasing) and to maintain chlorophyll levels in the rind (Bevington 1973, Coggins *et al.* 1965, Embleton, Jones and Coggins 1973 and Gilfillan, Stevenson and Koekemoer 1974). Disorders such as rind staining and mould wastage are also reduced by GA sprays (Bevington 1973, El Zeftawi 1971 and Coggins *et al.* 1965).

Kuraoka, Iwasaki and Ishii (1977) showed that GA applied as a dip at a concentration of 100 ppm reduced the puffiness of Satsuma mandarins.

GA also has an effect on the internal fruit quality of some citrus cultivars. It has been shown to increase the ascorbic acid content (Coggins and Hield 1958) as well as increasing the solids and total acid content (Embleton, Jones and Coggins 1973).

Ellendale mandarins are exported from Australia to Canada and Europe on journeys of 6 to 8 weeks. Out-turns are frequently downgraded by puffiness and creasing of the fruit rinds as well as by rots and breakdown.

The purpose of this trial was to test the effectiveness of pre-harvest GA sprays in preventing the development of puffiness in Ellendale mandarins.

II. MATERIALS AND METHODS

Treatments

The following GA spray treatments were applied to ten-year-old Ellendale mandarin trees on a Gayndah citrus orchard.

GA Concentration	Timing	
	Date	Rind Colour
C_0—10 ppm	T_0—21 March	100% green
C_1—20 ppm	T_1—15 April	10–15% yellow
	T_2— 8 May	40–45% yellow
	T_3—Nil	

The trial design was a (2 x 4) x 3 factorial with single-tree plots.

The sprays were prepared from Grocel (R) tablets and contained wetter as recommended. They were applied using a high volume hand gun at 2 MPa.

The treatments were first applied in 1974. However, the fruit were harvested before assessments could be made. The treatments were therefore repeated in 1975 using the same datum trees.

Fruit Assessments

Forty fruit were randomly selected from each tree on each of the following harvest dates: 28 July 1975, 18 August 1975, and 8 September 1975.

Total yield was recorded at the final harvest date.

After collection the sample fruit were dipped in benomyl suspension, waxed and dried. Twenty fruit were randomly selected from each sample and stored at 7°C for 8 weeks, followed by 1 week at 20°C.

From the remaining 20 fruit, 10 were randomly selected and rated for colour. A panel of 12 people individually rated each fruit on a colour scale of 1 to 5. This scale was defined by a colour photograph of several fruit of each colour grading as follows:

1. 100% orange colour
2. 100% yellow colour
3. 10% green colour
4. 30% green colour
5. 60% green colour

After colour ratings had been recorded, these same 10 fruit were cut in half and rated by a panel for puffiness using again a 1 to 5 scale as follows:

1. Skin firmly attached to pulp.
2. Small air spaces appearing between the skin and pulp.
3. Skin distinctly separated from the pulp in one area.
4. Skin distinctly separated from the pulp in more than one area.
5. Skin virtually completely separated from the pulp.

The other 10 fruit set aside previously were cut in half, and reamed to provide one juice sample per plot. Brix was determined on each juice sample using a refractometer, while acid was determined by titrating 10 ml juice samples with 0·1 N sodium hydroxide and converted to percentage acid.

The procedure outlined for colour, puffiness, brix and acid was repeated when the fruit were removed from storage. As well, the number of stored fruits showing rots was counted and expressed as a percentage. These data were analysed using an arc sine transformation.

Two statistical analyses were carried out for each variable outlined above, and these are presented separately. Table 1 shows an analysis of variance comparing individual treatments with each other and with the control, and table 2 shows a follow-up analysis to partition the factorial effects of concentration and timing.

For each variable, Bartlett's test for homogenity of variance was used to test if the analyses could be combined over harvests. This could be done for all the variates and the data presented in tables 1 and 2 is a combination of the data over the three harvest dates.

III. RESULTS AND DISCUSSION

All combinations of concentration and time of application of GA treatments reduced the puffiness of the fruit (table 1), but there was no difference between the spray concentrations of 10 and 20 ppm (table 2). A trend was evident in response to timing with the later applications appearing to be more effective. However, these differences were not significant (table 2).

GA delayed the loss of green colour from the rind. At harvest all GA treatments produced significantly greener fruit than the control (table 1), with 20 ppm sprays having a greater effect than 10 ppm sprays (table 2). The sprays applied in early May maintained more green colour than sprays applied at other times (table 2). After 8-weeks storage the effects of GA on colour development could no longer be detected as all fruit had fully coloured.

GA applications reduced the acidity of the fruit at harvest and after storage (table 1), but had no significant effect on Brix values (data not presented). The early May application of GA reduced fruit acidity significantly more than sprays applied at other times (table 2). Data taken prior to storage showed no difference between concentrations of 10 and 20 ppm in reducing acidity. However, after storage the 20-ppm rate was shown to be more effective than 10 ppm (table 2).

Since GA lowered acidity without affecting Brix values and the early May application had the greatest effect, the palatability of early season fruit should be enhanced by GA sprays applied at about this time. This effect on acidity was evident in both non-stored and stored fruit.

The assessment of rots showed no differences in the percentage rots between controls and treatments or within treatments (table 1). As well, no GA treatment reduced yield when compared with controls despite sprays being applied for two consecutive years (table 1).

Fruit quality was compared between the three harvest dates in the statistical analysis of the experiment (data not presented), and the only significant differences were in brix/acid ratios which increased with time as expected.

TABLE 1

FRUIT QUALITY AND YIELD IN RELATION TO SPRAY TREATMENT

Treatment	Puffiness		Colour	Acid Percentage		Percentage Rots (Transformed Data)		Yield
	Prior to Storage	After Storage	Prior to Storage	Prior to Storage	After Storage	After Storage		
Control Mean	2·606	2·775	1·271	1·366	1·000	20·3	(0·467)	192·4
C_0T_0	1·978	2·077	1·984	1·221	0·910	17·8	(0·435)	186·2
C_0T_1	1·809	1·947	1·897	1·307	0·950	23·2	(0·502)	170·5
C_0T_2	1·786	1·795	2·275	1·124	0·890	15·1	(0·399)	254·8
C_1T_0	1·753	2·029	1·964	1·234	0·903	22·3	(0·492)	226·3
C_1T_1	2·097	1·952	2·271	1·272	0·889	23·0	(0·500)	219·2
C_1T_2	1·594	2·072	2·432	1·082	0·758	29·8	(0·577)	172·3
LSD 5%	0·448	0·510	0·202	0·134	0·079		(0·193)	55·3
LSD 1%	0·598	0·681	0·270	0·178	0·105		(0·257)	76·4
	Control $\gg$ C_0T_0, C_0T_1, C_0T_2, C_1T_0, C_1T_2 Control > C_1T_1	Control $\gg$ C_0T_0, C_0T_1, C_0T_2, C_1T_0, C_1T_1, C_1T_2	Control $\ll$ C_0T_0, C_0T_1, C_0T_2, C_1T_0, C_1T_1, C_1T_2	Control $\gg$ C_0T_2, C_1T_2 Control > C_0T_0	Control $\gg$ C_0T_2, C_1T_1, C_1T_2 Control > C_0T_0, C_1T_0		NSD	$C_0T_2 \gg C_0T_1$ C_1T_2 $C_0T_2 > C_0T_0$ Control $C_1T_0 > C_0T_1$

TABLE 2

FRUIT QUALITY AND YIELD IN RELATION TO GA CONCENTRATION AND TIMING

Treatment	Puffiness		Colour	Acid Percentage		Percentage Rots (Transformed Data)		Yield
	Prior to Storage	After Storage	Prior to Storage	Prior to Storage	After Storage	After Storage		
Concentration								
C_0	1·858	1·940	2·052	1·217	0·917	18·54	(0·445)	203·8
C_1	1·815	2·018	2·222	1·196	0·850	24·92	(0·527)	205·9
LSD 5%	0·299	0·340	0·135	0·089	0·052		(0·111)	31·9
LSD 1%	0·399	0·454	0·180	0·119	0·070		(0·148)	44·1
	NSD	NSD	$C_1 > C_0$	NSD	$C_0 > C_1$	NSD		NSD
Timing T_0	1·866	2·053	1·974	1·228	0·907	19·97	(0·463)	206·2
Timing T_1	1·953	1·949	2·084	1·289	0·919	23·06	(0·501)	194·8
Timing T_2	1·690	1·934	2·353	1·103	0·824	21·96	(0·488)	213·6
LSD 5%	0·366	0·417	0·165	0·109	0·064		(0·136)	39·1
LSD 1%	0·488	0·556	0·220	0·146	0·086		(0·182)	54·0
	NSD	NSD	$T_2 > T_1, T_0$	$T_0 > T_2$ $T_1 \gg T_2$	$T_0 > T_2$ $T_1 \gg T_2$	NSD		NSD

The results show that GA sprays at 10 ppm were equally effective at reducing puffiness at the three application dates. However, the later time of application reduced fruit acidity when compared with the two earlier applications. Since colour break (10–15% yellow) coincided with the second application date, and the third application date gave slightly superior results, a spray for general recommendation should be applied at 10 ppm within a 3-week period after colour break. Colour break provides a physiological standard for timing of application.

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REFERENCES

BEVINGTON, K. B. (1973).—Effect of gibberellic acid on rind quality and storage of coastal navel oranges. *Australian Journal of Experimental Agriculture and Animal Husbandry* 13:196-199.

COGGINS, C. W. Jr. and HIELD, H. Z. (1958).—Gibberellin on orange fruit. *California Agriculture,* Vol. 12, No. 9.

COGGINS, C. W., HIELD, H. Z., EAKS, I. L., LEWIS, L. N. and BURNS, R. M. (1965).—Gibberellin Research on Citrus. *Citrograph* 50:457-468.

EL ZEFTAWI, B. M. (1971).—Some effects of GA and 2, 4-D on navel oranges. *Journal of the Australian Institute of Agricultural Science* 37:151.

EMBLETON, T. W., JONES, W. W. and COGGINS, C. W. Jr. (1973).—Aggregate Effects of Nutrients and Giberellic Acid on "Valencia" Orange Crop Value. *Journal of the American Society for Horticultural Science* 98:281-285.

GILFILLAN, I. M., STEVENSON, J. A. and KOEKEMOER, W. (1974).—Gibberellic Acid Reduces Creasing in Late-Season Navels. *The Citrus and Sub-Tropical Fruit Journal* 482:4-5.

KURAOKA, T., IWASAKI, K. and ISHII, T. (1977).—Effect of GA_3 on Puffing and Levels of GA-like Substances and ABA in the Peel of Satsuma Mandarin (Citrus unshu Marc.) *Journal of the American Society for Horticultural Science* 102:651-654.

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