Effect of ethephon (2 chloro ethylphosphonic acid) applied to the trees on fruit ripening in 'Golden Nugget' loquat (Eriobotrya japonica Lindl.)

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Effect of ethephon (2-chloro ethylphosphonic acid) applied to the trees on fruit ripening in 'Golden Nugget' loquat (*Eriobotrya japonica* Lindl.)

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SUMMARY – The effect of ethephon applied on leaves on fruit ripening was studied in loquat (*Eriobotrya japonica* Lindl.) cv. 'Golden Nugget'. Foliar sprays were done on 4 year old trees early in the growing season (second week of October) with ethephon at rates of 40, 80, and 120 ppm, plus an untreated control. Two groups of loquats were labelled after spraying: (i) fruit with an equatorial diameter greater or equal to 40 mm, with a green to yellowish-green (7.5 GY 5/7 Munsell) exocarp (M1); and (ii) fruit with a 25-40 mm equatorial diameter, with a green exocarp (7.5 GY 5/7 to 5 GY 6/8 Munsell) (M2). Weekly samples were analysed for soluble solids and titratable acidity. Every two days fruit ripening was evaluated. Sensory evaluation was done at the final harvest, when fruit was fully ripe. Trees were also monitored for leaf, flower or developing fruit abscission. M1 fruit treated with the highest rate of ethephon reached ripeness 7 days earlier than the control. Increasing ethephon rates also altered the acidity of the M2 fruit. No effects on vegetative development of the trees were detected, with no symptoms of abscission in leaves nor developing flowers or fruit.

Key words: Loquats, ethephon, ripening, fruit.

RESUME – *"Effet de l'ethephon (acide 2-chloroéthylphosphonique) appliqué aux arbres à la maturité des nèfles 'Golden Nugget' (*Eriobotrya japonica *Lindl.)". L'effet de l'ethephon appliqué sur les feuilles à la maturité des fruits a été étudié sur les nèfles (*Eriobotrya japonica *Lindl.) cv. 'Golden Nugget'. Des pulvérisations foliaires ont été effectuées sur des arbres de quatre ans au début de la saison de croissance (deuxième semaine d'octobre) avec de l'ethephon à des doses de 40, 80 et 120 ppm, et un témoin non traité. Deux groupes de nèfles ont été marqués après pulvérisation : (i) fruit (M1) à diamètre équatorial supérieur ou égal à 40 mm, à exocarpe de couleur verte à vert jaunâtre (7,5 GY 5/7 Munsell) ; et (ii) fruit (M2) à diamètre équatorial de 25-40 mm, à exocarpe vert (7,5 GY 5/7 à 5 GY 6/8 Munsell). Des échantillons hebdomadaires ont été analysés pour les solides solubles et l'acidité titrable. Tous les deux jours, la maturité des fruits a été évaluée. L'évaluation sensorielle a été faite à la fin de la récolte, lorsque le fruit était totalement mûr. Les arbres ont également été suivis en ce qui concerne les feuilles, fleurs ou abscission du fruit en développement. Les fruits M1 traités avec les doses les plus élevées d'ethephon ont atteint la maturité 7 jours plus tôt que les témoins. Des doses croissantes d'ethephon ont également modifié l'acidité des fruits M2. On n'a pas détecté d'effets sur le développement végétatif des arbres, ni de symptômes d'abscission chez les feuilles, fleurs ou fruits en développement.*

Mots-clés : *Nèfles, ethephon, maturité, fruit.*

Introduction

The loquat (*Eriobotrya japonica* Lindl.) has good consumer acceptance, because it is available very early in the season. The profitability of this crop is based on its ability to reach maturity and ripen earlier in the season than other species. One of the ways to force early ripening is by using growth regulators that alter physiological processes in the plant. Among those, ethephon has been shown to promote ethylene production by the plant, accelerating the physiological process of fruit maturation (Lieberman, 1979). The objective of this project was to study the effects of foliar ethephon sprays on fruit maturation, and the potential for concentrating the loquat harvest season. Secondary effects on leaves, flowers and small fruits were also evaluated.

Materials and methods

The experiment was conducted with four year old loquat trees, in an orchard within the La Palma Experimental Station, near Quillota in Central Chile. Sixteen trees of similar vigor and fruit load/quality were selected. Each tree was considered an experimental unit; four replicates were used for each treatment. Treatments consisted of foliar sprays of ethephon (Ethrel, 48% 2-chloroethylfosfonic acid) at rates of 40, 80 and 120 ppm, plus a set of unsprayed control trees. Sprays were done early in the season, in the second week of October. In order to verify the effects of ethephon on flowering and fruit development, individual inflorescences were labeled and the number of flowers and early stages of fruit development were recorded and monitored over a five week period. Fruits were marked according to the developmental stage at which they received the spray. The more advanced maturity stage (M1) consisted of fruit with an equatorial diameter greater or equal to 40 mm, and a green to yellowish-green exocarp. The earlier stage of maturity (M2) consisted of fruit with a 25-40 mm diameter, with a green exocarp. In each tree 11-15 fruit bunches were marked for the M1 stage, and 20-23 bunches for the M2 stage. One third of the bunches were harvested at one week intervals for chemical analyses, and two thirds were kept until ripening in order to study the effects on ripening at the time of harvest, collecting fruit every two days. The last harvest was done with firm fruit that had an orange exocarp, a characteristic associated with the end of the ripening process (optimum for consumption). Sensory evaluation was done at the end of the harvest period on M1 fruit, using a hedonic scale that measures likes or dislikes in an ordered scale. A randomized block design was used for the chemical analyses. Precocity was estimated according to the system used by Stembridge and Gambrell (1974).

Results and discussion

Vegetative development

Ethephon sprays did not modify the development of leaves, flowers or small fruits, over a period of five weeks. The rates used did not promote abscission, possibly because of the presence of abscission inhibitors or due to the low rates used in this study.

Effects on fruits

The response of the fruit at the two maturity stages (Tables 1 and 2), increasing the rates of foliarly applied ethephon did not affect fruit soluble solids. This suggests that there is a non-climateric response. Also, that loquat fruits do not accumulate reserve carbohydrates at any stages of fruit development.

Table 1. Effect of four rates of pre-harvest sprays of ethephon on soluble solids (°Brix) at maturity stage M1

Ethephon rate (ppm)	Sample date				
	I (22/10)	II (29/10)	III (03/11)	IV (10/11)	V (16/11)
0	5.38	5.85	7.32	11.35	13.1
40	5.07	5.70	7.67	10.97	14.1
80	5.82	5.90	8.30	11.90	14.3
120	5.37NS[†]	5.65NS	8.1NS	11.2NS	14.4NS

[†]NS: not significant at analysis of variance P>0.05.

Table 2. Effect of four rates of pre-harvest sprays of ethephon on soluble solids (°Brix) at maturity stage M2

Ethephon rate (ppm)	Sample date					
	I (22/10)	II (03/11)	III (10/11)	IV (16/11)	V (22/11)	VI (27/11)
0	5.40	5.73	7.45	9.75	13.1	14.8
40	5.65	5.93	6.90	8.92	13.3	13.6
80	5.30	6.10	8.35	10.25	14.6	15.0
120	5.70NS†	5.60NS	7.30NS	10.42NS	14.0NS	14.5NS

†NS: not significant at analysis of variance P>0.05.

Acidity in the fruit treated at the first maturity stage tended to naturally decrease at the last stage of maturity, decreasing progressively from ripening until harvest (Table 3). The effect of ethephon on fruit acidity suggests that ethylene acts on enzyme activity, by regulating and controlling the expression of mRNA that promote ripening (Sisler *et al.,* 1984; McGlasson, 1985; Yang, 1985). When analyzing the response of the second maturity stage (Table 4), no effect of ethephon was detected on titratable acidity. This response could be explained by the earlier maturity stage at which the fruit were treated (Weaber, 1980; Hirai, 1982).

Table 3. Effect of four rates of pre-harvest sprays of ethephon on titratable acidity (meq malic acid/100 m of juice) at maturity stage M1†

Ethephon rate (ppm)	Sample date				
	22 October	29 October	03 November	10 November	16 November
0	34.85	31.65	30.85c	18.6d	15.35c
40	33.70	28.85	28.15bc	15.2c	12.80b
80	31.95	28.25	22.80a	11.1a	10.19a
120	32.50NS	30.60NS	26.25b	13.5b	11.55b

†Different letters in each column indicate significant differences, Tukey α = 0.05; NS: not significant at analysis of variance P>0.05.

Table 4. Effect of four rates of pre-harvest sprays of ethephon on titratable acidity (meq malic acid/100 m of juice) at maturity stage M2

Ethephon rate (ppm)	Sample date					
	22 October	03 November	10 November	16 November	22 November	27 November
0	40.20	38.33	24.30	19.90	15.00	12.15
40	40.70	35.20	22.45	17.15	13.40	11.45
80	41.40	36.46	22.70	17.70	13.05	10.05
120	39.30NS†	37.40NS	21.95NS	19.95NS	13.15NS	11.50NS

†NS: not significant at analysis of variance P>0.05.

The ratio of soluble solids to titratable acidity in fruit of the more advanced maturity stage is shown in Table 5. The differences produced could be due to the effect of ethephon on titratable acidity (Table 4), as there was no significant effect on soluble solids (Table 3), and also because the fruit do not contain an important carbohydrate content that could be degraded. Fruit from the less advanced maturity stage did not show a response to ethephon with regards to this ratio (Table 6), as there was no significant effect on either of the two components of this ratio in M2 fruit.

Table 5. Effect of four rates of pre-harvest sprays of ethephon on the ratio of soluble solids (ºBrix) to titratable acidity (ºBrix: meq malic acid/100 m of juice) at maturity stage M1†

Ethephon rate (ppm)	Sample date				
	I (22/10)	II (29/10)	III (03/11)	IV (10/11)	V (16/11)
0	0.15	0.18	0.20c	0.66c	0.84c
40	0.15	0.20	0.27bc	0.75bc	1.08b
80	0.18	0.23	0.37a	1.07a	1.46a
120	0.18NS	0.18NS	0.30b	0.82b	1.27ab

†Different letters in each column indicate significant differences, Tukey ∝ = 0.05; NS: not significant at analysis of variance P>0.05.

Table 6. Effect of four rates of pre-harvest sprays of ethephon on the ratio of soluble solids (ºBrix) to titratable acidity (ºBrix: meq malic acid/100 m of juice) at maturity stage M2

Ethephon rate (ppm)	Sample date					
	I (22/10)	II (3/11)	III (10/11)	IV (16/11)	V (22/11)	VI (27/11)
0	0.13	0.14	0.31	0.50	0.88	1.20
40	0.14	0.18	0.30	0.52	0.95	1.18
80	0.13	0.17	0.40	0.58	1.00	1.35
120	0.14NS†	0.15NS	0.33NS	0.52NS	1.00NS	1.30NS

†NS: not significant at analysis of variance P>0.05.

Effect on fruit ripening

Ethephon sprays induced color change in the M1 fruit of the more advanced maturity stage (Table 7). Fruits of the second maturity stage were not affected, suggesting that the less mature M2 stage fruit is not susceptible to foliarly applied ethephon.

Table 7. Effect of four rates of pre-harvest sprays of ethephon on fruit treated at maturity stages M1 and M2 on fruit harvest dates

Ethephon rate (ppm)	Harvest date compared with the control	
	M1 Stage	M2 Stage
0	0.0	-1.3
40	-4	0.0
80	-7	-1.1
120	-7	-1.9

Sensory analysis

Among the sensory evaluations, there was no effect of the treatments on the intensity of sweetness. With regards to the acidity of the fruit, the results reinforce what was observed in the titratable acidity measurements, with a marked difference in acidity intensity between treated and untreated fruit. There was no difference in flavor among the treatments. Also, no difference was detected for general acceptability among the treatments and the control fruit (at the fully ripe stage).

Conclusions

Ethephon rates of 40 to 120 ppm did not affect the foliage of loquat trees, and no effects on vegetative development were detected. Early sprays of ethephon did not alter the level of soluble solids in loquat fruit at the maturity stages studied. Increasing ethephon rates applied early in pre-harvest did not affect the sweetness of the fruit, but did decrease the intensity of the fruit acidity. Ethephon rates of 80 and 120 ppm applied pre-harvest to fruit at an advanced maturity stage increased fruit ripening, allowing the fruit to reach the fully ripe stage (harvest) 7 days earlier than the control.

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