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## CHEMICAL FRUIT THINNING OF LOQUAT BY NAAm

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**SUMMARY** – Fruit size is essential for loquat marketing and profitability. In this crop most cultivars use to set too heavily making mandatory some kind of fruit thinning. Usually, thinning is done by hand at February, but this practice is expensive and of limited results due to its late execution. Chemical fruit thinning is the obvious alternative; however, due to the limited importance of this crop, efforts for developing chemical fruit thinning in loquat have been scarce. In this experiment, we tested thinning capacity of NAAm and its effects on fruit size, earliness and yield of cultivar 'Algerie'. Our results showed that a single application of 60 ppm of NAAm at the end of full bloom efficiently thin fruiting shoots up to a level of 4 fruits per inflorescence. Despite prolonged bloom we found no advantage in dividing dose in two applications. Repeated applications elapsed a week did not increase thinning significantly. Improvement of fruit size and earliness went parallel to thinning effects of the treatments with commercial grading under NAAm treatments comparable to that attained by hand fruit thinning. A important advantage of chemical fruit thinning by NAAm is that, because its early intervention, it caused only minor reduction in yield with no significant differences with respect to unthinned trees. Major break of NAAm thinning was variable thinning effects within the trees, mostly related with position of the bearing-fruits shoots.

**Key words:** Eriobotrya japonica, fruit size, fruit set, fruit quality, yield.

**RESUME** – Le grosseur de la fruit cest essential pour le marketing et le profit du néflier du Japon. Dans ce fruitiere le majorité de les varieteés present a large nouaison on a fait des pollinisations contrôllées sur des arbres âgés de 23 ans de cv. 'Algerie'. Des fleurs de rameaux étiquetés ont été emballées et soit auto-pollinisées soit pollinisées avec un melange de pollen de pollen cv. 'Tanaka' et 'Golden Nugget'. Des rameaux-contrôle ont été exposés à la pollinisation libre. On a déterminé le nombre et la qualité des fruits formés dans les trois traitements. Nos résultats montrent que sous pollinisation croisée et libre on peut obtenir une plus grande nouaison que avec l'auto-pollinisation. Malgré une plus grande récolte, les fruits obtenus avec la pollinisation croisée et libre furent plus lourds et plus grands dû au moins en part à une augmentation significative du nombre de semences. La pollinisation croisée fournit aussi des fruits avec un developpement plus rapide qui se manifesta par une augmentation notable du contenu total de sucre. On n'a remarqué aucune variation dans la ratio pulpe/semences. Des observations sous le microscope ont montré que l'auto-incompatibilité de 'Algerie' n'est pas complète. Les observations au microscope égalèrent les effets de traitements de pollinisation sur le nombre de semences, mais la basse nouaison dans auto-pollinisation suggere que la penetration du ovule par les tubes pollinique peut être une appréciation inadéquate pour une fertilization réussie dans cette espèce.

**Mots-clés:** Eriobotrya japonica, grosseur de la fruit, nouaison, qualité des fruits, récolte.

## INTRODUCTION

Loquat profusely blooms in autumn in terminal panicles located on current year wood. In winter mild climates, most loquat cultivars use to set abundantly and consequently fruit size is small. Because fruit size is critical for marketing loquat, some kind of thinning becomes, therefore, mandatory. By altering sink/source relation, thinning not only improves fruit size, but also speeds up fruit development, aspect revealed in an earlier ripening also important for this crop that gets premium prices at the beginning of the season. On the other hand, as in other fruit crops, thinning imposes

some yield losses (Cuevas *et al.*, 1997). So far, usual procedure for thinning loquat is fruit thinning by hand at February (around 60-80 days after bloom), after winter and “June” drop have passed (Rodríguez, 1983). Its late execution in fruit development results in moderate increases in fruit size. This practice is also very expensive, representing between 25-30% of the production costs in Spain (Agustí *et al.*, 2000). Finally, availability of labor force for thinning is becoming an increasingly problem in developed countries. Chemical fruit thinning is the obvious alternative for overcoming those difficulties, and so it recognized for different authors (Rodríguez, 1983; Ateyyeh and Qrunfleh, 1997; Agustí *et al.*, 2000). However, due to the limited importance of this crop, efforts for developing chemical fruit thinning in loquat have been scarce and discontinuous. Here we report results that support the use of the amide of the naphthaleneacetic acid (NAAm) as an efficient thinner in loquat.

## MATERIALS AND METHODS

The experience was carried out in 2000/2001 campaign in a small solid block of cultivar ‘Algerie’ grafted on ‘Provence’ quince. The orchard is located at the Experimental Station of ‘Las Palmerillas’ in El Ejido (Almería, SE of Spain). Trees are 23 years-old, vase-trained, spaced 6 x 4 m and East-West orientated. Orchard is conducted under non-tillage and management can be considered adequate since commercial yields place around 25 t ha<sup>-1</sup>. Experiments were performed on selected trees with an equal surplus level of flowering and good sanitary conditions.

Based on previous experiences, we assessed different concentrations and dosage of NAAm checking effects on main, terminal panicles placed at two positions: the top of the canopy and at medium height of the tree. Experimental design was, therefore, a split-plot with thinning treatment as main factor and position of the fruitful shoot as secondary factor. Levels of main factor were five: four thinning treatments and control-unthinned trees. Thinning treatments were 30 and 60 ppm of NAAm applied at the end of full bloom, and the same dose but divided in two applications: 15 ppm + 15 ppm, and 30 ppm + 30 ppm, the first application at the end of full bloom, the second one week later. The formulation of NAAm used was Clerthin (ETISA, Spain). No surfactants were added. Trees where no intervention was done and all set fruits were allowed to reach harvest served as control. Number of repetitions, represented by trees, was four. As mentioned above, the levels of secondary factors were two: the top of the tree and observer’s height. Number of repetitions, here inflorescences distributed around the tree, was eight per level. Effects of thinning treatments were also observed on another eight secondary panicles product of summer growth that are weaker and less abundant.

Thinning capacity of NAAm was determined based on fruit set and yield records. Fruit size and earliness assessed fruit quality in response to thinning treatments. Fruit seed number and pulp/seed ratio were also estimated to check NAAm effects on seed development. Initial fruit set as the number of fruits per panicle was computed at January 25<sup>th</sup>. Final fruit set was computed at March 21<sup>st</sup>, 28 days before harvest. Yield as kg per tree was recorded at harvest. Fruits from tagged shoots were collected when first fruits reach ripening, and their size measured by its weight (up to the nearest 0.01 g) and equatorial diameter (up to the nearest 0.01 mm). Fruits were later sectioned and number and diameter of seeds recorded. Pulp/seed relation was determined as pulp width divided by seeds diameter. Earliness was estimated by total soluble solids (TSS) from juice obtained at harvest using the lower half of each fruit.

## RESULTS AND DISCUSSION

No interaction between thinning treatments and positions of the fruitful shoot was detected in most of the parameter. Therefore, for simplicity, effects of both factors would be presented separately. NAAm applications derived in a significant fruit thinning regardless of concentration. That was verified at initial fruit set as well as at final fruit set (Table 1). Light fruit drop occurred between both dates only slightly more intense for trees with higher fruit load at January 25<sup>th</sup>. Regulation of fruit load in this variety occurred, therefore, early in fruit development. Consequently, initial and final fruit set records were very similar, and the sequence of treatments was not altered (Table 1). Optimum level of fruit set, estimated for this cultivar at 4-5 fruits per panicle (Salvador-Sola, 1999), was achieved by a single application of 30 and 60 ppm of NAAm at the end of full bloom. 30+30 ppm treatment also adjusted well fruit load; 15+15 ppm application was less efficient. Unthinned trees showed characteristic high fruit set of this species with an average of more than 10 fruits per panicle, clearly excessive and

detrimental for commercial fruit size. Despite prolonged bloom in loquat our results suggest no advantage in dividing dose in two applications. Repeated applications elapsed a week did not increase thinning significantly as the comparison of single and double applications of 30 ppm and results from 60 ppm treatment reveal (Table 1). An important advantage of chemical fruit thinning by NAAm is that, because its early intervention, it caused only minor reduction in yield with no significant differences with respect to unthinned trees (Table 1). Unthinned trees produced 120 kg per tree while 30 ppm and 60 ppm treatments produced 95 and 96 kg per tree respectively. 15+15 ppm, the less efficient treatment based on thinning records, averaged 125 kg per tree.

Table 1. Thinning capacity of treatments evaluated by fruit set and reduction in yield.

Treatments	Initial fruit set (fruit/inflorescence)*	Final fruit set (fruit/inflorescence)*	Yield (kg/tree)*
Control	11.63 a	10.53 a	120,0 a
15 + 15 ppm	7.58 b	6.82 b	124.9 a
30 + 30 ppm	5.80 b	5.01 b	88.7 a
30 ppm	5.05 b	4.58 b	95.5 a
60 ppm	4.64 b	4.14 b	96.2 a

\* Values with the same letter do not differ significantly.

Improvement of fruit quality went parallel to thinning effects. Fruit size at harvest increased in response to thinning treatments. Fruits collected from trees receiving a single dose of 60 ppm of NAAm were the heaviest at harvest with significant differences with respect to unthinned trees and trees receiving two applications of 15 ppm (Table 2). Differences with respect to a single dose of 30 ppm were important, although did not reach statistical significance. ANOVA showed a significant interaction between thinning treatments and position of the shoots for this parameter ( $p=0.025$ ). Fruit diameter, parameter that determines commercial grading, was less sensible to treatments. Differences in fruit diameter were small and only significant between trees receiving 60 ppm of NAAm and unthinned trees (Table 2). However, fruit diameter increased as thinning did. Earliness also resulted improved under the most effective thinning treatments. Tagged fruits from trees getting 60 ppm reached 9.0 °Brix at harvest date, while the fruits from control unthinned trees only reached 7.4 °Brix, showing a significant delay in ripening. Trees receiving 60 ppm divided in two applications produced fruits with 9.1°Brix; the other thinning treatments placed in intermediate positions (Table 2). Number of seeds per fruit did not show any significant variation despite that NAA and NAAm have been reported as seed abortion agents in this variety (Agustí *et al.*, 2000). Nevertheless a light trend to lower number of seeds with increasing NAAm concentration could be foreseen (Table 2). Pulp/seed ratio was also unaffected. In term of width, but not weight, approximately 50 % of the fruit corresponded to pulp, the other 50% was occupied by seeds regardless of treatments. Pigmy seed-aborted fruits were not produced under NAAm treatments, neither phytotoxicity due to NAAm was detected on foliage. Our results partially coincide with previous works. Kilavuz and Eti (1993) compared NAA, NAAm and hand fruit thinning and observed that both chemicals were able to thin cultivars 'Akko XIII', 'Gold Nugget', and 'Hafif Çukurgöbek'. These authors observed that thinning increased with growing concentration, but the best results were achieved with 25 ppm of both products since higher concentrations led to excessive, sometimes complete fruit removal. In our experiments on 'Algerie' better results were achieved increasing concentration of NAAm up to 60 ppm. Attayef and Qrunflesh (1997) thinned young 'Tanaka' trees by applying only 20 ppm of NAA at full bloom, but not a month later. As indicated by Wertheim (2000) recommended rates vary among cultivars, although NAAm can be applied usually at higher rates than NAA. More recently, Agustí *et al.*, (2000) reported regular thinning using only 20 ppm of NAA, and its potassium salt with a wetting agent on 'Algerie' trees, but 20 ppm of NAAm (using different formulation that here analyzed) caused excessive fruit abscission, and greater yield losses. Different commercial formulation could be the reason of disparity. NAAm is, however, considered a more reliable fruit thinner for apple and pear than NAA with weaker effects allowing so higher rates to be applied (Wertheim, 2000).

Although much less important, effects of chemical thinning were also studied on secondary shoots. Secondary panicles are often completely removed under hand fruit thinning programs because its weaker condition made them in farmer's opinion unable to sustain and develop any fruit load. Our observations reveal, however, that when thinned by NAAm secondary panicles are able to enlarge and ripen one or two fruits to records (34 g and 35 mm with X<sup>a</sup> Brix) close to those previously reported

for fruits formed on main shoots. That makes unnecessary remove them by hand and represents in sizable increase in yield.

Table 2. Fruit quality in response to thinning treatments.

	Weight (g)*	Diameter (mm)*	Earliness (°Brix)*	Number of seeds*	Pulp/seed ratio*
Control	15.75 b	32.38 b	7.44 b	1.51 a	1.01 a
15 + 15 ppm	27.26 ab	34.45 ab	8.50 ab	1.53 a	0.97 a
30 + 30 ppm	35.60 a	36.77 a	9.14 a	1.48 a	0.95 a
30 ppm	33.95 a	34.96 a	8.44 ab	1.45 a	1.01 a
60 ppm	33.54 a	37.94 a	9.01 a	1.44 a	1.30 a

\* Values with the same letter do not differ significantly.

Major break of NAAm was variable thinning effects within the trees, mostly related with position of the bearing-fruits shoots. In this sense, panicles placed at the top of the tree were insufficiently thinned. Differences with panicles formed at medium height were significant (7.6 vs 4.9 fruits per panicle;  $p < 0.01$ ). More important, the value of 7.6 at the top is the average, meaning that some shoots at that position carried many more fruits. Unsatisfactory thinning at the top of the canopy was not clearly related to vigor of the shoot since sampled shoots were chosen similarly at both positions. Rather, insufficient thinning at the top seems due to inadequate foliar uptake of NAAm at the heights, in part due to the cuticle of the leaves (Schönherr et al., 2000), in part due to runoff. Increasing concentration is not a solution since probably it would lead to excessive thinning in the rest of the tree. Improvement could come from increasing product absorption perhaps by means of a wetter agent, although preliminary trials have been disappointing (Cuevas et al. in preparation).

## CONCLUSIONS

In summary, in this experiment we have tested NAAm and demonstrated its thinning capacity for loquat. Our results showed that a single application of 30-60 ppm of NAAm at the end of bloom efficiently thin fruiting shoots of 'Algerie' up to a level of 4-5 fruits per inflorescence, fruit load considered close to the optimum. Fruit quality improved in response to thinning. Another important advantage of fruit thinning by NAAm is that, because its early intervention, it caused only a slight reduction in yield with no significant differences with respect to unthinned trees. Major break of NAAm thinning was variable thinning effects within the trees, mostly related with position of the bearing-fruits shoots. Addition of a wetter agent is in study, although initial results did not show improvement. Finally, our results have revealed the possibility to efficiently thin loquat by chemicals, making not only possible lessen production costs, but also to break strong dependency of family hand labor that constrains orchard size.

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