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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 set too heavily making it necessary to have some kind of fruit thinning. Usually, thinning is done by hand in February, but this practice is expensive and of limited results since it is done late. Chemical fruit thinning is the obvious alternative. 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 thinned fruiting shoots up to a level of 4 fruits per inflorescence. Despite prolonged bloom we found no advantage in dividing doses in two applications. Repeated applications over a week did not increase thinning significantly. Improvement of fruit size and earliness went parallel to thinning effects of the treatments. An important advantage of thinning by NAAm is that, because its early intervention, it caused only minor reduction in yield with no significant differences with controls. Major disadvantage of NAAm thinning was its variable effects on the trees, mostly related to the position of the bearing-fruit shoots.

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

***RESUME –** "Eclaircissage chimique des néfles par NAAm". La taille du fruit est essentielle pour le marketing et la rentabilité du néflier du Japon. Dans cette espèce, la plupart des variétés ont normalement une grande nouaison, ce qui oblige à faire l'éclaircissage des fruits. Normalement, on fait l'éclaircissage manuellement en février, mais cette pratique est très chère et ses résultats sont très limités du fait de son exécution tardive. L'éclaircissage chimique est l'alternative évidente. Dans cette étude, on a évalué la capacité d'éclaircissage du NAAm et ses effets sur la taille du fruit, la précocité et la production de la variété 'Algérie'. Nos résultats ont montré qu'une seule application de 60 ppm de NAAm à la fin de la pleine floraison éclaircit efficacement les rameaux fructifères jusqu'à un niveau de 4 fruits par inflorescence. Malgré la floraison prolongée, on n'a pas trouvé un meilleur effet en partageant la dose en deux applications. Des applications répétées avec un écart d'une semaine n'ont pas augmenté le niveau d'éclaircissage. L'amélioration de la taille et de la précocité du fruit fut parallèle aux effets d'éclaircissage des traitements. Un important avantage de l'éclaircissage chimique avec NAAm est que, grâce à sa précoce intervention, il provoque seulement une légère réduction dans la récolte, pas significative, si l'on compare avec les arbres sans éclaircissage. Le principal inconvénient de l'éclaircissage avec NAAm fut ses effets variables sur les arbres, lesquels sont en rapport avec la différente position des rameaux fructifères.*

Mots-clés : Eriobotrya japonica, *taille du 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 naphtaleneacetic 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 conduced under non-tillage and management can be considered adequate since commercial yields place around 25 t/ha. 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 25th. Final fruit set was computed before 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. Yield as kg per tree was recorded at harvest.

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 25th. 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 (Table 1).

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	11.63a	10.53a	120.0a
15 + 15 ppm	7.58b	6.82b	124.9a
30 ppm	5.05b	4.58b	95.5a
30 + 30 ppm	5.80b	5.01b	88.7a
60 ppm	4.64b	4.14b	96.2a

†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 ($p=0.025$), due to slight changes in intensity of the effects of NAAm depending on shoot position. 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 9.0ºBrix at harvest date, while the fruits from control unthinned trees only reached 7.4ºBrix, showing a significant delay in ripening. Trees receiving 60 ppm divided in two applications produced fruits with 9.1ºBrix; 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). 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. Ateyyeh 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).

Table 2. Fruit quality in response to thinning treatments

	Weight (g)†	Diameter (mm)†	Earliness (ºBrix)†	Number of seeds†	Pulp/seed ratio†
Control	24.13c	32.38b	7.44b	1.51a	1.01a
15 + 15 ppm	28.71bc	34.45ab	8.50ab	1.53a	0.97a
30 ppm	31.60abc	34.96a	8.44ab	1.45a	1.01a
30 + 30 pm	38.01ab	36.77a	9.14a	1.48a	0.95a
60 ppm	41.40a	37.94a	9.01a	1.44a	1.30a

†Values with the same letter do not differ significantly.

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 around 8.1ºBrix) 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.

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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