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DEFICIT IRRIGATION EFFECTS ON FLOWERING OF LOQUAT

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SUMMARY - In the tropics and subtropics, natural episodes of drought trigger flower induction in many woody plants. Bearing in mind such effects, we have applied deficit irrigation strategies on loquat with the aims of obtain earlier bloom and therefore earlier harvest that benefits of better marketing. The experiments were carried out during three consecutive years on trees of cultivar ‘Algerie’. Three treatments have been selected: Control, receiving about 40% of Epan measured with a Class A pan placed in the orchard. Continuous Deficit Irrigation (CDI), with 20% saving of water, and stress uniformly applied along the year, and Regulated Deficit Irrigation (RDI), with the same reduction in irrigation, but stress concentrated on postharvest, from May to August, when reduction reached 55% of the amount of water received by control trees. Both deficit irrigation treatments caused an earlier flowering. Under RDI, full bloom was advanced between 13 and 20 days depending on year. CDI caused minor but progressive effects on bloom date. Advancement of full bloom under CDI was only of 3 days the first year of treatments, but 10 days third year. Earlier flowering led to earlier harvesting. Deficit irrigation did not affect the number of flowers per panicle, but a higher proportion of secondary shoots formed flowers under RDI, leading so to greater bloom density. Deficit irrigation affected also flower quality. At this respect control trees presented heavier flowers than deficit irrigation treatments. However, so far flower dry weight had no impact on both quantity and quality of the fruits harvested. After three years of treatments, deficit irrigation has been proved a feasible and a more profitable strategy to produce loquat.

Key words: Loquat, deficit irrigation, earliness, flowering, harvesting.

SUMMARY - Dans le regions tropicale et subtropicale, des épisodes naturelle de sécheresse provoque floraison en beaucoup des arbres. En considerens cettes efects, on a appliqueé des estratégies d´arrosage déficitaire chez le néflier du Japon avec l´objetif de obtenir une floraison et une récolte plus précoce qui va favorisé une meilleur marketing. Les expériences ont été développé pendant trois anneés consécutif sur des arbres de cv. Algerie. Trois traitements ont été sélectionné : control, qui a reçu approximatifment 40% de la Epan mesuré avec un tanque classe A placé dans le fruitier. L´arrosage Déficitaire Continuel (CDI), avec une economie d´eau du 20%, et une stress appliqueé uniformement pendant tout l´année, et l´arrosage deficitaire contrôlé (RDI), avec la même réduction d´arrosage, mais stress concentré aprés de la récolte, depuis le mois de Mai á le mois d´Août, quand la réduction était 55% de la quantité d´eau reçu par les arbres control. Les deux traitements d´arrosage déficitaire ont provoqué une floraison plus précoce. Sous RDI, la floraison complète a été avancé entre 11 et 30 jours on dependons de l´année. Le CDI a provoqué des efects plus petites mais progressifs sur la date de floraison. L´avance de la floraison complète sous CDI a été solement de un jour le premier année de traitements, mais 9 jours le troisième année. Une floraison plus précoce a conduit a une récolte plus précoce. L´arrosage déficitaire n´as pas afecté le numero de fleurs par panicule, mais une proportion plus grande de rameaux secondaire ont formé des fleurs sous RDI, et cela a conduit a une densité de floraison plus grande. L´arrosage déficitaire a affecté aussi la qualité de la fleur. En relation a ça, les arbres control présentèrent des fleurs plus lourde que le traitements d´arrosage déficitaire. Cependant, le poids sèche ne pas montré aucun impact sur la quantité et la qualité des fruits recolté. Après trois ans de traitements, l´arrosage déficitaire a montré d´être une stratégie viable et plus rentable pour produir le néflier du Japon.

Key words: Néflier du Japon, arrosage déficitaire, precocité, floraison, récolte.

INTRODUCTION

Loquat (*Eriobotrya japonica*, *Rosaceae*, *Maloideae*) is a subtropical evergreen fruit crop that blooms at fall, develops its fruits during winter and ripens them at early spring. Its unusual phenology allows loquat to reach market before any other spring fruit crop. Avoidance of such a competence makes earliness of paramount importance for loquat marketing. In this sense, prices are very high for loquat at the beginning of the season (March and April), but fall sharply on May and June when cherries, peaches, plums and other spring fruits arrive market. For above reasons, any culture practice able to improve loquat earliness may have a significative impact on payments returns, increasing loquat profitability. Orchard water management could bring us such a target.

In 1984, Mitchell *et al*. coined the concept of regulated deficit irrigation (RDI) as a water management strategy that reduces the amount of water available for the crop during non-critical phenological stages, while fully covers crop water demand the rest of the year. RDI main objective is to save water but reducing the impact of water shortage on productivity and fruit quality. Proper selection of non-critical periods is the key for successful RDI. Behboudian and Mills (1997) in a recent review emphasize the principle of economical profit behind any deficit irrigation strategy. They define deficit irrigation as a water management system that deliberately provokes a period of water deficit in the plant or soil seeking any economical benefit. In this experience, we have combined both considerations trying to obtain better returns for loquat yield by appropriately selecting a period of water deficit linked to flower induction promotion. In its center of origin, loquat bloom date is probably controlled by natural episodes of rainy and dry weather. As happens in other subtropical woody plants flower induction is often triggered by a rest condition imposed by drought. Current theories sustain that bud rest is needed before vegetative meristem evolve into a reproductive structure in response to hormonal changes (Nir *et al*. 1972, cited by Behboudian and Mills, 1997). Moderate water stress appears, therefore, as a tool for promoting bloom and advance harvest in loquat. Main objective of this work is to cause earlier flowering by deficit irrigation with permissible effects on bloom density and quality.

MATERIALS AND METHODS

Trials were performed during three consecutive seasons on a solid block of cultivar ‘Algerie’ located in ‘Las Palmerillas’ Experimental Station located near El Ejido (Almería, SE of Spain). Trees are grafted on ‘Provence’ quince and spaced 2.5 X 5 m. At the beginning of the trial, the trees presented a uniform canopy volume of 2.67 m^{-3} with 2 m height. Orchard soil is sandy loam with low water retention capacity (field capacity=13.44%, wilting point= 5.12%). Two lines of 2.3 l h^{-1} drip emitters per tree row were used to apply water. Emitters are pressure compensating and extruded into the tubing every 0.5 m. Water schedule was programmed with AGRONIC 4000 and a system of electric valves.

Average precipitation in the area limits to 220 mm, mainly during fall and spring. Eto reaches 1726 mm with extreme values 2.4 mm day^{-1} on December and January and 8.7 mm day^{-1} on July. Fertilizers have been applied trough water system at a year rate of 160 FU ha^{-1} N, 120 FU ha^{-1} P_2O_5 y 120 FU ha^{-1} K_2O.

Three treatments have been selected: Control, receiving about 40% of Epan measured with a Class A pan placed in the orchard. Continuous Deficit Irrigation (CDI), with 20% saving of water, and stress uniformly applied along the year. Finally, Regulated Deficit Irrigation (RDI), with the same reduction in irrigation, but stress concentrated on postharvest from May to the end of August, when reduction reached 55% of the amount of water received by control trees.

Effects of deficit irrigation treatments on reproductive phenology, flower intensity and quality were estimated. Phenology was followed according to procedure reported by Barranco *et al*., (1994) from summer bud to initial fruit set using phenological stages described by Cuevas *et al*. (1997). Length and date of bloom and full bloom were calculated based on observations. Flower quality was estimated by flower dry weight using 100 king flowers from 10 different trees. Flowers were sampled in a late balloon stage, then their bracteoles were removed and the flowers were cut at gynoecium level. Finally the flowers were placed at 70ºC for several days until permanent dry weight was reached. Bloom density as number of flowers per panicle and proportion of buds evolving into reproductive structures was also determined. The number of flowers was counted on four terminal panicles per tree on four trees per treatment every year. On 2000/01 campaign we followed evolutions of 25 terminal and 25 lateral shoots on four trees per treatment. On 2001/02 we did the same with 10 main and 10 lateral shoots on six different trees per treatment.

RESULTS AND DISCUSSION

Control trees reached full bloom between November 23th and 25th depending on year. RDI made trees bloom 13 days earlier on 1999/00, 19 days earlier on 2000/01 and 20 days 2001/02 campaigns. CDI had minor, but progressive effects on bloom date. First year, full bloom was advanced only three days; on 2001/02 CDI trees reached full bloom 10 days before control trees. Earlier flowering in response to water deficit has been often reported in subtropical crops (Nakajima *et al*., 1993; Sánchez-Blanco *et al*., 1989; Galán, 1999). *Forzatura* or restriction of water available for lemon trees is used since long in Spain and Italy for producing out of season, summer crop. That technique, in fact, inspires our experimental approach. Our results also coincide with observations of earlier flowering season in loquat during dry years (Rodríguez, 1983). This author recommends a reduction in irrigation rates during June, July and August with the idea of promote flowering.

Deficit irrigation treatments diminished dry weight of flowers. Flowers from RDI trees were the lightest with significant differences with respect to control and CDI (Table 1). CDI trees formed lighter flowers than control trees, with significant differences on 1999/00 and 2001/02 (Table 1). Water stress although implemented solely for advancing flower induction process, it had collateral effects on subsequent flower development; its negative effects, appreciated on lower dry weight of flowers, were manifest every year and may reflect plant water status during formation of panicles. No interaction among years and treatments was detected on flower dry weight (p=0.25).

Table 1. Quality of flowers expressed by dry weight (g). In bold means for treatments and years.

	Dry weight of single flower (g)*			
	1999/00	2000/01	2001/02	Mean
Control	0.521 a	0.508 a	0.490 a	0.506
CDI	0.475 b	0.500 a	0.432 b	0.469
RDI	0.429 c	0.414 b	0.395 c	0.413
Mean	0.475	0.474	0.439	

*Values with the same letter do not differ significantly.

Intensity of flowering was estimated by means of the number of flowers per panicle and also for the proportion of terminal and lateral shoots developing panicles. The number of flowers per panicle showed a large variability among years (Table 2), but did not show any change in response to treatments. No interaction was either detected between irrigation treatments and years in this parameter. (p=0.50). On the other hand, bloom intensity resulted very high regardless of treatments. Almost 100% of main shoots developed flowers in all treatments (Table 3). No differences were either found in the number of lateral shoots sprouted below terminal panicles. However, some effects were caused by deficit irrigation on the fate of these lateral shoots. Under RDI a higher proportion of them formed a panicle; differences were significant only first year (Table 3). Our results coincide with many others authors in which moderate water deficits postharvest lead to an increase in bloom density next year (Mitchell *et al*., 1984; Larson *et al*., 1988; Li *et al*., 1989). Positive effects of deficit irrigation on bloom density have been reported in subtropical (Nakajima *et al*. 1993; Sánchez-Blanco *et al*., 1989) as well as in temperate fruit crops (Raese *et al*., 1982; Mitchell *et al*., 1984; Chalmers *et al*., 1985; Degman *et al*., 1932; Proebsting *et al*., 1977 (cited by Behboudian *et al*. (1997). Some others have documented no effects or lower bloom density when deficit irrigation is implemented Mills *et al*. (1994 Brun *et al*. (1985) y Caspari *et al*. (1994). Discrepancies must be due to the moment and intensity of water stress (Behboudian and Mills, 1997).

Table 2. Number of flowers for panicle. In bold means for treatments and years.

	Number of flower for panicle			
	1999/00	2000/01	2001/02	Mean
Control	194.5	198.9	179.3	190.9
CDI	174.2	240.2	212.3	201.6
RDI	186.3	218.3	199.4	208.7
Mean	185.0	219.2	197.0	

Differences no significative.

Table 3. Percentage of main and lateral shoots developing flowers, and number of lateral shoots.

	2000/01			2001/02		
	% panicles on main shoots	Lateral shoots per main shoot	% panicles on lateral shoots *	% panicles on main shoots	Lateral shoots per main shoot	% panicles on lateral shoots
Control	100	0.31	30.4 b	100	0.22	58.3
CDI	97.7	0.34	20.0 b	100	0.38	51.7
RDI	100	0.58	96.4 a	100	0.24	86.7

*Values with the same letter do not differ significantly.

CONCLUSIONS

In short, our results confirmed that loquat responds to moderate summer water stress with earlier and more intense flowering that in turn lead to earlier harvesting season. Negative effects on flower quality caused by water stress did not have, so far, an significant impact on fruit set or fruit quality. We focus now in timetable modifications of water stress date and intensity with the idea of maximize advancement in bloom and eliminate negative effects on flower quality.

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