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Productive potential of six almond cultivars under regulated deficit irrigation

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Abstract. Spanish almond production has been based on traditional cultivars mainly planted in marginal land and under rainfed conditions (300-650 mm per year). Currently, the new cultivars released and the increase of irrigated almond areas is allowing a change in almond culture. In the year 2000 a trial was planted in Les Borges Blanques (Lleida) with the aim to assess the productive potential of six late almond blooming cultivars ('Ferragnès', 'Francolí', 'Glorieta', 'Guara', 'Lauranne' and 'Masbovera') under regulated deficit irrigation (2500 m³/ha per year). In the first years the six cultivars assessed performed well, reaching the equivalent kernel production of 2000 kg/ha in 2007 (8th year). Some other traits like blooming date, harvest date, vegetative growth and kernel quality were also recorded in this trial.

Keywords. Almond – Production – Regulated deficit irrigation – Vegetative growth – Kernel quality.

Potentiel productif de six cultivars d'amandier sous irrigation contrôlée

Résumé. La production espagnole d'amandes est basée sur des variétés traditionnelles, cultivées sur terrains marginaux et en conditions de non irrigation (300-650 mm par année). Actuellement, les nouvelles variétés obtenues et l'augmentation de la surface irriguée permettent de modifier la culture de l'amandier. L'année 2000, dans la ville de Les Borges Blanques (Lleida), a commencé un essai dans l'objectif d'étudier le potentiel productif de six variétés à floraison tardive ('Ferragnès', 'Francolí', 'Glorieta', 'Guara', 'Lauranne' et 'Masbovera') avec irrigation contrôlée (2500 m³/ha par année). Lors des premières années toutes les variétés testées ont eu un bon résultat, donnant une production équivalente d'amandons de 2000 kg/ha en 2007. D'autres caractères, comme l'époque de floraison, l'époque de récolte, la croissance végétative et la qualité de l'amandon, ont été analysés dans l'essai.

Mots-clés. Amandier – Productivité – Irrigation contrôlée – Croissance végétative – Qualité de l'amandon.

I – Introduction

Spanish almond production has been based on traditional early blooming cultivars mainly planted in marginal land and under rainfed conditions (300-650 mm per year). Only 6% of almond surface in Spain is irrigated (MAPA, 2007). The low productivity in these orchards (150 kg/ha of kernel) is mainly due to drought, the occurrence of frosts at blooming time and a deficient pollination (Felipe, 2000).

An important change in cultivar composition in Spain took place from the 80s, first with the release of two late blooming cultivars, 'Ferragnès' and 'Ferraduel' (INRA France) that were widely grown, and later in the 90s with the release of late blooming self-compatible cultivars from breeding programs of Spain and France: 'Guara', 'Lauranne', 'Masbovera', 'Glorieta', 'Francolí', 'Antoñeta' and 'Marta' (Felipe and Socias i Company, 1987; Grasselly, 1991; Vargas and Romero, 1994; Dicenta *et al.*, 1999).

Currently, in Spain the increase of irrigated areas (with limited quantities of water) is allowing a big change in almond orchards, because this crop can be profitable under regulated deficit irrigation (Girona, 2007; Vargas and Romero, 2007).

A cultivar trial was started in 2000 at Les Borges Blanques (Lleida), with the aim of assessing the productive potential of the new cultivars, with regulated deficit irrigation.

II – Materials and methods

The cultivars included in the trial were: 'Ferragnès', 'Francolí', 'Glorieta', 'Guara', 'Lauranne' and 'Masbovera' released by different breeding programs. The origin of these cultivars is reflected in Table 1. All the cultivars are late blooming. 'Guara', 'Lauranne' and 'Francolí' are self-compatible, whereas 'Ferragnès', 'Glorieta' and 'Masbovera' are self-incompatible. Cultivars were grafted onto GF-677.

Table 1. Genetic origin of six cultivars tested (Felipe and Socias i Company, 1987; Vargas and Romero, 1994; Grasselly and Duval, 1997)

Cultivars	Origin	Crossing year	Breeding program
'Guara'	Clonal selection	1983	CITA
'Ferragnès'	'Cristomorto' × 'Ai'	1960	INRA
'Lauranne'	'Ferragnès' × 'Tuono'	1978	INRA
'Francolí'	'Primorskyj' × 'Tuono'	1976	IRTA
'Glorieta'	'Primorskyj' × 'Cristomorto'	1975	IRTA
'Masbovera'	'Primorskyj' × 'Cristomorto'	1975	IRTA

The trial was established at Les Borges Blanques (Lleida), where the soil is clay-loam texture, deep and stone free. The average rainfall of this area is 350 mm per year. The cultivars are cultivated under regulated deficit irrigation (2500 m³/ha per year).

The grafted trees were planted, in January of 2000, at 6 m × 6 m tree spacing. A randomized blocs design, 3 repetitions and 11 trees per plot, were used.

Blooming date, ripening time, growth habit, branching density and training and pruning ease were observed. Tree vigour (trunk section at 30 cm high from the ground) production and nut characteristics [nut and kernel weight, double kernels (%), shelling percentage (%) and kernel appearance (score 1-9)] were recorded too.

Data production and nut characteristics were analyzed by ANOVA test, and means separations were performed by Duncan's Multiple Range Test by SAS Enterprise Guide 3.0 (2004).

III – Results and discussion

In Table 2 the average full blooming date can be observed. The average full flowering date of 'Glorieta', 'Guara' and 'Masbovera' was 3-4 days before 'Francolí', 'Ferragnès' and 'Lauranne'.

Table 2. Average full blooming date, 5 years records (2003-2007)

Cultivars	Years					Average full blooming date
	2003	2004	2005	2006	2007	
'Glorieta'	16 March	10 March	24 March	18 March	10 March	16 March
'Guara'	18 March	15 March	24 March	18 March	10 March	17 March
'Masbovera'	16 March	15 March	24 March	18 March	12 March	17 March
'Francolí'	19 March	15 March	24 March	25 March	14 March	19 March
'Ferragnès'	18 March	15 March	27 March	20 March	14 March	19 March
'Lauranne'	21 March	17 March	27 March	20 March	14 March	20 March

The average ripening time of 'Guara', 'Lauranne' and 'Francolí' was at the end of August and beginning of September, and of 'Glorieta', 'Ferragnès' and 'Masbovera' was about mid September (Table 3).

Table 3. Average ripening time, 3 year records (2005-2007)

Cultivars	Years			Average ripening time
	2005	2006	2007	
'Guara'	24 August	27 August	1 September	28 August
'Lauranne'	1 September	30 August	5 September	2 September
'Francolí'	5 September	6 September	31 August	4 September
'Glorieta'	7 September	6 September	15 September	9 September
'Ferragnès'	5 September	21 September	14 September	13 September
'Masbovera'	6 September	21 September	17 September	15 September

In Fig. 1 the strong vigour of 'Masbovera', 'Francolí', 'Ferragnès' and 'Glorieta' can be observed, and they are more vigorous than 'Lauranne' and 'Guara'. Vigour differences are more evident in last years.

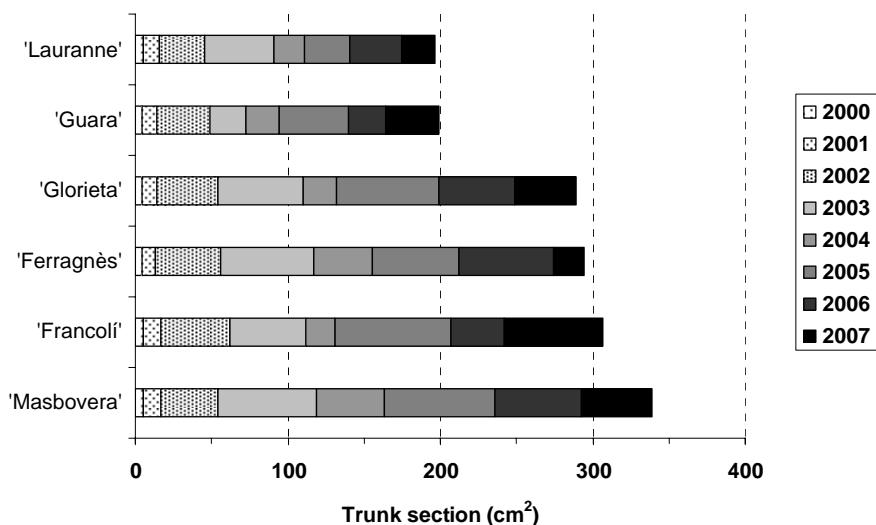


Fig. 1. Vigour of six cultivars tested, accumulated trunk section (cm²).

Some other traits like growth habit, branching density and training and pruning ease are given in Table 4. All cultivars have very easy training and pruning, except 'Guara' that presents a drooping growth habit and needs a careful training and pruning. Cultivars characteristics are similar to the reported by other authors (Duval and Grasselly, 1994; Grasselly and Duval, 1997; Vargas and Romero, 1999; Felipe, 2000; Cordeiro *et al.*, 2005; Vargas *et al.*, 2007).

Table 4. Tree growth habit, branching density and training and pruning ease

Cultivars	Growth habit	Branching density	Training and pruning ease
'Guara'	Drooping	Scarce	Difficult
'Ferragnès'	Medium-upright	Mid	Very easy
'Lauranne'	Medium spreading	Mid	Easy
'Francolí'	Medium	Mid	Very easy
'Glorieta'	Medium-upright	Mid	Very easy
'Masbovera'	Medium-upright	Mid	Very easy

All six cultivars presented a good productive behaviour in this trial. In Tables 5 and 6 the mean kernel production by tree and the equivalent kernel production (kg/ha) are given. Frosts have not happened during the trial, but in 2003 unfavourable climatic conditions avoided bees foraging and consequently the crossed pollination of self-incompatible cultivars.

Table 5. Mean and accumulated kernel production per tree (kg/ha)

Cultivars	Mean kernel production per tree						Accumulated kernel production per tree (2002-2007)
	2002	2003	2004	2005	2006	2007	
'Lauranne'	0.05 bc	2.4 a	5.9 b	5.2 a	7.3 a	9.6 a	30.4 a
'Ferragnès'	0.02 bc	0.8 b	5.3 bc	5.5 a	5.2 a	9.6 a	26.4 ab
'Francolí'	0.08 b	2.1 a	13.4 a	0.1 d	6.9 a	3.5 c	26.1 ab
'Glorieta'	0.06 bc	0.9 b	7.4 b	2.6 c	4.8 a	8.0 ab	23.7 bc
'Masbovera'	0.01 c	0.6 b	3.6 cd	3.1 bc	5.0 a	8.5 ab	20.8 c
'Guara'	0.16 a	2.7 a	2.2 d	3.9 b	5.9 a	5.9 b	20.8 c

a, b, c, d: values with the same letter are not significantly different (Duncan, $p < 0.05$).

Table 6. Accumulated kernel production per tree and mean and accumulated equivalent kernel production (kg/ha)

Cultivars	Mean equivalent kernel production (kg/ha)						Accumulated equivalent kernel production (kg/ha) (2002-2007)
	2002	2003	2004	2005	2006	2007	
'Lauranne'	13	669	1633	1432	2023	2678	8448
'Ferragnès'	5	212	1474	1540	1453	2655	7339
'Francolí'	21	585	3730	30	1906	967	7239
'Glorieta'	17	240	2045	735	1322	2216	6577
'Masbovera'	1	169	991	874	1387	2354	5776
'Guara'	44	747	618	1077	1652	1636	5773

'Lauranne', 'Guara', 'Francolí', 'Glorieta' and 'Ferragnès' stood out for their bearing earliness (2003-2004). 'Francolí' was the earliest bearing, but showed alternate bearing. All cultivars showed a high production capacity, overcoming 1300 kg of kernel per ha in 2006. So far 'Lauranne', 'Ferragnès' and 'Francolí' were outstanding, with more than 7000 kg of kernel/ha of accumulated production.

Nut and kernel features are presented in Table 7. 'Ferragnès', 'Guara', 'Glorieta' and 'Masbovera' stood out for their high kernel weight (1.5-1.6). The only cultivar that presented a

high percentage of double kernels was 'Guara' with 14.3%. The shelling percentage only varied between 27.2 and 33.7. All the cultivars showed an acceptable appearance, standing out 'Glorieta', 'Guara' and 'Masbovera'.

Table 7. Nut characteristics. Mean values of 4 years observations (2004-2007) on nut and kernel weight (g), double kernels (%), shelling percentage and kernel appearance (score 1-9). Nut number per sample = 50

Cultivars	Nut weight (g)	Kernel weight (g)	Double kernels (%)	Shelling percentage (%)	Kernel appearance (1-9)
'Guara'	4.6 d	1.5 c	14.3 a	32.5 b	6.4 b
'Ferragnès'	4.9 c	1.6 a	0.3 c	33.7 a	6.1 c
'Lauranne'	3.8 f	1.2 e	1.6 b	32.1 b	6.1 c
'Francolí'	4.2 e	1.3 d	1.2 b	31.4 b	5.6 d
'Glorieta'	5.8 a	1.6 b	1.7 b	27.2 c	7.0 a
'Masbovera'	5.4 b	1.5 c	0.0 c	28.1 c	6.5 b

a, b, c, d, e, f: values with the same letters are not significantly different (Duncan, $p < 0.05$)

IV – Conclusions

Over the first years, the six cultivars assessed in the trial performed very well under regulated deficit irrigation, reaching important productions from the 5th year. These are preliminary results, during the coming the productive potential of all six cultivars will be further assessed.

References

- Cordeiro V., Alves C., Vieira J. and Barroso M.R., 2005.** Evaluation of almond cultivar adaptation in Trás-os-Montes region (Portugal). In: *Options Méditerranéennes, Series A*, 63, p. 113-116.
- Dicenta F., Berenguer T. and Egea J., 1999.** 'Antoñeta' y 'Marta': Dos nuevas variedades de almendro autocompatibles y de floración tardía. In: *Fruticultura Profesional, Especial Frutos Secos II*, 104, p. 48-53.
- Duval H. and Grasselly Ch., 1994.** Behaviour of some self-fertile almond selections in the south-east of France. In: *Acta Horticulturae*, 373, p. 69-74.
- Felipe A.J., 2000.** *El Almendro I - El Material Vegetal*. Zaragoza: Integrum.
- Felipe A.J. and Socias i Company R., 1987.** 'Aylés', 'Guara' and 'Moncayo' almonds. In: *HortScience*, 22, p. 961-962.
- Girona J., 2007.** Resposta productiva de l'ametller al reg. In: Dossier Tècnic 22: L'ametller, DARP, p. 20-22.
- Grasselly Ch., 1991.** Avijor 'Lauranne'. In: *L'Arboriculture Fruitière*, 436(2), p. 75.
- Grasselly Ch. and Duval H., 1997.** *L'Amandier*. Paris: CTFIL.
- MAPA (Ministerio de Agricultura Pesca y Alimentación), 2007.** *Anuario de Estadística Agroalimentaria 2006*. (<http://www.mapa.es>).
- Vargas F.J. and Romero M.A., 1994.** 'Masbovera', 'Glorieta', and 'Francolí', three new almond varieties from IRTA. In: *Acta Horticulturae*, 373, p. 75-82.
- Vargas F.J. and Romero M.A., 1999.** Ensayo de variedades de almendro de floración tardía en Tarragona. In: *Fruticultura Profesional, Especial Frutos Secos II*, 104, p. 43-47.
- Vargas F.J. and Romero M.A., 2007.** L'ametller: Un cultiu en procés de canvi. In: Dossier Tècnic 22: L'ametller, DARP, p. 3-5.
- Vargas F.J., Romero M.A., Clavé J. and Alegre S., 2007.** Varietats d'ametller IRTA. In: Dossier Tècnic 22: L'ametller, DARP, p. 6-12.