An elite self-compatible selection from the Zaragoza breeding programme

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Abstract. The almond (*Prunus amygdalus* Batsch) breeding programme at the CITA de Aragón aims at the development of self-compatible cultivars in order to avoid all the problems related to cross-pollination, blooming if possible when the risks of late frosts are over. Previous releases have shown commercial levels of fruit set in growing conditions of single-cultivar orchards, but incidence of late frosts is still damaging in particular years the crop in some inland growing regions. Selection G-2-25, coming from the cross 'Felisia' × 'Bertina', shows very good traits for a commercial cultivar, blooming in addition two weeks later than 'Felisia', the latest blooming cultivar released so far. It is thus considered for registration because of its erect growth habit, early ripening, high and regular bloom density, autogamy (S_6S_f genotype), high fruit set, tolerance to diseases and drought, hard shell, large kernel, very high content of oleic acid and medium content of tocopherol.

Keywords. *Prunus amygdalus* – Breeding – Late blooming – Self-compatibility – Fruit quality – Productivity.

Une sélection d'élite auto-compatible issue du programme d'amélioration de Zaragoza

***Résumé**. Le programme d'amélioration génétique de l'amandier (*Prunus amygdalus *Batsch) du CITA d'Aragon a comme but principal l'obtention de cultivars auto-compatibles avec l'objectif d'éviter tous les problèmes relatifs à la pollinisation croisée, avec une floraison aussi tardive que possible, quand les risques de gelées sont moindres. Les obtentions antérieures ont montré des niveaux commerciaux de nouaison dans des conditions de culture en vergers d'un seul cultivar, mais l'incidence de gelées tardives est encore dommageable lors d'années particulières en régions intérieures. La sélection G-2-25, provenant du croisement 'Felisia' × 'Bertina', montre de très bonnes caractéristiques pour devenir un cultivar commercial, avec en plus une floraison qui se situe deux semaines après 'Felisia', le cultivar à floraison la plus tardive obtenu jusqu'à présent. Cette sélection est par conséquent envisagée pour être enregistrée en raison d'une croissance à port érigé, maturation précoce, densité florale forte et régulière, autogamie (génotype S_6S_f), forte nouaison, tolérance aux maladies et à la sécheresse, coque dure, grand amandon, contenu très élevé en acide oléique et contenu moyen en tocophérol.*

Mots-clés. Prunus amygdalus – *Amélioration – Floraison tardive – Auto-compatibilité – Qualité du fruit – Productivité.*

I – Introduction

The almond breeding programme of the CITA of Aragón aims to develop new self-compatible and late-blooming cultivars to solve the main problem detected in Spanish almond growing, its low productivity, due to the occurrence of frosts at blooming time or later and to a deficient pollination (Felipe, 2000). The first three cultivars released were 'Aylés', 'Guara' and 'Moncayo' (Felipe and Socias i Company, 1987), 'Guara' having represented more than 50% of the new almond orchards in the last years (MAPA, 2002). Later three more cultivars were registered in 1998, 'Blanquerna', 'Cambra' and 'Felisia' (Socias i Company and Felipe, 1999), 'Blanquerna' being of very good productivity and kernel quality, and 'Felisia' of very late blooming time (Fig. 1). Two more cultivars 'Belona' and 'Soleta' were registered in 2005 (Socias i Company and

Felipe, 2007), characterised by their high kernel quality and considered possible commercial substitutes for the two preferred cultivars in the Spanish market, 'Marcona' and 'Desmayo Largueta'. Selection G-2-25 is now considered for registration because of their good horticultural and commercial traits.

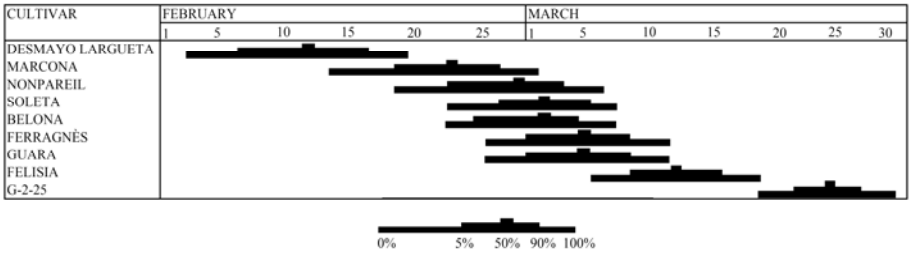

Fig. 1. Mean flowering time of the new selection as related to other cultivars (7-years average). Percentages refer to the amount of flowers opened.

II – Origin

Selection G-2-25 comes from the cross of 'Felisia', a self-compatible and late-blooming release of the Zaragoza breeding programme of small kernel size (Socias i Company and Felipe, 1999), and 'Bertina', a late-blooming local selection of large kernel size (Felipe, 2000). This cross was made with the aim of utilizing two late blooming almond cultivars, one of them carrying the late-bloom allele *Lb* (Socias i Company *et al*., 1999), of very different kernel size and genetically very distant, in order to avoid the problems related to inbreeding depression (Alonso and Socias i Company, 2007).

III – Blooming time

Blooming time has been a very important trait considered when evaluating the selection. As an average, its blooming time is 25 days later than 'Nonpareil', 20 days after 'Guara' and 13 days after 'Felisia', the latest blooming cultivar released so far (Fig. 1). Its consistent late blooming time is due to its very high chilling and heat requirements, much higher than in any other almond genotype (Alonso *et al*., 2008). Flowers are of small size, white, with epistigmatic pistils, both on spurs and on one-year shoots, with a high and regular bloom density.

IV – Autogamy

Self-compatibility was tested as soon as the original seedling produced the first flowers by examining the arrival or not of pollen tubes at the ovary after self-pollination (data not shown). Sets after self-pollination and autogamy were studied on three grafted trees of each selection during several years due to the large variability found between years in field trials for fruit set (Socias i Company *et al*., 2005). Average set after artificial self-pollination was 17.9%, higher than after cross-pollination, 15.7%, although not statistically significant. Average set in bagged branches was 9.8%, higher than the threshold of 6% indicated by Grasselly *et al*. (1981) for autogamy. These sets, lower than those considered for a commercial crop in Californian cultivars (Kester and Griggs, 1959), ensure a good crop level because of the high bloom density of this selection (Kodad and Socias i Company, 2006). Its *S*-allele genotype has been determined as S_6S_f.

V – Performance

Field behaviour has been evaluated in three grafted trees of an experimental plot and in three external trials. One on the most important points considered was resistance to frosts. Especially important was the observation in 2003 and 2004, with severe frosts in most almond growing regions of Spain. Whereas cultivars considered as resistant to frosts such as 'Guara' (Felipe, 1988) suffered important yield reductions, G-2-25 did not suffer any damage (Kodad and Socias i Company, 2005).

Tree training has been easy because of its erect growth habit, without the problem of bending branches of 'Guara'. Adult trees show an intermediate vigour and a good equilibrium between vegetative growth and production and a low branching index, thus pruning may be reduced. Field observations in the trials showed its tolerance to *Polystigma* and other fungal diseases, as well its tolerance to drought in the non-irrigated trials.

Ripening time is early, although later than in 'Guara', which allows the succession of harvest. Nut fall before harvest has been very low, but nuts fell easily when shaken.

The external trials have shown its good adaptation to different growing and weather conditions. A trial in Aniñón (Zaragoza) at 800 m asl and of very cold climate has had good production even in years with late frosts. A trial in El Pinós (Alacant), at 575 m asl but with a milder climate, has shown their very good production as well as vegetation (G. Valdés, unpublished). Blooming and ripening dates observed in these locations have been, as expected, earlier in El Pinós than in Zaragoza, but later in Aniñón.

VI – Industrial quality

Nuts show a very good aspect and good size (4.9 g). Shell is hard (shelling percentage of 24%), adapted to the Spanish industry. Kernels also show a very good aspect and good size (1.2 g), heart-shaped, without double kernels (Fig. 2). Industrial cracking has been carried out by the Cooperative "Frutos Secos Alcañiz" and has shown very good results, without presence of double layers in the shell. Kernel breakage at cracking has been low, with 86.2% of whole kernels.

Fig. 2. Fruits of the new selection.

The chemical composition of the kernels has been determined in order to establish their best utilization opportunities. The content in fatty acids is high, similar to that of 'Marcona' (Table 1), a very interesting trait for "turrón" (nougat) production. The percentage of oleic acid, that of higher quality for fat stability and nutritive value in the lipid fraction (Socias i Company *et al*., 2008), is especially high, close to 75% (Table 1). The amount of tocopherol is medium, indicating the need for a rapid processing of kernels after cracking.

Table 1. Oil and tocopherol composition of the new selection as compared to other cultivars

Genotype	Oil content	Oleic	Linoleic	α-tocopherol	γ -tocopherol	δ -tocopherol	Total tocopherol
Marcona	59.10	71.75	19.40	463.3	18.5	24.1	505.9
Largueta	57.35	70.65	20.55	304.3	15.3	16.0	335.6
Ferragnès	60.30	73.55	17.70	377.5	18.7	19.8	416.0
G-2-25	59.10	74.95	16.55	201.5	12.1	12.3	225.9

Roasting has been tested for appetizer use, by the industry "Almendras Castillo de Loarre". Behaviour has been good, although less than in the favourite one in the Spanish market, 'Desmayo Largueta'. Kernel taste, both raw and roasted, is very good.

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