Journal American Pomological Society 57(2):89-92 2003

Almond Bloom in a Changing Climate

R. SOCIAS i COMPANY[1], A.J. FELIPE[1] AND J. GÓMEZ APARISI[1]

Abstract

Almond shows an extended blooming season. Later blooming cultivars avoid the possibility of late frosts and also benefit from temperatures more favorable for pollination and fertilization. For these reasons, the almond breeding program of Zaragoza has mainly pursued the development of very late blooming cultivars, and also cultivars showing a wide range of bloom times.

Introduction

The Mediterranean climate is characterized by very low rainfall during late winter and early fall. Thus, almond (*Prunus amygdalus* Batsch syn. *P. dulcis* (Mill.) D.A. Webb) is a nut species adapted to this climate (9) due to its specific requirements in relation to rains. Rains during the fall disrupt harvesting operations. Rains during bloom interfere with pollination, reducing the activity of pollinating insects. As a consequence, a high negative correlation has been found in California between the total rainfall in February and final crop level (2). Heavy rains over long periods are not typical for present growing regions during almond bloom, but a climatic change may disturb almond pollination if there is a shift of the main rainy season towards the almond blooming time (15). The global climatic change now in progress has affected rainfall patterns, leading to greater threats to the almond bloom.

Almond shows an extended blooming season when all cultivars are taken into account (12). Later blooming cultivars avoid damage from late frosts and also benefit from more favorable temperatures for pollination and fertilization. The almond breeding program of Zaragoza (6) has pursued not only the development of very late blooming, but also of mid blooming cultivars, thus opening the possibilities of selecting a bloom season from a wider calendar range. This paper summarizes progress in delaying bloom in almond and the strategy of breeding new cultivars in order to widen the cultivar choices with regard to bloom time.

Materials and Methods

Phenological stages were recorded in 1997 for a collection of commercial cultivars and seedlings of the Zaragoza breeding program according to Felipe (4). Dates of the different blooming stages were established depending on the approximate percentage of opened flowers (Fig. 1). For the study of the possibilities of later bloom, the cross 'Felisia' x 'Bertina' was chosen because both parents are very late blooming (Fig. 1). 'Felisia' is a release from our breeding program (13), selected because of its self-compatibility and late bloom. It is derived from the cross 'Titan' x 'Tuono', and although 'Titan' is a seedling of 'Tardy Nonpareil', it has broken the linkage shown in the 'Tardy Nonpareil' progeny between late bloom and low productivity (7). 'Bertina', a local cultivar, is probably a chance seedling distinguished because of its late bloom. Almond bloom is rated according to the almond descriptors (8) on a rating scale from 1 (very early) to 9 (very late) by comparison to defined reference cultivars.

Results and Discussion

Figure. 1 shows the blooming time of several almond cultivars in Zaragoza in 1997. This bloom season was both earlier and shorter than usual due to high temperatures during this period. Bloom date changes from year to year depending on

[1]Unidad de Fruticultura, Servicio de Investigación Agroalimentaria de la Diputación General de Aragón. apartado 727, 50080 Zaragoza, Spain. e-mail: rsocias@aragob.es.

the climatic characteristics, mainly temperature, but the sequence of blooming of the different cultivars often remains the same, with typically small shifts (5). Thus, the coincidence of bloom for two cultivars may change depending on the year. In this evaluation reference cultivars for almond bloom (8) are identified with their rating, but the difference observed between reference cultivars 1 and 2 is very small whereas that between reference cultivars 2 and 3 is larger, demonstrating that year-to-year shifts may produce a closer or more distant grouping of the different cultivars for bloom time depending on the temperature evolution (1).

The reference cultivar for very late blooming ('Tardy Nonpareil') is not included in our collection, but its bloom time could be approximately that of 'Ferralise' (7). 'Felisia', a cultivar recently released from our breeding program is, thus, beyond this blooming scale. Because of this cultivar, and the presence of other very late blooming seedlings in breeding progenies (7, 14), this bloom scale has become inapplicable with revision recommended at the X GREMPA (Group de Recherches et d'Études Méditerrenéen pour l'Amandier) Colloquium in Meknès (Morocco) in October 1996.

Blooming of the first cultivar, 'Constantini', started on January 26, and that of the last selection, G-1-27, finished on March 22, giving a continued blooming period of approximately two months. A wide choice among the old commercial cultivars (Fig. 1) and new seedlings is now available. However, no self-compatible cultivars are found among the early blooming ones, restricting the scope of this choice when self-compatibility is looked for.

A wide distribution of bloom time is observed among the different seedlings from the cross 'Felisia' x 'Bertina' (Fig. 2). Selections shown in bold in Fig. 2 are self-compatible, late blooming, of good kernel quality (11), and of high productivity. They are under evaluation for possible cultivar release, but they have also been crossed with early blooming cultivars in order to benefit from the peculiar trans-

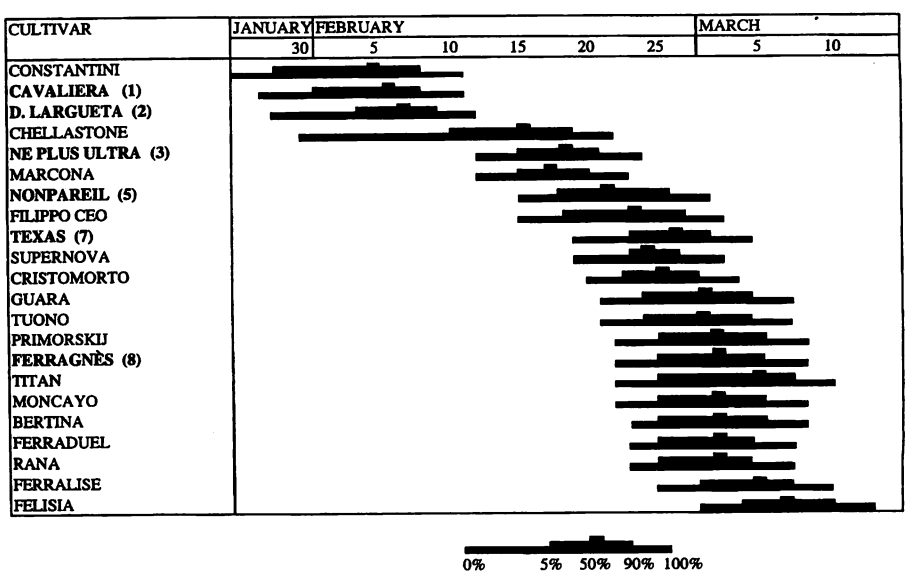

Figure 1. Bloom time of several almond cultivars in Zaragoza in 1997. Names in bold are reference cultivars (8) on a 1 (very early bloom) to 9 (very late bloom) scale. Percentages indicate the amount of flowers opened.

mission of blooming time in almond, both quantitatively (10) and qualitatively (14), with the late blooming allele (*Lb*) being dominant over earlier blooming (14). The use of late-blooming cultivars with unique geographical origins has also allowed the accumulation of genes with additive effects conferring extremely late bloom time (14). These selections appear to be heterozygous for this *Lb* allele (3) and further widen the possibilities of selecting cultivars with very extended bloom periods.

Acknowledgements

Research conducted under project AGF98-0211-C03-01 of the Spanish Comisión Interministerial de Ciencia y Tecnología. Data collection by J.M. Ansón is highly appreciated.

Literature Cited

1. Alonso, J.M., M.T. Espiau, J.M. Ansón and R. Socias i Company. 2002. Estimación de las necesidades en frío y calor para la floración del almendro mediante series temporales fenológico-climticas. V Jornadas Experimentación Fruticultura SECH, Lleida.
2. Alston, J., H. Carman, J.E. Christian, J. Doreman, J.R. Murua and R. Sexton. 1995. Optimal reserve and export policies for the California almond industry: theory, econometrics and simulation. Univ. California, Giannini Foundation Monograph 42, 130 p.
3. Ballester, J., R. Socias i Company, P. Arús and M.C. de Vicente. 2001. Genetic mapping of a major gene delaying blooming time in almond. Plant Breed. 120: 268-270.
4. Felipe, A.J. 1977a. Almendro. Estados fenológicos. Inf. Técn. Econ. Agrar. 27: 8-9.
5. Felipe, A.J. 1977b. Épocas de floración de variedades de almendro. An. Inst. Nac. Invest. Agrar., Ser. Prod. Veg. 7: 105-112.
6. Felipe, A.J. and R. Socias i Company. 1985. L'amélioration génétique de l'amandier à Sar-agosse. Options Méditerr. CIHEAM/IAMZ 85: 9-14.
7. Grasselly, C. and G. Olivier. 1985. Avancement du programme "tardivité de floraison" chez l'amandier. Options Méditerr. CIHEAM/IAMZ 85/1: 47-54.

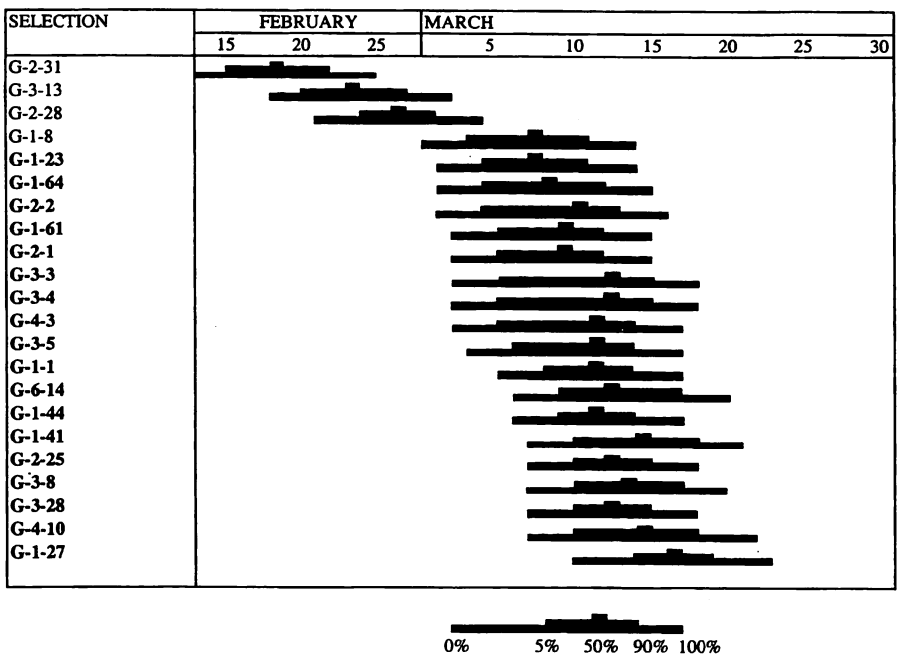

Figure 2. Bloom time of several almond selections in Zaragoza in 1997. Selections in bold are being used in further crosses.

8. Gülcan, R. 1985. Almond descriptors (revised). International Board for Plant Genetic Resources, Rome.
9. Kester, D.E. and R. Asay. 1975. Almonds. In: J. Janick and J.N. Moore (eds) Advances in Fruit Breeding. Purdue Univ. Press, West Lafayette, Indiana, p. 387-419.
10. Kester, D.E., P. Raddi and R. Asay. 1973. Correlation among chilling requirements for germination, blooming and leafing in almond (*Prunus amygdalus* Batsch). Genetics 74 (2,2): sl35.
11. Kodad, O. and R. Socias i Company. 2002. La composición química de la almendra como criterio de calidad. V Jornadas Experimentación Fruticultura SECH, Lleida.
12. Socias i Company, R. and A.J. Felipe. 1992. Almond: a diverse germplasm. HortScience 27: 717-718, 863.
13. Socias i Company, R. and A.J. Felipe. 1999. 'Blanquerna', 'Cambra' y 'Felisia': tres nuevos cultivares autógamos de almendro. Inf. Tecn.. Econ. Agrar. 95V: 111-117.
14. Socias i Company, R., A.J. Felipe and J. Gómez Aparisi. 1999. A major gene for flowering time in almond. Plant Breed. 118: 443-448.
15. Tank, A.K. 2002. Changing temperature and precipitation extremes in Europe's climate. Change 63: 14-16.