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SOME LATE FLOWERING AND EARLY MATURING ALMONDS (*PRUNUS AMYGDALUS* BATSCH) GERMPLASM

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Almond cultivation in the north-western Himalayas is greatly hampered by extremely low temperature during flowering and onset of the monsoons at the time of fruit ripening. This necessitates selection of late blooming and early maturing almonds for the region. As many as eight exotic cultivars including Non Pareil and six indigenous seedling selections were observed for time of bud break, flowering (full bloom) and fruit maturation for three consecutive years (1990 to 1992). Both the time of flowering and fruit maturation exhibited a great deal of variation indicating a part of it being due to genotypic variation. Five cultivars namely Nikitskyi, Prianyi, Tree No.2, Tree No.125 and White Brandis flowered 11 to 27 days late but matured 12 to 21 days earlier than the most popular cultivar Non Pareil. The utilization of these selections in commercial production and breeding programme is suggested.

Key words : Almond, *Prunus amygdalus*, evaluation, late flowering, early maturing, genetic diversity

Spring frost at the time of flowering and the onset of the monsoon rains towards fruit maturation are the major limiting factors in the cultivation of almond (*Prunus amygdalus* Batsch) in the north-western Himalayas. In such a situation, the fruit breeders opt for avoiding the climatic adversities by selecting late flowering and early maturing cultivars rather than selecting genotypes tolerant to environmental stresses (Alston and Roy, 1985; Kester *et al.*, 1990). This is more feasible in a crop like almond which has shown extensive variability in morphological, metric and electrophoretic traits (Aruleskar *et al.*, 1986), mainly because of its outcrossing nature. In the past, many workers have reported the occurrence of very early to very late flowering and maturing almond cultivars in a given set of environmental conditions (Agabbio and Ortu, 1974; Felipe, 1977; Rough *et al.*, 1978). However, only a few almond cultivars and some wild forms have been indicated to be late blooming and early maturing (Denisov, 1988; Kester *et al.*, 1990). On the lines indicated above, the present study was specifically undertaken to spot out late flowering as well as early maturing almond genotypes, either for use as direct cultivars or as donor parents in future breeding programmes.

MATERIALS AND METHODS

The evaluation studies were carried out in the Almond Collection Block of the Department of Fruit Breeding, University of Horticulture and Forestry, Nauni, Solan (H.P.) located at a height of around 1200 metres above msl and situated at 31°N latitude and 77°E longitude. The experimental material consisted of 16 year old bearing trees of 13 almond cultivars and selections on wild peach rootstock. The observations for time of bud-break, full bloom and fruit maturation were recorded during 1990 to 1992. The time of bud break was recorded when the green calyx was evident and scales of swelling buds had just begun to separate. The time of full bloom was recorded when more than 75 per cent flowers had reached anthesis stage and that of fruit maturation when first hull dehiscence took place. Days to maturation were counted from the date of full bloom to the date of hull dehiscence. For comparison, similar observations were recorded on cultivar Non Pareil, the most important commercial cultivar of the region where these studies were conducted.

RESULTS AND DISCUSSION

The lateness in time of bud break as compared to standard cultivar 'Non Pareil' ranged from as many as 31 days (Tree No. 125) to two days (Badamjor Spillo No. 2) in 1990; 19 days (Badamjor Spillo No. 2) to two days (Local Selection, Pethick's Wonder) in 1991 except Ne Plus Ultra (early by four days) and 16 days (Ribba Selection, Star Basin) to two days (Drake, Local Selection) in 1992 (Table 1). Cultivars Ribba Selection, Spillo No. 7, Star Basin, Tree No. 2, Tree No. 125 and White Brandis showed bud break late by atleast ten days than Non Pareil during all the three years. However, cultivar Nikitskyi showed late bud break by ten days than the check in 1991 and 1992 while similar observation was recorded for Badamjor Spillo No. 2 in 1991 and for Prianyi in 1992.

All the cultivars and selections under study reached full bloom stage later than Non Pareil during three years except in 1991 when Drake Ne Plus Ultra, Pethick's Wonder and Local Selection reached full bloom stage almost alongwith Non Pareil, the last one behaving similarly in 1992 also (Table 1). Time of full bloom was late than that of Non Pareil by 38 days (Tree No. 125) to three days (Badamjor Spillo No. 2, Local Selection), 27 days (Ribba Selection) to eight days (Prianyi) and 22 days (Ribba Selection) to nine days (Badamjor Spillo No. 2, Ne plus Ultra, Pethick's Wonder) in 1990, 1991 and 1992, respectively. Eight cultivars, namely, Nikitskyi, Prianyi, Ribba Selection, Spillo No. 7, Star Basin, Tree No. 2, Tree No. 125 and White Brandis attained full bloom stage after eight or more number of days than the check during all the three years.

Table 1 : Time of flowering and maturation in some almond cultivars/selections

Cultivar/ Selection	Date of bud break			Date of full bloom			Date of hull dehiscence			Days to maturation		
	1990	1991	1992	1990	1991	1992	1990	1991	1992	1990	1991	1992
Badamjor Spillo No. 2	12/1	23/2	8/2	26/1	4/3	26/2	-	24/7	10/7	-	142	135
Drake	15/1	9/2	2/2	5/2	17/2	28/2	7/7	8/7	27/7	152	141	150
Local Selection	10/1	6/2	2/2	26/1	17/2	16/2	8/7	20/7	6/7	163	153	141
Ne Plus Ultra	10/1	31/1	8/2	28/1	19/2	26/2	30/6	20/7	10/7	153	151	135
Nikitskyi	15/1	14/2	10/2	2/2	28/2	28/2	30/6	8/7	9/7	148	130	132
Pethick's Wonder	15/1	6/2	8/2	30/1	18/2	26/2	2/7	20/7	24/7	153	152	149
Prianyi	16/1	12/2	10/2	4/2	27/2	4/3	11/7	8/7	1/7	157	131	119
Ribba Selection	20/1	14/2	16/2	10/2	18/3	10/3	27/7	-	27/7	167	-	139
Spillo No. 7	20/1	15/2	14/2	5/2	2/3	5/3	20/7	-	27/7	165	-	144
Star Basin	22/1	14/2	16/2	9/2	2/3	8/3	27/7	11/7	1/8	168	130	146
Tree No. 2	31/1	18/2	10/2	18/2	2/3	8/3	11/7	11/7	26/6	143	130	110
Tree No. 125	10/2	14/2	10/2	2/3	8/3	28/2	2/7	27/6	1/7	121	111	124
White Brandis	22/1	17/2	14/2	8/2	7/3	6/3	2/7	16/7	9/7	144	131	125
Non Pareil (Check)	10/1	4/2	31/1	23/1	19/2	19/2	19/7	25/7	20/7	177	156	154

Eight out of 13 cultivars, viz., Local Selection, Drake Ne Plus Ultra, Nikitskyi, Prianyi, Tree No. 2, Tree No. 125 and White Brandis matured earlier than Non Pareil during all the three seasons (Table 1). Badamjor Spillo No. 2 also matured earlier except in 1990. The earliness in fruit maturation ranged from 19 days (Ne Plus Ultra, Nikitskyi) to eight days (Prianyi) in 1990, 28 days (Tree No. 125) to one day (Badamjor Spillo No. 2) in 1991 and from 24 days (Tree No. 2) to ten days (Badamjor Spillo No. 2, Ne Plus Ultra) in 1992.

In almonds, both the time of flowering and fruit maturation are quantitatively inherited and are dependent upon multiple factors (Kester and Asay, 1975). Such an inheritance pattern makes a particular trait more vulnerable to express variably under specific environments particularly the temperature (Rattigan and Hill, 1988). Similar observations have been made in the present study as evident from the fluctuating temperatures during flowering (Fig. 1) where the bud break in early flowering cultivars got initiated in second week

of January in 1990 and three weeks later in 1991 and 1992. High post-dormant temperatures (15-20° C) are known to enhance flower development, thereby shortening the flowering period (Neiddu *et al.*, 1990). Relatively less number of days taken from bud break to full bloom in 1991 in most of the cultivars and selections are indicative of the above contention. In 1990, the overall blooming was earlier in all the genotypes; early blooming genotypes flowered 3-4 weeks earlier while late blooming genotypes flowered 1-4 weeks earlier than they did in 1991. Almost the same trend for early and late flowering cultivars has been reported earlier (Hill *et al.*. 1985). The latest flowering entry

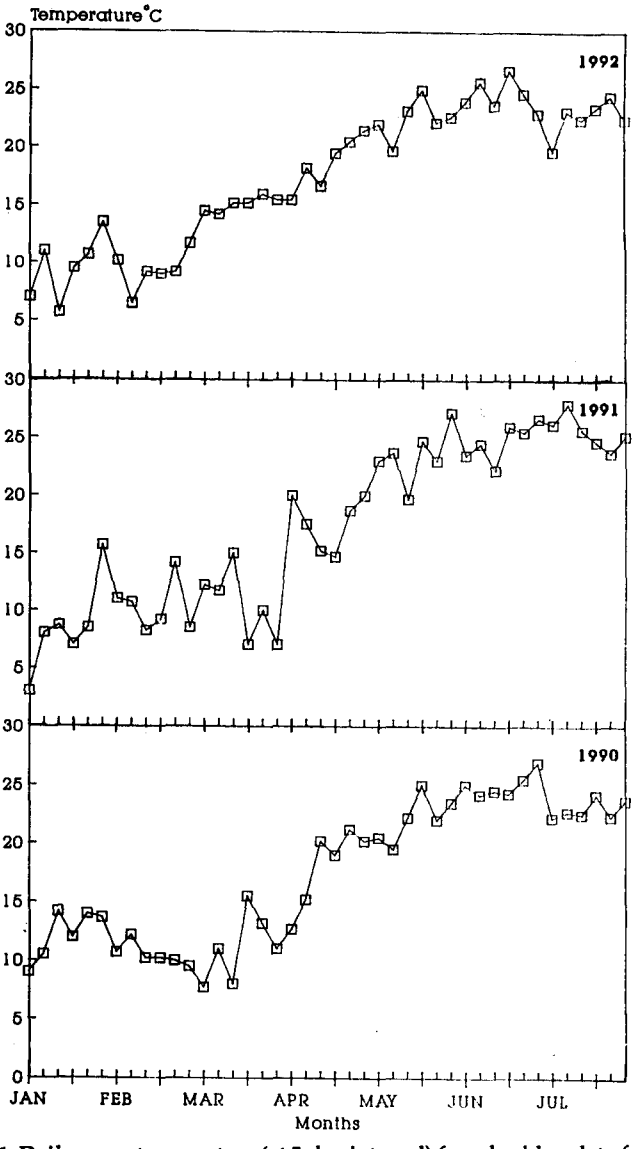

Fig. 1. Daily mean temperature (at 5-day interval) from bud-break to fruit maturation

Tree No. 125 did not vary significantly in its trend over the years. This may be due to resistance of this particular genotype to frequent winter thaws whereby the time of flowering is advanced by several weeks as a result of sudden changes in temperature (Denisov, 1988). The data in Table 1 indicated that date of bud break and the date of full bloom, showed similar trends and hence can be considered a selection criterion for late flowering as pointed out earlier by Tydeman (1964) for apples.

Fruit maturation in almond as judged by the onset of hull splitting also depicted a great deal of variation in the germplasm under study (Table 1) further implying that this trait is cultivar specific (Kester and Asay, 1975). The year to year variation in days taken by fruits to mature is partly attributed to fluctuations in temperatures, which advanced the date of flowering (full bloom) by two to three weeks in 1990 and partly due to varied heat requirement (Ratigan and Hill, 1988). The different maturation times of similar genotypes over the seasons may be due to varied number of degree days received during the three years recokned from date of full bloom to harvest time as has been reported for other stone fruit crops. This gets the support from the findings of Kester *et al.* (1977) who reported that fruit maturity in almond shows large genotype × year interaction. In almonds, there is no set association between the time of flowering and fruit ripening (Rugini and Monastra, 1991), yet cultivars namely Ferralise, Distomou Viotias and some wild forms (*Amygdalus arabica* and *Amygdalus spinosissima*) are reported to be late blooming as well as early maturing (Denisov, 1988; Kester *et al.*, 1990). In our study, Nikitskyi, Prianyi, Tree No. 2, Tree No. 125 and White Brandis (Table 2) have been found to be late flowering as well as early maturing than 'Non Pareil'. The five selections spotted out as mentioned above hold promise for overcoming the major environmental problems of almond cultivation in the north-western Himalayas.

Table 2 : Almond cultivars/selections showing late flowering and early maturity

S. No.	Cultivar/ selection	Date of full bloom (days after cv.Non Pareil)				Date of hull dehiscence (days before cv. Non Pareil)			
		1990	1991	1992	Mean	1990	1991	1992	Mean
1.	Nikitskyi	10.0	9.0	11.0	10.0	19.0	17.0	11.0	15.6
2.	Prianyi	12.0	12.0	16.0	13.3	8.0	17.0	19.0	14.6
3.	Tree No. 2	26.0	11.0	20.0	19.0	8.0	14.0	24.0	15.3
4.	Tree No. 125	38.0	17.0	16.0	27.0	17.0	28.0	19.0	21.3
5.	White Brandis	16.0	16.0	18.0	16.7	17.0	9.0	11.0	12.3

It is concluded that late flowering and early maturing selections may be tested under different agro-climatic conditions for determining their suitability as commercial cultivars or may be used as parents in breeding programme aimed at developing improved cultivars possessing these characteristics.

REFERENCES

Agabbio, M. and S. Ortu. 1974. Studies on the flowering biology of various almond cultivars. *Rivista della Ortoflorofruitticoltura Italiana* **58**(5): 315-329 (cf. *Hort. Abstr.* **45**: 7309)

Alston, F.H. and P.Spiegel Roy. 1985. Fruit tree breeding: Strategies, achievements and constraints. *In*: Attributes of Trees as Crop Plants, M.G.R. Cannel and J.E. Jackson, (Eds.), Titus Wilson & Son Ltd., Kendel, Cumbria, Great Britain, p 49-67.

Aruleskar, S., D.E. Parfitt and D.E. Kester. 1986. Comparison of isozyme variability in peach and almond cultivars. *J. Hered.* **77**(4): 272-274.

Denisov, V.P. 1988. Almond genetic sources in the USSR and their use in production and flowering. *Acta Hort.* **224**: 299-306.

Felipe, A. 1977. Flowering time of almond cultivars. *Anales del Institute Nacional de Investigaciones Agrarias, production Vegetal.* **7**: 105-112 (cf. *Hort. Abstr.* **48**: 7826),

Hill, S.J., D.W. Stephenson and B.K. Taylor. 1985. Almond pollination studies: Pollen production and viability, flower emergence and cross-pollination tests. *Aust. J. Exp. Agric.* **25**: 697-704.

Kester, D.E. and R.N. Asay. 1975. Almonds *In*: Advances in Fruit Breeding: J. Janick and J.N. Moore (Eds.). Purdue University Press, West Lafayette, Indiana, USA. p 387-419.

Kester, D.E., P.E. Hansche, V. Beres and R.N. Asay. 1977. Variance components and heritability of nut and kernel traits in almond. *J. Amer. Soc. Hort. Sci.* **102**(3): 264-266.

Kester, D.E., T.M. Gradziel and C.Grasselly. 1990. Almonds (Prunus). *In*: Genetic Resources of Temperate Fruit and Nut Crops. J.N. Moore and J.R. Ballington Jr. (Eds.) *Acta Hort.* **290**: 701-758.

Neiddu, G., F. Giunta and M.Mulas. 1990. Influence of postdormant temperatures on bloom time of four almond cultivars. *Scient. Hort.* **43**(1-2): 63-67.

Rattigan, K. and S.J. Hill. 1988. Relationship between temperature and flowering in almond: effect of location. *Aust. J. Expt. Agri.* **27**(6): 905-908.

Rough, D., D.E. Kester and W. Micke. 1978. Evaluation and selection of current varieties. *In*: Almond Orchard Management. W.Micke and D.E. Kester (Eds.). Agricultural Sciences Publications, Barkeley, California, USA. p 21-24.

Rugini, E. and F.Monastra. 1991. Almonds. *In* Temperate Fruits. S.K. Mitra, D.S. Rathore and T.K. Bose (Eds.). Hort. and Allied Publishers, Calcutta, India.

Tydeman, H.M. 1964. The relation between time of leaf break and of flowering in seedling apples. *Rep. E. Malling Res. Stn.* 1963, p 70-72.