Gartenbauwissenschaft, **67** (2). S. 61–64, 2002, ISSN 0016–478X.

The Effects of Temperature on Pollen Germination and Pollen Tube Growth of Apricot and Sweet Cherry

Einfluss der Temperatur auf die Pollenkeimung und das Pollenschlauchwachstum bei Aprikosen und Süßkirschen

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Summary

This study was carried out in order to determine the effects of different temperatures (5, 10, 15 and 20 °C) on the pollen germination and tube growth of apricot 'Hasanbey', 'Mahmudun Eriği', 'Karacabey', 'Şalak' and 'Şekerpare' and sweet cherry 'Napoleon', 'Salihli' and 'Sapıkısa' at 1.5 % agar + 15 % sucrose medium. Temperature affected pollen germination and pollen tube growth in all cultivars. The lowest rate of pollen germination and pollen tube length of apricot and cherry were obtained at 5 °C. The best results related with pollen germination and pollen tube growth in these cultivars, except 'Şalak', were observed at 15 °C and 20 °C. However, the rate of pollen germination and tube length at 5 °C were higher in some cultivars than the others. Therefore, these cultivars could be well adapted to the low temperatures during pollination periods.

Zusammenfassung

In dieser Arbeit wurde der Einfluss verschiedener Temperaturen (5, 10, 15 und 20 °C) auf die Pollenkeimung und das Pollenschlauchwachstum bei den fünf Aprikosensorten 'Hasanbey', 'Mahmudun Eriği', 'Karacabey', 'Şalak' und 'Şakerpare' und den drei Süßkirschensorten 'Napoleon', 'Salihli' und 'Sapıkısa' untersucht. Die Keimungen erfolgten auf Medium mit 1.5 % Agar und 15 % Saccharose. Die Keimung der Pollenkörner und das Pollenschlauchwachstum wurden von der Temperatur beeinflusst. Bei Aprikosen und Kirschen waren bei 5 °C die niedrigsten Keimraten von Pollenkörnern und das geringste Pollenschlauchwachstum zu beobachten. Bei Temperaturen von 15 und 20 °C wurden bei allen Sorten außer 'Şalak' gute Ergebnisse hinsichtlich Pollenkeimung und Pollenschlauchwachstums festgestellt. Bei 5 °C traten bei einigen Sorten eine im Vergleich höhere Pollenkeimung und stärkeres Pollenschlauchwachstum als bei den anderen Sorten auf. Aus diesem Grund wird vermutet, dass diese Sorten eine gute Adaptation auf niedrige Temperaturen in der Blütezeit zeigen.

Introduction

The most important goal for fruit growers is achieving high yields in fruit culture. For this sufficient fruit setting is important. Pollination and fertilization are most important factors affecting fruit setting. Genetic and ecological conditions also affect pollination and fertilization in fruit culture.

Most apricot cultivars are commonly fertile and some European apricot cultivars are usually non selffertile (MEHLENBACHER et al. 1991). However, almost all sweet cherry cultivars are non selffertile except for a few new cultivars (ÖZBEK 1978; MEHLENBACHER et al. 1991). For this reason, pollination is highly necessary for fruit species having fertilization problems. Properties of pollen in selecting variety are wellknown.

Apricot is an early flowering fruit species. Ecological conditions affect pollination and fertilization during early spring and fruit setting is lower due to abnormal ecological conditions. Usually, pollen germination is negatively affected by high or low ambient temperatures (ÖZBEK 1989; WESTWOOD 1978). Also, pollination and pollen germination are affected by rainfall during flowering.

Temperature requirement for the pollen germination and pollen tube growth in fruit species and cultivars may differ in early or late flowering period. For example, the desired temperature to optimal pollen germination of walnut was lower in early flowering varieties than late flowering walnut counterparts (LUZA et al. 1987). Furthermore, almond pollens could germinate even at 5 °C but the rate of pollen germination was considerably low (GODINI et al. 1987). However, even a germination temperature of 10 °C was not enough for pear pollen (MELLENTHIN et al. 1972). Additionally, EGEA et al. (1992) observed that pollen germination and tube growth speed was low at 5 °C for apricot varieties and the germination rate increased with increasing temperature.

Extreme temperatures during the flowering period, not only impede pollen germination and tube growth but also reduce bee activities, which is of an important role in pollination (VASILIAKIS and PORLINGIS 1984). Consequently, lowered bee activity may results in inadequate pollination and lowered fruitset.

The objective of this study was to determine the effects of different temperatures on pollen germination and pollentube growth rate of different apricot and sweet cherry cultivars. In order to provide information for cultivar selection with respect to temperature.

Material and Methods

The pollen used in this study were collected from five different mature (15–20 age) apricot, i.e. 'Hasanbey', 'Mahmudun Eriği', 'Karacabey', 'Şalak' and 'Şekerpare' and three sweet cherry varieties namely 'Napoleon', 'Salihli' and 'Sapıkısa' grown in Çoruh Valley-Turkey in 1998. Flowers of all cultivars were collected at the baloon stage and their anthers stored over night in the laboratory. Previous research indicated that a medium of 15 % sucrose and 1.5 % agar was suitable for pollen germination of these cvs. (BOLAT and PIRLAK 1999a). The plates included 10 ml of the medium, and the pollen grains were spreaded over the medium, then placed into different growth chambers adjusted to 5, 10, 15 and 20 °C for 24 h under dark conditions. For each treatment, six plates were used and six different microscobic area were randomly observed to count germinated pollen. All observations of these plates were made at X 100 magnification using a light microscope. In addition, the lengths of the pollen tubes for each treatment in six areas were measured using an ocular micrometer in a light microscope at the end of the 24 h, and chloroform was applied to halt tube growth (BOLAT and PIRLAK 1999b; EGEA et al. 1992). The experimental model was a randomized block design. Duncan's Multiple Range test was used to compare the means. The counts of pollen germination were subjected to arcsin square root transformation before the statistical analysis (DOWDY and WEARDEN 1983).

Results and Discussion

Temperature significantly affected pollen germination in apricot and sweet cherry. Differences of values of pollen germination in cultivars were statistically significant at all temperatures (Table 1).

Pollen germination rate at 5 °C was 23.11–41.61 % in apricot and 24.11–37.46 % in sweet cherry. The highest pollen germination rates were observed in 'Hasanbey', 'Mahmudun Eriği' and 'Şalak' cvs., respectively. Pollen germination rates were lower by 30 % in the other two cvs. Pollen germination rates at 5 °C were 36–37 % in 'Napoleon' and 'Salihli' and 30 % in 'Sapıkısa' sweet cherry cvs. The lowest degree for pollen germination temperature, which was 5 °C, was not appropriate for pollen germination. Pollen germination is generally an

Table 1. Effects of different temperatures on the rate of pollen germination of apricot and sweet cherry cultivars.
Einfluss unterschiedlicher Temperaturen auf die Pollenkeimung bei Aprikosen und Süßkirschen.

Species and cultivars	**Pollen germination rates (%)**			
	Temperatures (°C)			
	5 °C*	**10 °C**	**15 °C**	**20 °C**
Apricot				
'Hasanbey'	41.61 a	58.28 b	63.51 a	70.88 b
'M. Eriği'	37.73 a	54.35 c	58.38 b	79.16 a
'Karacabey'	25.56 c	43.93 d	40.83 c	62.38 c
'Şalak'	32.28 b	66.21 a	57.70 b	59.50 c
'Şekerpare'	23.11 c	43.01 d	55.61 b	64.11 c
$D_{5\%}$	***3.90***	***3.73***	***4.69***	***5.11***
Sweet cherry				
'Napoleon'	36.88 a	52.78 b	56.58 b	65.88 b
'Salihli'	37.46 a	60.68 a	75.16 a	70.95 a
'Sapıkısa'	24.11 b	36.75 c	42.21 c	55.28 c
$D_{5\%}$	***5.29***	***8.97***	***4.94***	***2.99***

* Mean separation within columns by Duncan's Multiple test at 0.05 level.

Table 2. Effects of different temperature on pollen tube growth of apricot and sweet cherry cultivars.
Einfluß unterschiedlicher Temperaturen auf das Pollenschlauchwachstum bei Aprikosen und Süßkirschen

Species and cultivars	**Pollen tube lenght (µm)**			
	Temperatures (°C)			
	5 °C*	**10 °C**	**15 °C**	**20 °C**
Apricot				
'Hasanbey'	114 ab	257 b	260	288
'M. Eriği'	89 b	265 b	253	298
'Karacabey'	37 c	254 b	218	288
'Şalak'	137 a	382 a	268	269
'Şekerpare'	142 a	248 b	264	299
$D_{5\%}$	***40***	***46***	–	–
Sweet cherry				
'Napoleon'	77 ab	315 a	328 b	354
'Salihli'	58 b	335 a	423 a	307
'Sapıkısa'	100 a	251 b	230 c	275
$D_{5\%}$	***31.6***	***32.5***	***45.2***	–

* Mean separation within columns by Duncan's Multiple test at 0.05 level.

advantegous for adequate fruit setting. Similar results were reported by GARCIA and EGEA (1979) in almond, VACHUN (1981) in apricot and CEROVIC and RUZIC (1992) in sour cherry in their studies.

Lower ambient temperature in flowering period in spring causes inadequate fertilization in fruit species for lower temperatures affecting pollen germination (CEROVIC and RUZIC 1992; EGEA et al. 1992; VASILIAKIS and PORLINGIS 1984). Also, pollen germination rates at 5 °C were lower than 30 % which is minimum value in 'Karacabey' and 'Şekerpare' apricot cultivars and 'Sapıkısa' sweet cherry cultivar (ÖZBEK 1978, 1989). But, cultivars achieving high germination at 5 °C, could resistant low temperatures because of early flowering. 'Hasanbey' and 'Mahmudun Eriği' apricot and 'Napoleon' and 'Salihli' sweet cherry had an advantage for cool areas owing to their pollen germination rates at low temperatures.

The cultivars showed statistically significant differences in pollen germination rates at 10, 15 and 20 °C (Table 1). The pollen germination rates at these temperatures were 43.01, 66.21, 36.75 and 60.68 % at 10 °C, and 40.83, 63.51, 42.71 and 75.16 % at 15 °C, and 59.50, 79.16, 55.28 and 70.95 % at 20 °C, respectively. The highest pollen germination rates for apricot were 'Şalak' at 10 °C, 'Hasanbey' at 15 °C and 'Mahmudun Eriği' at 20 °C; and for sweet cherry the highest rates were from 'Salihli' at all temperatures. Pollen germination rates increased with increasing temperatures above 5 °C in all cvs. studied. Treatments of 15 and 20 °C produced the highest pollen germination rates in both apricot and sweet cherry cvs., except for 'Şalak' cultivar. Most of the cvs. produced higher pollen germination rates at temperatures above 10 °C, with the rates increasing as temperature increased. Fruit species and cvs. may have higher pollen germination rates and extension of temperature ranges could be an indicator of the ability of their wider geographical adaptation in terms of the requirements of temperatures in fertilization. VACHUN (1981) suggested that optimum temperature required for pollen germination in apricot was about 15 °C, and that temperatures above 25 °C caused a decrease in pollen germination rates. Also, EGEA et al. (1992) indicated that temperatures between 15 and 20 °C produced the highest pollen germination rates with slight differences for the cultivars. The results of this study was nearly identical to that reported by VACHUN (1981) and EGEA et al. (1992) and the small variations observed in our study may have been due to genotypic effects.

The effects of temperatures on pollen tube length were found different owing to cultivars investigated. While pollen tube length at 5 and 10 °C was statistically different in apricot, the cvs. were in the same groups at 15 and 20 °C. In addition, while pollen tube length differences between the cvs. were significant at 5 °C, it was not significant at 10, 15 and 20 °C. Pollen tube length showed differences between 37–142 µm at 5 °C in apricot (Table 2). Under these conditions of minimum ambient temperature, the pollen tube length of 'Şekerpare' and 'Şalak' apricot cvs. was considerably higher than the others. Also, pollen tube lengths in sweet cherry was the shortest in 'Salihli' (58 µm) and longest in 'Sapıkısa' (100 µm) at 5 °C. A temperature of 5 °C was probably not high enough for optimal pollen tube growth in both species. However, similar data were obtained during the other studies in apricot and sour cherry (CEROVIC and RUZIC 1992; EGEA et al. 1992). As in germination, cultivars showing good performance of pollen tube growth at low temperatures, were probably less affected by ambient temperatures in spring.

The pollen tube length significantly increased with temperatures up to 10 °C. Also, this increasing rate reached three times in some cvs. At this temperature the longest pollen tube length was in apricot cv 'Şalak'. The pollen tube growth was between 125 µm ('Sapıkısa') and 335 µm ('Salihli') in sweet cherry at 10 °C.

Pollen tube length increased at 15 and 20 °C compared with lower temperatures, but slightly lower in apricot than that of sweet cherry. The highest pollen tube length were observed at 15 and 20 °C for all apricot and sweet cherry cvs. except for 'Şalak' apricot cultivar studied in this research. Many researchers examining the effects of temperature on pollen germination and tube growth in different fruit species reported that species and cultivars may show variability for the pollen germination and tube growth among fruit trees (CEROVIC and RUZIC 1992; EGEA et al. 1992; GARCIA and EGEA 1979; GODINI et al. 1987; KIM et al. 1995; LUZA et al. 1987; MELLENTHIN et al. 1972). Furthermore, CEROVIC and RUZIC (1992) reported that optimum pollen tube growth in sour cherry was at 15–20 °C, but the lowest temperature to reach ovary was 5–10 °C. Also, some studies reported that pollen tube growth increase with the temperature, but effective pollination period could decrease due to the decrease in functional stage of ovule (POSTWEILLER et al. 1985).

In conclusion, different temperature treatments were effective on pollen germination and tube growth of apricot and sweet cherry. However, pollen germination and tube growth varied at low temperatures, and some cvs. had better performance compared to the others in response to temperatures. The best results at pollen germination and tube growth were observed at 15 and 20 °C for apricot and sweet cherry cvs. except 'Şalak' apricot cv. However, the rate of pollen germination and tube length at 5 °C were higher in some cultivars than the others. Therefore, these cultivars could be well adapted to the low temperatures during pollination periods.

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Eingereicht: 11.09.01/10.12.01

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