

THE EFFECT OF TEMPERATURE ON POLLEN VIABILITY AND GERMINATION CAPACITY OF SOME STRAWBERRY AND BLACKBERRY CULTIVARS

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Abstract

This study is important for determining the different temperatures' effect (4, 18 and 24 ° C) on pollen germination and its viability for some strawberry ('Premial', 'Clery', 'Real', 'Mira', 'Alba', 'Idea', 'Elsanta', 'Onebor', 'Benton') and blackberry ('Lock Tay', 'Williams', 'Arapaho', 'Black Satin', 'Navaho', 'Hull') cultivars. The pollen viability was determined through the acetic carmine staining method. The fertile pollen was colored in red, and the sterile one in pink or it remained colorless (1.5 g agar + 15 g sucrose + 0.01 g boric acid in 100 ml distilled water), incubated 6-8 hours at all three temperatures and relative humidity 70-90%. The temperature affected the pollen germination and the cultivars germination capacity. The lowest pollen germination rate was obtained at 4 ° C (between 19.4 1% and 54.72% for strawberry and 9.10% and 24.35% for blackberry). The best strawberry results were observed at 18 ° C (57.97% in the Mira cultivar), respectively 24 ° C (56.77% in the Elsanta cultivar) and at 18 ° C (50.13% Williams variety), respectively 24 ° C (55.55% Arapaho variety).

Keywords: *Fragaria x ananassa*, germination, *Rubus sp.*, viability.

1. Introduction

The strawberry (*Fragaria × ananassa* Duch.) and the blackberry (*Rubus sp.*) are berry species with economic and food interest due to their high production potential. At present, there are approx. 600 varieties of strawberry spread over a wide geographical area (Dadu et al., 2019) and over 60 varieties of blackberry bred between 1985-2005 (Clark and Finn, 2005). The plant yield's quality and quantity depend on pollen viability and germination capacity. The efficiency of pollination is one of the conditions to get high yields, because pollen viability and germination capacity vary according to species, variety and environmental factors (Bolat and Pirlak, 1999; Shivanna, 1985; Cociu and al., 1997; Budan and Grădinariu, 2000; Butac and al., 2007).

The temperature is one of the most important climatic factors alongside with light and water which determine fundamental processes (photosynthesis, respiration, perspiration, water absorption, etc, Hiratsuka and Tomita, 1989; Wilkins and Thorogood, 1992; Hedhly et al., 2005). The influence of

air temperature on the plant is closely linked to the influence of soil temperature. The growth and the development of plants depend on temperature. In the specialized literature talking about the rate of growth as being: the increase per unit of time, and the development speed is defined as the inverse of the time needed to move from one development stage to the next, to cover a development phase (Petrişor, 2012).

Because the recent years climate changes affect the beginning of tree and berry growing season, in this study we have proposed to research on the viability and germination capacity of pollen in some strawberry and blackberry varieties, as well as the effect of temperature on these parameters in order to establish the value of varieties as pollinators and selection of the most valuable genitors for the new varieties breeding.

2. MATERIAL AND METHODS

Between 2018-2019, at the Research Institute for fruit growing Piteşti, Mărăcineni the pollen viability and capacity germination of 12 strawberry genotypes ('Alba', 'Benton', 'Cambridge Favourite', 'Clery', 'Elsanta', 'Honeoye', 'Idea', 'Premial', 'Onebor', 'Mira', 'Miss', 'Record') and 6 blackberry genotypes ('Lock Tay', 'Wilson's', 'Arapaho', 'Black Satin', 'Navaho' and 'Hull') were studied.

Flower buttons were collected from the open field and their anthers were extracted in Petri dishes, which were labeled and allowed to dry at 22-24°C. After 36-48 hours, anthers have cracked and the pollen has released.

Pollen viability was determined by the staining method with acetic carmine. Fertile pollen was stained in carmine red and sterile pollen was stained in pink or it remained colourless (Cociu, 1989; Botu, 1997).

Pollen germination capacity was determined "in vitro" by cultivating on solid nutrient medium (1.5 g agar, 15.0 g sucrose, 0.01 g boric acid in 100 ml distilled water) and with relative the humidity of 70-90% and the temperature of 4°C, 18°C and 24°C, climate accidents were counted the berry during flowering. The sprouted grains and ungerminated pollen grains at least 10-15 microscopic fields and the percentage has been calculated. MC-5 with the objective ×20 was used for reading.

The experimental data were classified using the MS Excel facilities their statistical processing was carried out using the Duncan test.

3. RESULTS AND DISCUSSIONS

The evaluation of pollen viability and germination capacity data in strawberry and blackberry species showed statistically assured differences.

The viability percentage of pollen in strawberry ranged from 28.5% ('Idea') to 86.68% ('Clery'). More than 50% was registered at the varieties 'Cambridge Favourite', 'Elsanta', 'Queen Elisa', 'Mira', 'Onebor', 'Premial' and 'Real' (fig. 1).

Regarding the pollen germination capacity, the genotypes have distinguished to three temperature values as follows: the germination capacity percentage at 4°C was between 19.14 % ('Clery') and 54.72 % ('Real') (fig. 2). All other genotypes have recorded values below 54.72%, thus the varieties 'Onebor' and 'Mira' were 29.94% and 35.64% (fig. 3).

Increasing values have been recorded in the 'Elsanta' genotypes with a value of 44.88% followed by the 'Alba' (45.55%), 'Benton' (47.00%) and 'Idea' (48.66%, fig. 2). For the genotypes studied in this temperature variation the percentage of germination capacity was less than 50%, except for 'Premial' and 'Real' genotypes which have recorded 52.65% and 54.72% respectively fig. 3).

At a temperature of 18°C the highest percentage was recorded by the variety 'Mira' (57.97%) and the lowest value was recorded by the variety 'Alba' (26.80%). A minor increase in the germination rate of the genotypes is observed, most of which have a germination capacity value below 50 % (fig.4).

At a temperature of 24°C, only 4 varieties out of those taken into the in recent study, recorded a percentage value greater 40% (the 'Onebor' 40.16%, the 'Benton' 42.89%, the 'Clery' 53.25% variety and the 'Elsanta' 56.77% variety), the others have recorded a percentage value between 17.52% and 34.32% (fig. 5).

At the blackberry, the percentage of pollen viability was recordered with high values, over 74.83% for all the studied varieties.

The variety 'Arapaho' registered the value 74.83% followed by 'Black Satin', 'Hull', 'Navaho'. The highest values have registered in the varieties 'Loch Tay' and 'Willson's' (82.51% and 89.69% respectively) (fig. 7).

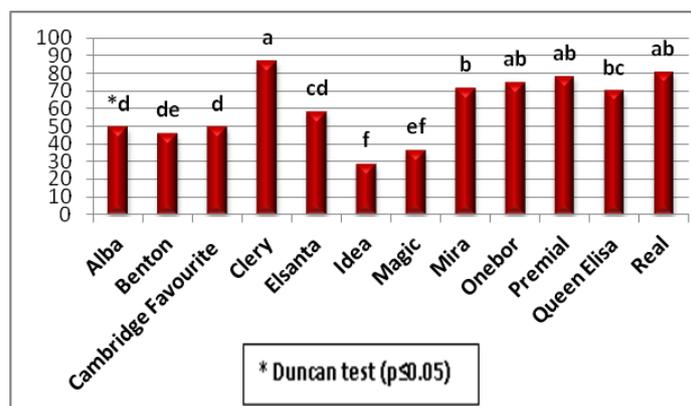


Figure 1. The strawberry pollen viability, value for the years 2018-2019

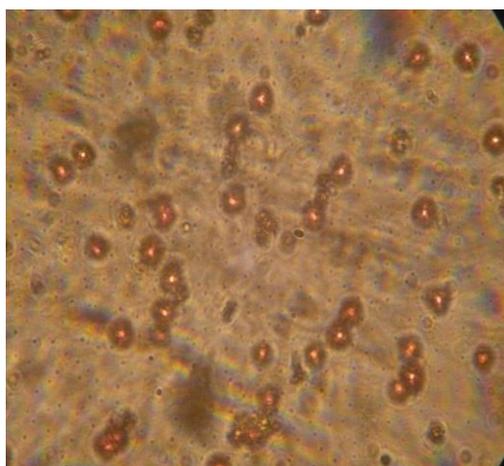


Figure 2. The strawberry pollen viability

At the blackberry, the pollen germination capacity at 4 ° C registered low values between 9.10% to the variety 'Arapaho' and 24.35% to the variety 'Navaho' (fig. 9). At 18°C, the highest value was recorded to the variety 'Willson's' (50.13%), and the lowest to the variety 'Loch Tay' (6.95%). The other recorded varieties values between 27.01% and 30.92% (fig. 10).

The highest values were recorded at 24°C, between 14.51% ('Loch Tay') and 55.55% ('Arapaho'). The recorded values in the other varieties ranged from 29.62% to 46.64% (fig. 11).

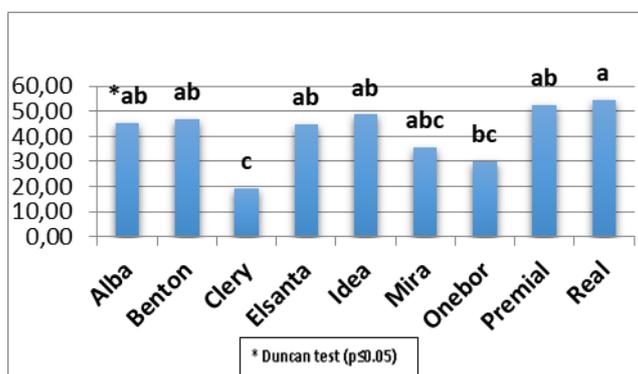


Figure 3. The pollen germination capacity at 4°C

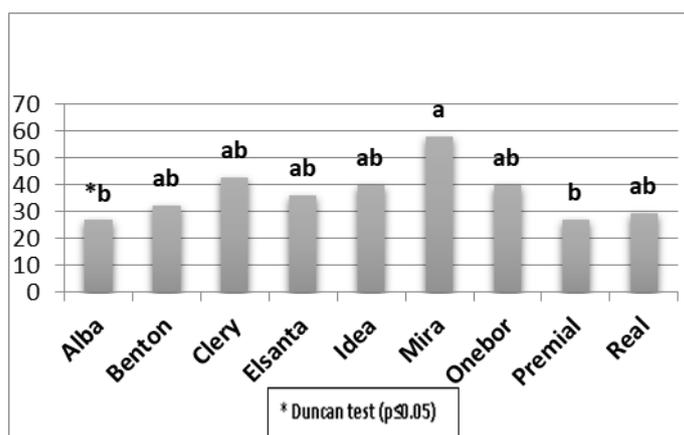


Figure 4. The pollen germination capacity at 18°C

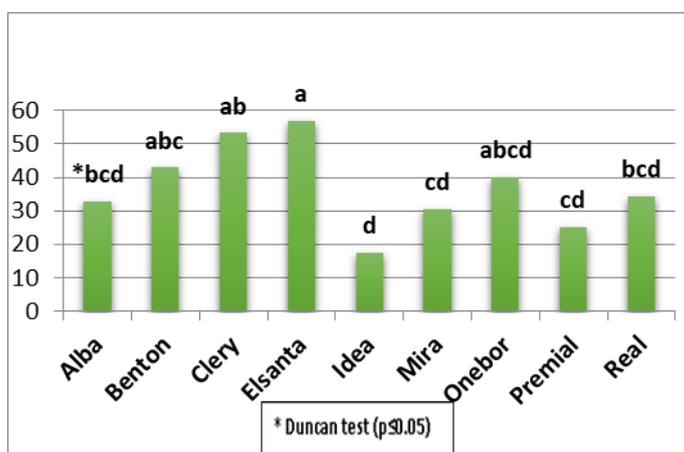


Figure 5. The pollen germination capacity at 24°C

The temperature of 24 ° C is favorable for the pollen germination capacity of the 6 varieties of blackberries studied. Also, the varieties 'Willson's' and 'Arapaho' are recommended as potential

parents in the breeding programme works of improvement due to the high values they registered at temperatures of 24°C and 18°C.

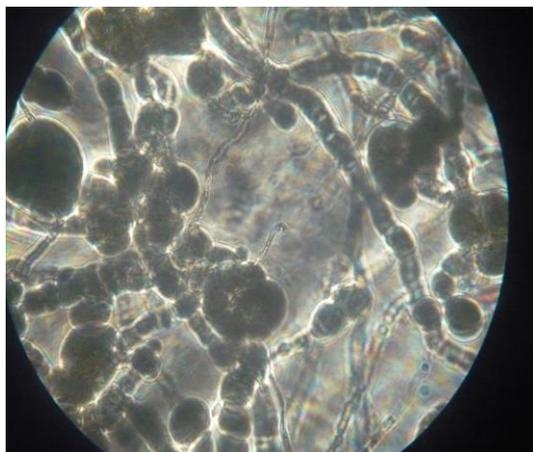


Figure 6. The pollen germination capacity at 24°C

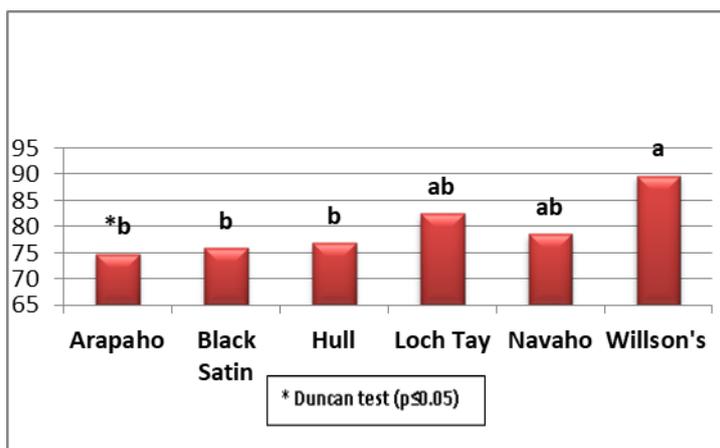


Figure 7. The blackberry pollen viability, value for the years 2018-2019



Figure 8. The blackberry pollen viability

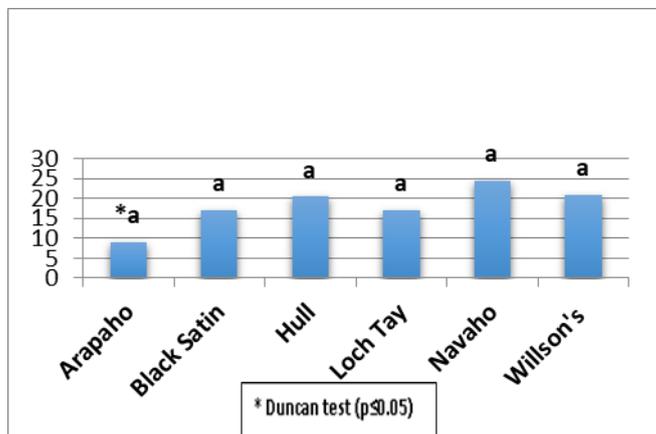


Figure 9. The pollen germination capacity at 4°C

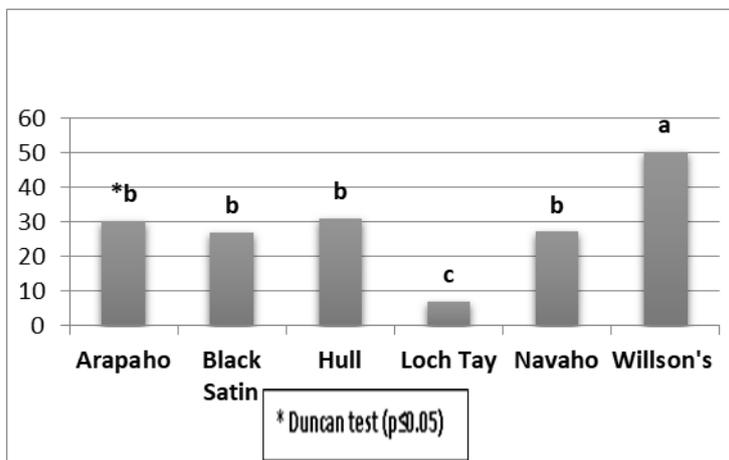


Figure 10. The pollen germination capacity at 18°C

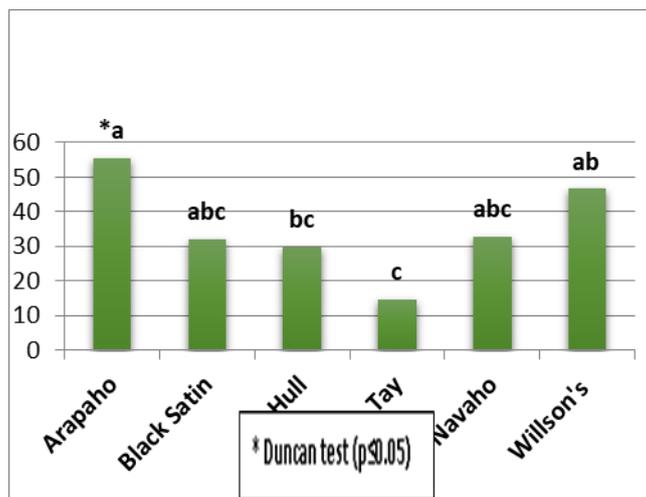


Figure 11. The pollen germination capacity at 24°C

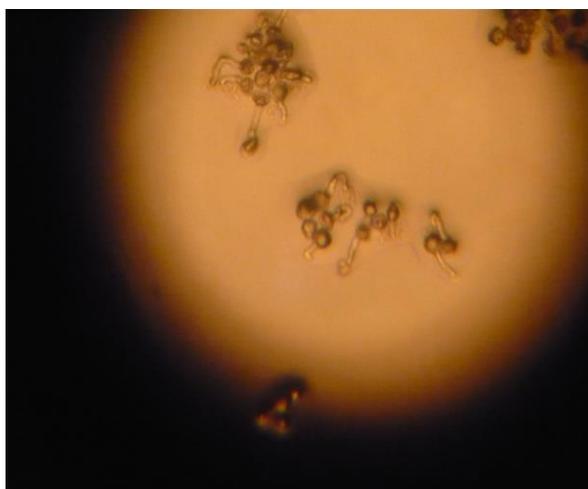


Figure 12. The pollen germination capacity at 24°C

4. CONCLUSIONS

At most species of trees and fruit berry a percentage of pollen germination of 10-15% ensures economical productions.

At strawberry, the varieties 'Clery', 'Real', 'Premial', 'Mira', 'Elsanta' were noted outstanding their high values regarding pollen the viability and the germination capacity.

At blackberry, the varieties 'Loch Tay', 'Navaho', 'Arapaho' and 'Willson's' recorded high levels of viability and germination at temperatures of 4°C, 18°C and 24°C.

From the obtained results it can be observed that both, strawberry and blackberry species, had the pollen germination capacity of high values, that is 19% even at 4°C.

These varieties of strawberry and blackberry can be recommended both as potential parents in future breeding programs as well as for their extension in commercial cultures.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

- Bolat, I., Pirlak, L. (1999), An Investigation on Pollen Viability, Germination and Tube Growth in Some Stone Fruits. Tr. J. of Agriculture and Forestry.
- Budan S., Grădinaru G., (2000), Cireșul [The cherry tree] Edit. 'Ion Ionescu de la Brad', Iași.
- Butac, M., Militaru M., Braniște N., Budan S., (2007), Studii privind fertilitatea și capacitatea de germinare a polenului la soiuri folosite ca genitori potențiali în lucrările de ameliorare la speciile măr, prun și cireș [Studies on the fertility and germination capacity of pollen in varieties used as potential parents in breeding works for apple, plum and cherry species, CEEEX 20 Project – WP].
- Chira E. (1963), The pollen sterility of scots and black pines (*Pinus silvestris* L., *P. nigra* Arnold) Lesn Aopis 9 Clark J., Dept. of Horticulture, University of Arkansas, USA, Finn C., Horticultural crops Research Laboratory, Oregon, USA, New trends in blackberry breeding.
- Cociu V., Botu I., Minoiu N., Pasc I., Modoran I., (1997), Prunul [The plum tree] Ed. Conphys.
- Dadu C., Donea V., Roșca I., Bodrug E., Sava P., Donea V.jr, Grati V. (2019). Arbori și arbuști fructiferi [The trees and berries].
- Hedhly, A., Hormaza, J.I., Herrero, M. (2005). The effect of temperature on pollen germination, pollen tube growth, and stigmatic receptivity in peach. Plant Biology.

- Hiratsuka, S., E. Takahashi & N. Hirata (1982). Pollen tube growth in detached styles of Japanese pear, *Pyrus serotina* Rehd. *J Palynology* 18.
- Petrișor G. Monitorizarea dinamicii factorilor de mediu și studiul influenței acestora asupra creșterii și fructificării mărului în sistemul superintensiv de cultură [Monitoring the dynamics of environmental factors and studying their influence on apple growth and fruiting in the super-intensive cultivation system].
- Shivanna KR and Johri BM (1985). *The angiosperm pollen: structure and function*. Wiley Eastern, New Dehli.
- Thorogood D. & M.D. Hayward, 1991. The genetic control of self-compatibility in an inbred line of *Lolium perenne* L. *Heredity*.
- Wilkins, P.W. (1991). Recent yield improvements through recurrent half-sib family selection in perennial ryegrass. *Proc. Eucarpia Fodder Crops Sect. for 1990, Wageningen*.