sciendo

ASN, Vol. 9, No 1, Pages 65–73, 2022

Acta Scientifica Naturalis

Former Annual of Konstantin Preslavsky University of Shumen: Chemistry, Physics, Biology, Geography

Journal homepage: https://content.sciendo.com/view/journals/asn/asn-overview.xml

Late spring frost effect on the reproductive traits of late nectarine cultivar-rootstock combinations (*Prunus persica* var. *nucipersica*)

Dimitar Vasilev

Departament of Plant Protection, Botany and Zoology, Faculty of Natural Sciences, Konstantin Preslavsky University of Shumen, 115 Universitetska Str., 9700 Shumen, Bulgaria

Abstract: *The study was conducted during the period 2017 – 2018 at the Agricultural Experimental Station – Khan Krum, Shumen region. The experimental orchard was established in the spring of 2011. The following nectarine cultivars were studied: Fantasia, Golden Grand, Morsiani 51, Cassiopeia and Fairlane grafted on a seedling rootstock (Elberta) and clonal GF 677, as well as the frost – resistant dessert-type cultivar Redhaven. In the period 2017 – 2018, negative temperatures were reported, at the end of March and at the beginning of April (-3.6°C and -5.0 °C respectively)which coincided with the full blooming phenological phase; as a result of which the blossoms froze (76 – 100%). A relatively low percentage of frozen blossoms was observed in cultivars grafted on rootstock GF 677. In 2017, the blossom damage was relatively low and yields were obtained, unlike in 2018. Negative spring temperatures had a negative impact on productivity if blossom damage percentage exceeded 80%.*

Keywords: nectarines, cultivars, late spring frost, *Prunus persica* var. *nucipersica*, yield

Introduction

Spring frost is one of the restrictive aspects for achieving good harvest and profitable fruit crop yields in our country. This is a challenge for early blooming peach and nectarine growers in our country. The fruit yield obtained from them is neither persistent nor predictable and that is a real problem. Some authors [2, 7]

Corresponding author: d.v.dimitrov@shu.bg
Full Paper
DOI: 10.2478/asn-2022-0007
©2022 Dimitar Vasilev, published by Sciendo
This work is licensed under the Creative Commons Attribution 3.0 Public License

mention that climate change, observed over the last twenty years, is a limiting factor for obtaining regular and quality fruit crop yields. Climatic change is a factor affecting fruit physiological disorders and yields.

Various authors researched the influence of abiotic factors on growth and fruiting. Earth's climate change affects blossoms and knots freeze which is often observed in stone fruit species [14, 15, 16, 17]. Some authors [17] noticed that there was moderately early blossoming in cultivars Golden Grand, Morsiani 51, Cassiopeia and Fairlane. In this regard [1, 5] dessert-type cultivar Redhaven is determined as medium early cultivar, and nectarine cultivar Fantasia as early blossoming cultivar. The research showed that both cultivars had good resistance to low winter temperatures.

The conditions for fruit trees' growth and development are affected by extreme meteorological phenomena such as drought, floods, spring frosts, hail. In addition, hydrothermal conditions have a large share in the formation of fruit crop yields [7].

Some authors concluded that late spring frosts happening three weeks after blooming with sepals falling off, had a negative effect on blossoms and the expected fruit yield [3].

A number of authors have studied the relationship between spring frost and peach and nectarine phenological phase [4, 12]. Other researchers [11] have determined that phenological and pomological characteristics are important for introduced nectarine cultivars adaptation. Frost resistance of blossoms is determined by genotype, phenology and a number of physiological characteristics. The author observed that spring frosts very often caused extracellular freezing cell damage and as a result of those anatomical effects influenced different morphological directions [10]. 15 peach and nectarine cultivars were tested using Redhaven as a standard [9]. Reports state that late spring frost percentage ranged from 13.8% to 67.6% which did not affect the crop yield. After comparing rootstocks grafted with peach cultivars Redhaven and UFO 4 and nectarine cultivar Big Top [13], it was found that rootstock Garnem promote two-day earlier scion blossoming, and GF 677 speed-up the blossoming process. Some authors [6] concluded that fruit tree ethylene treating slowed down blooming and thus avoiding damage.

The aim of the present study is to investigate the effect of late spring frosts on the reproductive traits of late nectarine cultivars.

Material and methods

The experimental orchard was established in the spring of 2017-2018 at the Agricultural Experimental Station - Khan Krum, Shumen region. The subject of study were the late nectarine cultivars Fantasia, Golden Grand, Morsiani 51, Cassiopeia and Fairlane grafted on seedlings (Elberta) and clonal rootstock GF 677. Frost-resistant dessert-type cultivar Redhaven was used as a reference cultivar. Negative temperatures (-3.6°C, -5.0°C) were recorded in the period 2017–2018 which happened along with the full blooming phenological

Corresponding author: d.v.dimitrov@shu.bg
Full Paper
DOI: 10.2478/asn-2022-0007
©2022 Dimitar Vasilev, published by Sciendo
This work is licensed under the Creative Commons Attribution 3.0 Public License

phase and as a result the studied cultivars had frozen blossoms. The experiment was based on the block method in four repetitions. Each repetition reported 400 blossoms, taken from the three layers of the canopy - lower, middle and upper. The samples were taken from the four cardinal points. Duncan's multiple range test was used to perform the data statistical process [8].

Results and Discussion

Figure 1 presents the data on the minimum temperatures range during full blooming for 2017 and Figure 2 presents data for 2018.

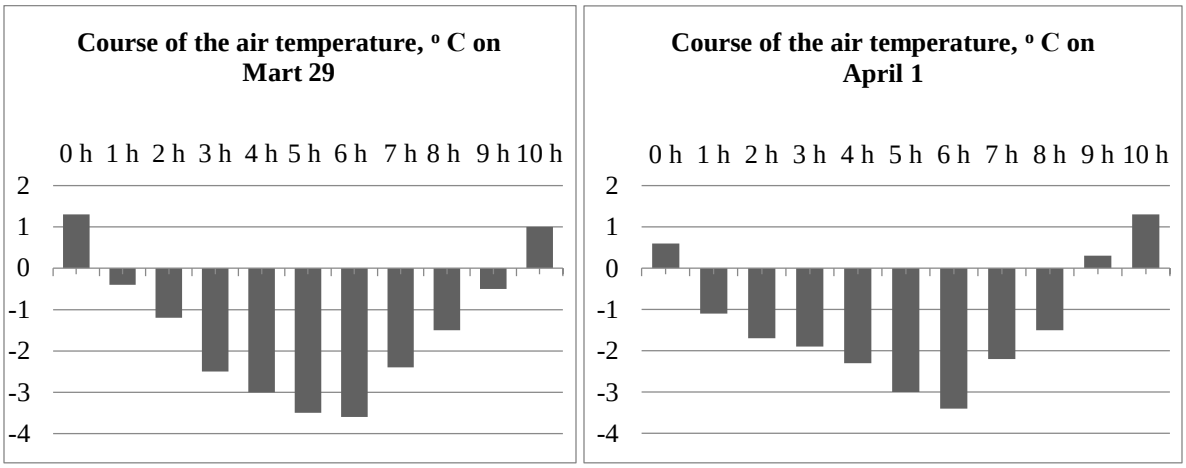


Figure 1. Negative temperatures incidence during the full blooming phenological phase for 2017

In 2017, the minimum temperatures on March 29th reached -3.6°C, and on April 1st: -3.0°C and -3.4°C. The presented results showed that in 2017 low temperatures had a relatively low impact compared to the one reported in 2018. That resulted in a relatively low percentage of blossom damage in 2017 compared to that in 2018. That may explain the yield difference in the two years of the study.

The data for the night negative temperatures on March 23rd and March 25th, 2018 show that they coincided with the full blooming phenological phase of the studied cultivars. It is evident that on March 23rd nightly negative temperatures lower than -4°C influenced the crop for 7 hours and on March 25th the same temperature values were reported for 9 hours. In this regard, on March 23rd, -5.0°C were reported for three hours, and on March 25th those temperatures were active for 6 hours. We should note that on March 25th a relatively low temperature range was reported (-5.0°C, -5.4°C).

Corresponding author: d.v.dimitrov@shu.bg
Full Paper
DOI: 10.2478/asn-2022-0007
©2022 Dimitar Vasilev, published by Sciendo
This work is licensed under the Creative Commons Attribution 3.0 Public License

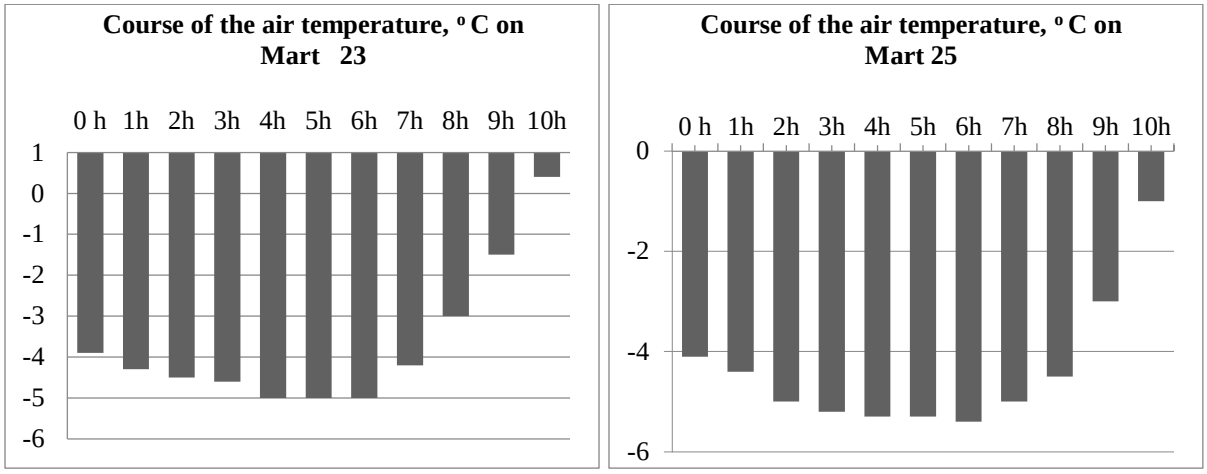


Figure 2. Negative temperatures incidence during the full blooming phenological phase for 2018

Having a long period of negative temperatures, followed by branch icing, resulted in 100 % fruit buds damage in most of the rootstock combinations and furthermore, reduced crop yields. Some authors [9, 14] observed that late spring frosts usually caused frozen pistil.

Data on frozen blossoms in the studied nectarine cultivars is presented in Table 1. The results show that the blossom damage in 2017 was relatively low compared to the one in 2018. Blossoms frost damage varied in the range from 76.1 % to 90.0% in 2017. Grafts on seedlings from the cultivars Fantasia, Cassiopeia and Fairlane are characterized by the highest frost damage percentage. They experienced relatively more damage than Redhaven /grafted on seedlings/, which was popular for its frost resistance.

Less than 80% of blossom damage had the grafts of clonal rootstock GF 677 - Fantasia, Golden Grand and Morsiani 51 (76.1-79.3%). The data for 2018 showed that low negative temperatures led to compromised crop yield. Cassiopeia, Golden Grand and Morsiani 51 (97.2% - 99.1%) on GF 677 rootstock showed values lower than 100%.

Tests on peach cultivars Inka and Harbinger, as well as nectarine cultivars Harko and John Revers in southern Poland have shown that low negative winter temperatures and late spring frosts are quite risky for obtaining regular predictable yields from the studied fruit tree species [16].

Corresponding author: d.v.dimitrov@shu.bg
Full Paper
DOI: 10.2478/asn-2022-0007
©2022 Dimitar Vasilev, published by Sciendo
This work is licensed under the Creative Commons Attribution 3.0 Public License

Table 1. Blossoms frost damage for the period 2017–2018

Cultivar/rootstock	Damaged flowers, % by years	
	2017	**2018**
Red Haven/seedlings	81.2 b	100.0 a
Fantasia/seedlings	87.3 a	100.0 a
Fantasia/GF 677	76.1 c	100.0 a
Golden Grand/seedlings	84.5 a	100.0 a
Golden Grand/GF 677	78. 8 b	98.3 a
Morsiani 51/seedlings	82.4 b	100.0 a
Morsiani 51/GF 677	79.3 b	99.1 a
Cassiopeia/seedlings	89.1 a	100.0 a
Cassiopeia/GF 677	80.2 b	97.2 a
Fairlane/seedlings	90.0 a	100.0 a
Fairlane/GF 677	83.0 b	100.0 a
LSD 5%	6.3	4.5

Table 2 presents a single tree yield and an average yield per decare. The presented data show that in 2017 a single tree yield was close to a normal yield. Rootstock combinations Morsiani 51 / GF 677 and Fairlane / GF 677 (18.1-18.7 kg) were the most productive ones. Cultivars grown on seedlings Fairlane and Fantasia (10.6-11.3 kg) showed relatively low single tree yields. The other rootstock combinations productivity values in the same group were in the range of 11.3 - 18.7 kg. The yield per decare in 2017 for the studied rootstock combinations varied from 932.8 to 1645.6 kg. The results show that the yield per unit area was evidently higher in the following samples: Fantasia, Morsiani 51 and Fairlain grafted on GF 677 (1522.4 - 1645.6 kg). Lower yields were reported for Fairlane /grafted on seedlings/ and Golden Grand /grafted on seedlings/ (932.8 - 994.4 kg). Productivity rate in 2017 was close to the normal one, due to the fact that there was a lower percentage of blossom damage compared to that one in 2018. The second year of the study, it was reported minimum yield obtained by Golden Grand, Cassiopeia and Morsiani 51 on GF 677 grafts.

Corresponding author: d.v.dimitrov@shu.bg
Full Paper
DOI: 10.2478/asn-2022-0007
©2022 Dimitar Vasilev, published by Sciendo
This work is licensed under the Creative Commons Attribution 3.0 Public License

Table 2. Reproductive traits for the period 2017–2018

Cultivar/rootstock	Yield from one tree, kg	Yield per dka, kg	Yield from one tree, kg	Yield per dka, kg
	2017	2017	2018	2018
Red Haven/seedlings	15.1 a	1328.8 c	-	-
Fantasia/seedlings	12.2 b	1073.6 d	-	-
Fantasia/GF 677	17.3 a	1522.4 b	-	-
Golden Grand/seedlings	11.3 b	994.4 e	-	-
Golden Grand/GF 677	15.5 a	1364.0 c	0.3 b	26.7 b
Morsiani 51/seedlings	14.6 b	1284.8 c	-	-
Morsiani 51/GF 677	18.1 a	1592.8 b	1.0 a	89.0 a
Cassiopeia/seedlings	13.4 b	1179.2 d	-	-
Cassiopeia/GF 677	16.7 a	1469.6 c	0.5 b	44.5 b
Fairlane/seedlings	10.6 c	932.8 e	-	-
Fairlane/GF 677	18.7 a	1645.6 a	-	-
LSD 5%	3.8	118.8	0.5	25.3

Table 3 presents the data on blossom damage in different canopy layers.

The data analysis showed that the lower canopy layer was characterized by the highest percentage of blossom damage. In 2017 frozen blossoms values ranged from 88.9% to 97.3%. In the middle canopy layer the damage was relatively small (80.5% - 90.0%), which was due to the weaker impact of cold air. The blossom damage rate in the upper canopy layer was the lowest (53.9% - 86.6%). Cultivar Fairlane /grafted on seedlings/ (86.6%) had been proven to have the most frozen blossoms, and the upper canopy layers in cultivars Fantasia /GF 677/ and Redhaven /grafted on seedlings/ (53.9 - 62.2%) were the least affected by the frost. Frost damage percentage was relatively lower in cultivars grafted on a clonal rootstock GF 677 compared to the grafted on seedlings. In 2018 most cultivars showed 100% of frost damage. A small amount of fruit was harvested from the middle and upper canopy layers of Golden Grand and Cassiopeia cultivars

Corresponding author: d.v.dimitrov@shu.bg
Full Paper
DOI: 10.2478/asn-2022-0007
©2022 Dimitar Vasilev, published by Sciendo
This work is licensed under the Creative Commons Attribution 3.0 Public License

with rootstock GF 677. Upper canopy layer crop was obtained from the combination cultivar Morsiani 51 / GF 677 rootstock.

Table 3. Frost for the period 2017 – 2018

Cultivar/rootstock	Damaged flowers, %					
	Parts of the canopy, 2017			Parts of the canopy, 2018		
	bottom	middle	upper	bottom	middle	upper
Redhaven/seedlings	93.1 b	88.3 b	62.2 d	100.0	100 .0 a	100.0 a
Fantasia/seedlings	94.3 a	86.5 bc	81.1 b	100.0	100.0 a	100.0 a
Fantasia/GF 677	90.3 b	84.1 de	53.9 e	100.0	100.0 a	100.0 a
Golden Grand/seedlings	96.7 a	89.3 a	67.5 c	100.0	100.0 a	100.0 a
Golden Grand/GF 677	90.5 b	82.4 e	63.5	100.0	98.0 b	97.0 b
Morsiani 51/seedlings	93.6 b	90.0 a	cd	100.0	100.0 a	100.0 a
Morsiani 51/GF 677	90.1 c	84.5 d	63.4	100.0	100.0 a	97.3 b
Cassiopeia/seedlings	97.3 a	88.1 b	cd	100.0	100.0 a	100.0 a
Cassiopeia/GF 677	88.9 c	80.5 e	63.3	100.0	97.4 c	94.2 c
Fairlane/seedlings	94.1 a	89.3 a	cd	100.0	100.0 a	100.0 a
Fairlane/GF 677	92.4 b	85.2 c	81.9 b	100.0	100.0 a	100.0 a
			71.2 c			
			86.6 a			
			71.4 bc			
LSD 5%	3.2	1.4	4.9	0	0.4	1.6

Conclusion

A relatively low percentage of damaged blossoms were observed in the late cultivars grafted on the clonal rootstock GF 677 compared to Elberta seedlings. The blossom damage in 2017 was relatively low compared to the one in 2018, which resulted in higher yields.

Negative spring temperatures had an unfavourable productivity effect, if blossom damage exceeded 80%. Flower frost damage rate was highest in the lower canopy layer compared to the middle and the upper canopy layers.

Corresponding author: d.v.dimitrov@shu.bg
Full Paper
DOI: 10.2478/asn-2022-0007
©2022 Dimitar Vasilev, published by Sciendo
This work is licensed under the Creative Commons Attribution 3.0 Public License

Acknowledgments

This study was carried out in the frame of Project No.RD-08-113/23.02.2022 Biological and plant protection studies in North-Eastern Bulgaria - Phase 3, funded by the University of Shumen.

References

[1]. Andonova, M., Peach, secrets and tips., Publishing House *„Eniovche", Sofia*, **2004**, p. 78.

[2]. Barua, U., Das, R., Gogoi, B., Response of Fruit Crops to Climate Abberation, Its Possible Affect in North East India and Mitigation Strategies – A Review, *International Journal of Current Microbiology and Applied Sciences*, **2021,** *10(2)*, 6 – 19.

[3]. Chunxian, C., William, O., Beckman, T., Peach Fruit Set and Buttoning after Spring Frost, *HortScience*, **2016,** *51(7)*, 816 – 821.

[4]. Gariglio, N., Mendow, M.,Weber, M., Favaro, M., Gonzales-Rossia, D., Pillati, P., Phenology and reproductive traits of Peaches and Nectarines in Central – East Argentina, *Sci. Agric. (Piracicaba, Braz.)*, **2009**, *66(6)*, 757 – 763.

[5]. Grigorov, I.,. New and promising cultivars peaches and nectarines, *Hristo G. Danov Publishing House, Plovdiv*, **1982**, 56.

[6]. Jiangyang, L., Sherif, S., Combating Spring Frost with Ethylene, *Front. Plant. Sci.*, **2019,** October, 1-6.

[7]. Kazandjiev, V., P. Malasheva., Agrometeorological conditions for growing of cherry (*Prunus avium* L.), and peach *(Persica vulgaris* Mill) orchards in Bulgaria, **2017**, *Proceeding International Conference "135 Years Institute of Plant Genetic Resources – Sadovo"' 29-30 may, Plovdiv*, ISBN 978-619-90842-1-2, 492 – 498, published at: *www.ipgrbg.com*

[8]. Lindanski, T., Statistical methods in biology and agriculture, Zemizdat, Sofia, **1988,** p. 374.

[9]. Ohlinger, B., Spomberger, A., Keppel, H., Suitability of peach and nectarine cultivars for organic production under pannonic climate conditions in Austria, **2008,** 123-126. http://orgprints.org/13656/.

[10]. Rodrigo, H., Spring frosts in deciduous fruit trees. Morphological damage and flower hardiness, *Scienta Horticulturae*, **2000**, 92, 155 – 173. DOI: 10.1016/S0304-4238(99)00150-8.

[11]. Seferoglu, G., Tekitas, F., Adaptation of Some Nectarine Cultivars in Aydin Region, *Pacistan Journal of Biological Sciences*, **2004**, *7(1)*, 114 – 117.

[12]. Szalay, L., Gyokos, I., Bekefi, Z., Cold hardiness of peach flowers at different phenological stages, *Hort. Sci. (Prague)*, **2018**, *45(3)*, 119 – 124.

Corresponding author: d.v.dimitrov@shu.bg
Full Paper
DOI: 10.2478/asn-2022-0007
©2022 Dimitar Vasilev, published by Sciendo
This work is licensed under the Creative Commons Attribution 3.0 Public License

[13]. Tabakov, S., Yordanov, A., Petrov, M., Influence of rootstocks GF 677 and GXN 15 (Garnem) of some phenophases of Peach cultivars, *Agricultural Sciences*, **2018**, *10(24),* 17 – 22.

[14]. Tsolov, T., Damage to fruit plants due to abiotic factors, *Zemizdat – Sofia,* **1989.**

[15]. Vassilev, D, Zhivondov, A., Damage of early nectarine cultivars of cold winter, *Rastenievadni nauki (Bulgarian Journal of Crop Science)*, **2016**, *53 (5 – 6)*, 113 – 117.

[16]. Wocior, S., Growth and cropping of two cultivars of peach and nectarine in the conditions of the Sandomierska Plateau, *Folia Horticulturae*, **2009**, *Ann. 21/1*, 73 – 80.

[17]. Zhivondov, A, Kolev, K., Gospodinova, M., Rankova, Z., Andonova, M., Nectarine – part one, *Zemedelie plius*, **2010**, *9*, 2 – 16.

Corresponding author: d.v.dimitrov@shu.bg
Full Paper
DOI: 10.2478/asn-2022-0007
©2022 Dimitar Vasilev, published by Sciendo
This work is licensed under the Creative Commons Attribution 3.0 Public License