

**AGRICULTURAL ACADEMY-SOFIQ
INSTITUTE OF FRUIT GROWING – PLOVDIV**

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**COMPLEX AGROBIOLOGICAL STUDY OF
PEACH AND NECTARINE CULTIVARS AND
ELITES**

*Dissertation for the award of educational and scientific degree "Doctor"
In the professional field 6.1 Plant Production and scientific specialty Horticulture*

Scientific supervisor: prof. dr. Argir Zhivondov

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The studies were carried out in 2020-2022 in a collection orchard of peaches and nectarines on the territory of the Institute Fruit Growing - Plovdiv. A total of 36 peach and nectarine cultivars and elites were studied. The dissertation has 143 pages and contains 42 figures, 50 tables and 31 photos. The literature cited includes 216 titles, 211 in the Latin and 5 in the Cyrillic.

The public defense of the dissertation will take place in the meeting room of the Institute of Fruit Growing - Plovdiv fromhours atat a meeting of a Specialized Scientific Jury appointed by order of the President of the SSA.

INTRODUCTION

The peach (*Prunus persica* (L.) Batsch) is a plant of the forest-mountain regions and is characterized by great adaptability to different soil and climatic conditions. It therefore has a wide distribution range and finds favourable conditions for development in southern Europe, North Africa, Asia, America and Oceania. In terms of area under cultivation in Bulgaria, the peach and nectarine rank fourth after the plum, cherry and apple. Their cultivation and production is concentrated in the south-eastern region and accounts for 65.5 % of the country's total fruit production. In recent years there has been a decline in production due to poor weather conditions the crop for 2023 is 10799 tonnes.

The peach is a widespread and preferred species by growers, as it starts fruiting in the second year after planting and quickly provides income. The fruit has an extremely attractive appearance, combined with excellent flavour, a pleasant aroma and high nutritional value, making it one of the most popular on the market. The fruit is suitable for consumption both fresh and after processing into compotes, jams, nectars, etc.

In the face of climate change, growers are faced with problems related to the yield and plant health of fruit trees. In the region of Plovdiv, spring frosts are increasingly frequent and lead to compromised yields. Diseases and pests are other major problems facing production. Peach curl disease (*Taphrina deformans*), is the most widespread and can affect 90-100% of the foliage reducing the vigour of the trees. Other common diseases are powdery mildew (*Sphaerotheca pannosa*), smut (*Stigmina carpophila*), early and late brown rot (*Monilinia laxa*; *Monilinia fructigena*), plum pox (*Plum pox virus*). The main pests are the peach twig moth (*Anarsia lineatella*), which forms 3-4 generations per year, the eastern fruit worm (*Grapholita molesta*) and the green peach aphid (*Myzus persicae*). In response to these problems, worldwide breeding programmes are aimed at producing varieties with increased resistance to the causal agents of economically important pests combined with quality fruit of high nutritional value. By developing such cultivars, the aim is to solve major plant protection problems and meet the ever-increasing demands of consumers.

The breeding of peaches and nectarines in the Institute of Fruit Growing - Plovdiv started recently after its foundation. Since then a total of 47 peach varieties have been created in the country, 32 of which are the work of breeders from the Institute of Fruit Growing in Plovdiv. In 1989, the first official breeding programme was launched at the same institute, the main objectives of which were:

- Extending the ripening season of the fruit;
- Resistance to the most economically important diseases, curly leaf spot (*Taphrina deformans*) and powdery mildew (*Sphaerotheca pannosa*);
- Improvement of fruit quality characteristics.

As a result, two cultivars with a very early ripening period, 'Flavia' and 'Filina' (20-25juni), as well as the first Bulgarian nectarine cultivar 'Gergana' were obtained. The inclusion of the species *Prunus davidiana* and the variety Fergansky zhty in the sexual hybridisation resulted in the cultivars 'Laskava' and 'Evmplyiya', which are the only Bulgarian cultivars resistant to

powdery mildew and curly mildew diseases. A rich hybrid stock has been established, the evaluation of which continues at the stage of elites propagated on seed peach rootstock and is the subject of this dissertation.

PURPOSE AND OBJECTIVES

The aim of the study is to comprehensively investigate and analyze the pomological characteristics and economic qualities of new and promising cultivars and selected elites that outperform standard cultivars on a complex of indicators. On this basis the best cultivars are recommended for introduction into production practice and the best elites for recognition as new cultivars. In order to achieve this goal, the following tasks have been set.

1. Tracking the vegetation period.
2. Investigation of fruit and stone biometrics.
3. Study the pomological characteristics of flowers and leaves;
4. Study of agrobiological characteristics of trees.
5. Study the influence of biotic and abiotic stress factors on selected cultivars and elites.

MATERIAL AND METHODS

The study was carried out in the period 2020-2022 in a collection plantation on the territory of the Institute of Fruit Growing - Plovdiv. The study included 12 cultivars and 8 elites of peaches, 9 cultivars and 7 elites of nectarines (all 36 genotypes). The trees were grafted on seed peach rootstock in 2014. They were planted at 5 m row spacing and 3 inside spacing. They were formed according to the free growing cup system. Conventional plant protection was conducted in the collection plantation. The soil surface in the inter-row was maintained in black fallow by intermittent cultivation and the strip in the row by mowing. The trees were grown under non-irrigated conditions.

Data for the peach cultivars and elites studied were compared with those of the standard dessert cultivars Meykrest for the very early cultivars and Redhaven for the others. For nectarines, we used the cultivar Goldenrand as the standard.

MONITORING INDICATORS

A combination of contemporary methodologies and descriptors were used in defining the criteria and survey indicators, giving a comprehensive characterization of the cultivars and elites studied.

1. Course of phenological phases;
2. Type of flowers, size, shape, coloration;
3. Strength of flowering;
4. Fruit ripening;
5. Degree of skin softening;
6. Fruit shape;
7. Fruit symmetry;
8. Percentage of skin colour;
9. Fruit flesh colour;
10. Intensity of colouring of fruit flesh from skin to stone;
11. Biometric measurements of fruit;
12. Chemical composition of fruit;
13. Organoleptic evaluation;
14. Fruit yield;
15. Fertility indices;
16. Shape, size, colour and relief of the stone;
17. Biometric measurements of the stone;
18. Leaf petiole - size, shape and dimensions;
19. Presence, number, shape and location of leaf glands;
20. Notching of the periphery of the leaf spot;
21. Length of leaf petiole;
22. Trunk height, thickness and diameter;
23. Length and structure of annual increment;
24. Crown volume;
25. Morphological characteristics of the mixed branch;
26. Resistance to winter and late spring frosts;
27. Infestation by peach leaf curl diseases;
28. Infestation by green peach aphid;
29. Complex agrobiological assessment.

The results obtained were statistically processed using the method developed by David B. Duncan (Duncan, 1955; Harter, 1960). The software used was "R3.1.3", in combination with "RStudio-0.98" and the package "agricolae 1.2-2" installed (Mendiburu, 2015).

RESULTS AND DISCUSSION

Course of phenological phases

In 2020, budbreak phenophase BBCH 51 starts between 15-19 February. In the same year, the earliest flowering onset phenophase BBCH 61 was recorded for peach elites 4-22, 91-23, 19-132, 19-113 - on 13 March. For all other varieties and elites this phase occurred in the period from 14 to 18 March. The latest date for the beginning of flowering was recorded for the variety Eumolpiya - 25 March and elite 30-59 - 29 March. In the three years of the study, the flowering phenophase BBCH 63 occurred earliest in 2020 - on 16 March, which was determined by the higher values of the day temperature in the pre-flowering period. Rainfall of 10l/m² was also recorded at this time from 15 to 20 March (Fig. 16). Philina and peach elites 19-77, 19-132, 19-113 were the first to enter the flowering phenophase. During the following days from 17 to 23 March, flowering phenophase was recorded in all other cultivars and elites except Eumolpia - 28 March. The peach elite 30-59 had the latest flowering - on 7 April. Petal drop was recorded 3 to 6 days after full bloom. The duration of flowering is of great importance for pollination. From the beginning of flowering to petal fall (Table 1) the period ranges from 7 days in Flavia, Filina, Elegant Lady, 19-113 and 19-78, to 13 days in Ferlino and 30-59. In 2020, minimum, maximum and average daily temperatures (Fig. 13) are high and determine the earlier start of the growing season (Tables 2, 3). The duration of the entire growing season in peaches ranged from 220 days in Maycrest to 274 in elite 91-23.

In the second year of the study, the onset of phenological development occurred from February 26 to March 12. Filina and Flavia were the first to enter this phase and elite 30-59 were the last. In 2021, the earliest flowering onset phase occurred on March 29 for Laskava and the two peach elites 19-113 and 19-132. The following two days, March 30 and 31, occurred en masse in most observed cultivars and elites. No rainfall was recorded during this period (Fig. 17). The exception was observed at Maycrest on 1 April, followed by Eumolpiya on 2 April. Again, the latest this phase was recorded was at peach elite 30-59 on - 19 April. The full bloom phase occurred en masse in most cultivars and elites observed from 3 to 6 April, with the same phase occurring on 22 April in elite 30-59. The mass petal fall this year was recorded mainly on 7, 8 and 9 April.

In 2021, measured minimum, mean and maximum daily pre-flowering temperatures are lower compared to the previous year (Figure 14). For this reason, flowering was also delayed by a few days this year. The average flowering duration was 7 to 12 days in Laskava and Maycrest. The date of flowering and its duration can vary from year to year, depending largely on the length of the growing season.

The entire growing season for peaches in the year in question ranged from 239 days for Ruby Trees to 263 days for Tardi belle.

In 2022, phenological development began from 3 to 16 March. The individual flowering phases passed most rapidly in the third year of the study due to the sharp rise in temperatures (Fig. 15), at which time there was again no rainfall (Fig. 18). The massive display of petals preceded the onset of flowering by two to three days. The onset of flowering started on 28 March for peach elites 4-22, 91-23, 19-132 and 19-113. For almost all the others the same phase occurred in the following three days. The latest to enter this phase was elite 30-59 on 3 April.

Within two to three days after this phase, all observed cultivars and elites entered full bloom. The petal fall phase was recorded within 3 to 5 days in all variants. The shortest flowering time was 6 days in the variety Laskava and the longest in Elegant Lady - 10 days. Flowering duration in all others was 7 to 9 days.

The entire growing season ranges from 231 days at 30-59 to 259 days at Tardi belle. For the whole period of the study, the growing season was the longest in Tardi belle white and the shortest in Maycrest.

Onset of flowering in 2020 in nectarines occurred earliest in Morsiani 90, on 11 March. Massively this phase was recorded for all other cultivars and elites from 13 to 16 March. The exception was observed in Adriana, 4-151 and 23-42. Full flowering occurred from 16 to 23 March. The duration of flowering in nectarines was longer than that of peaches, averaging 10 days this year. The smallest duration of 8 days in this 2020 year is in Sunfree, Big Top and 29-31, and the longest is 12 days in 4-176. Petal drop is within 4 to 7 days after full bloom. The duration of the entire growing season ranges from 253 days in Otumfrey to 272 days in Morsiani 90.

In 2021, the flowering onset phenophase BBCH 61 was recorded later compared to the previous year, from 30 March to 1 April. The latest recorded in this phase was 23-42 on 4 April. Full bloom lasted from 4 to 6 days in all cultivars and elites observed. Petal drop was mainly from 7 to 10 April, with 23-42 being the latest recorded in this phase. The duration of flowering in days ranged from 7 in 4-171 to 11 in Otumfrey, Nectagrand 4 and 4-176. Morsiani had the longest growing season this year at 90-259 days and the shortest at 230 days at 23-42.

In the last year of the study, the onset of flowering occurred 2-3 days earlier than the previous year - from 28 to 30 March. The latest this phase was found was on 1 April at 23-42. Full bloom was recorded up to 2 days after onset and petal fall 4 to 6 days later. In general, the duration of flowering in 2022 was shorter in nectarines compared to previous years, ranging from 7-8 days, and 9 days were recorded in Gergana and 4-151. The average duration of the entire growing season was longest in Morsiani 90 and shortest in Elite 23-42.

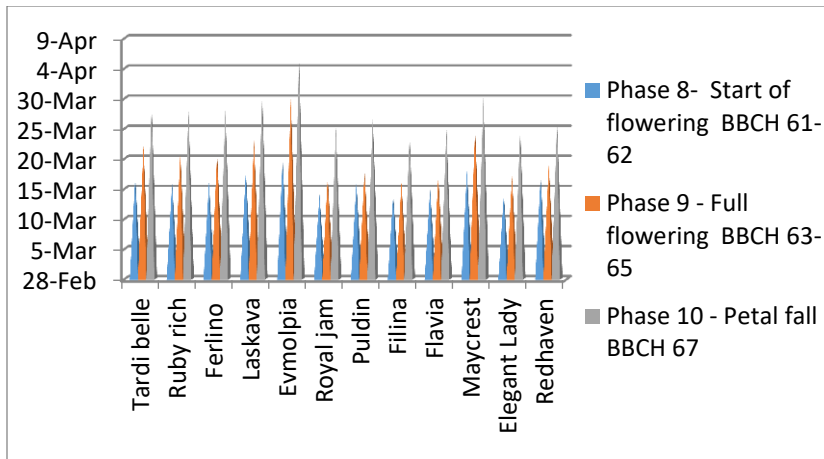


Fig.1 Peach cultivars phenological development in 2020.

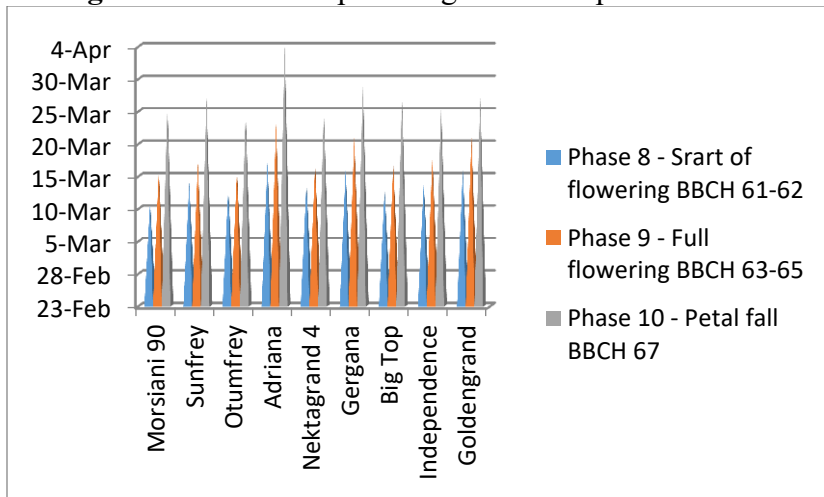


Fig.3 Nectarine cultivars phenological development in 2020.

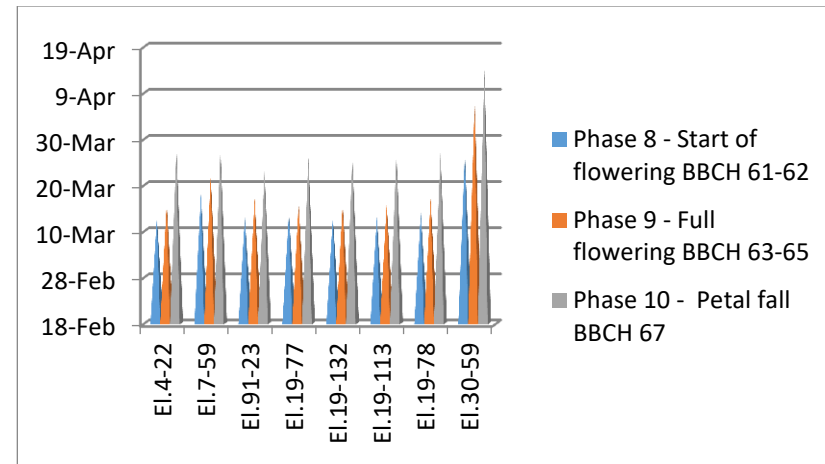


Fig.2 Peach elite phenological development in 2020.

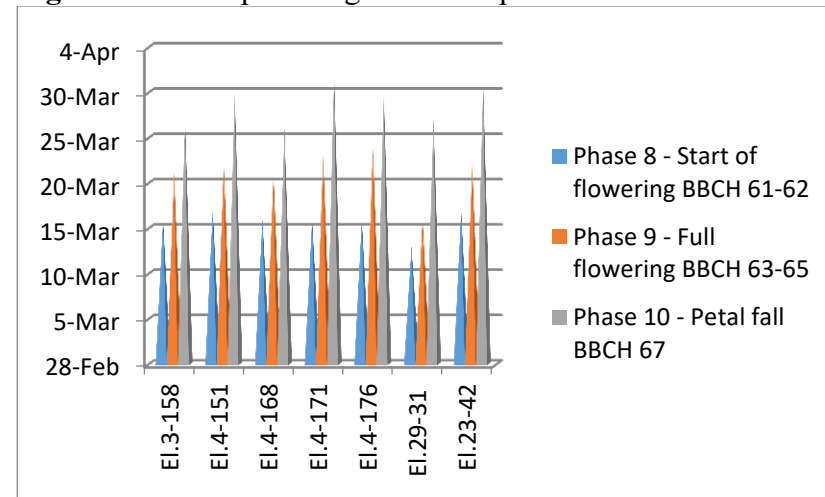


Fig.4 Nectarine elites phenological development in 2020.

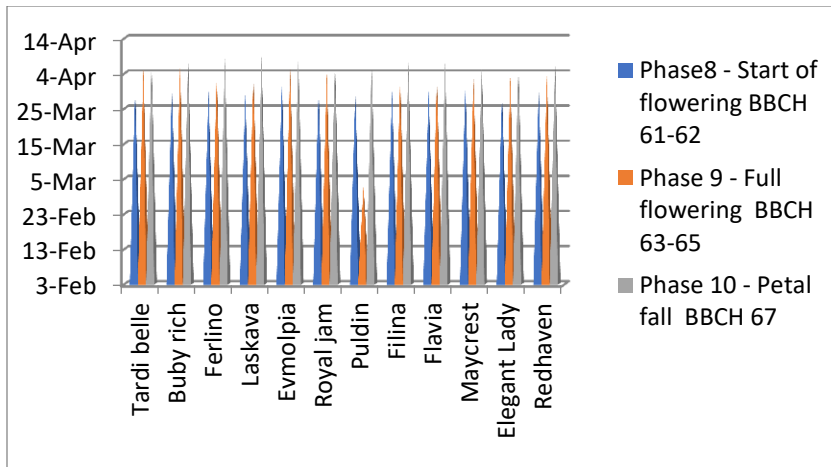


Fig. 5 Peach cultivars phenological development in 2021

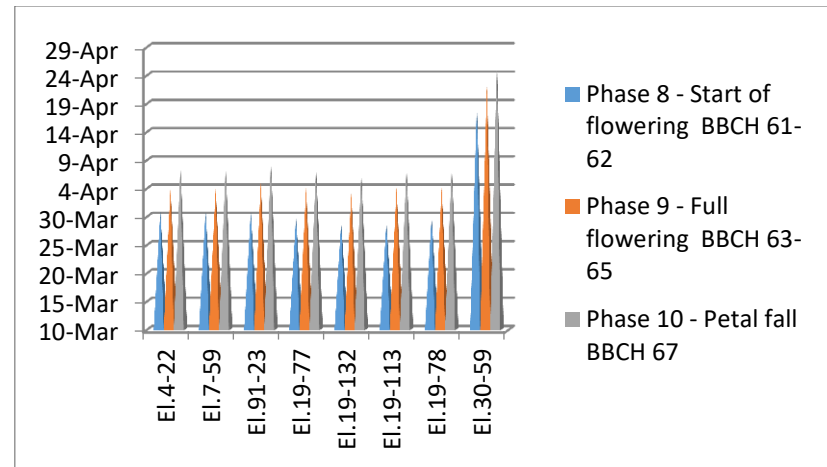


Fig. 6 Peach elite phenological development in 2021.

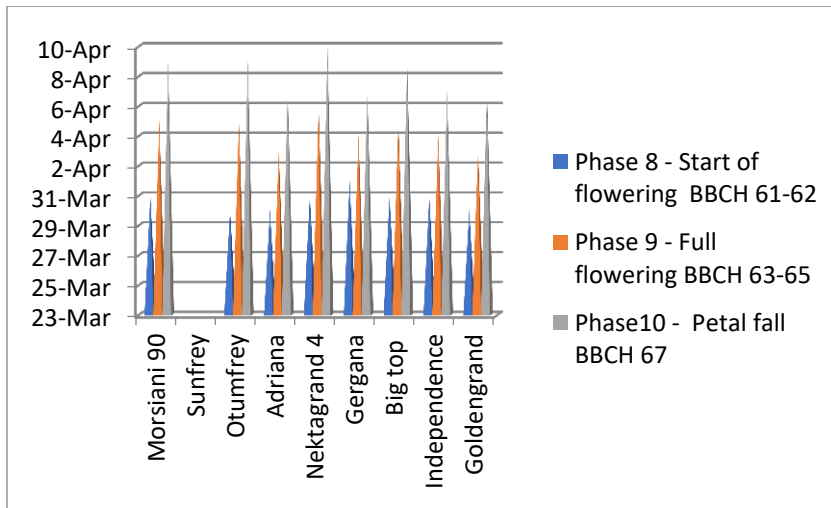


Fig. 7 Nectarine cultivars phenological development in 2021.

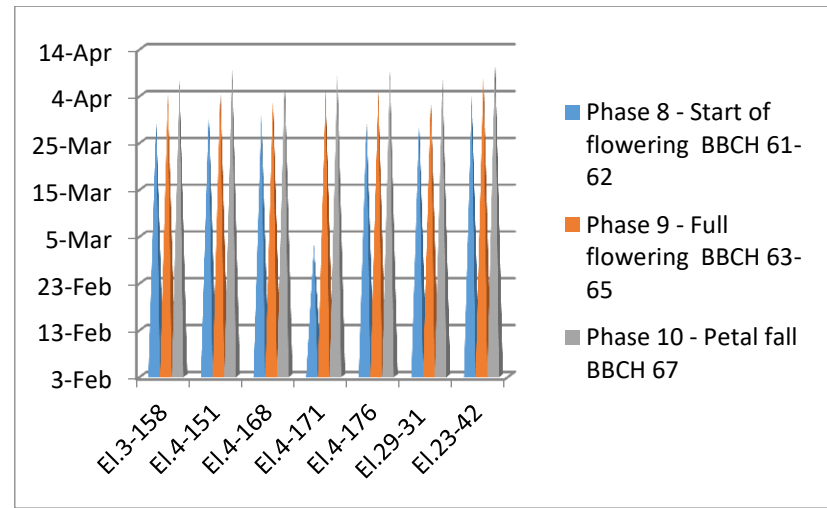


Fig. 8 Nectarine elites phenological development in 2021.

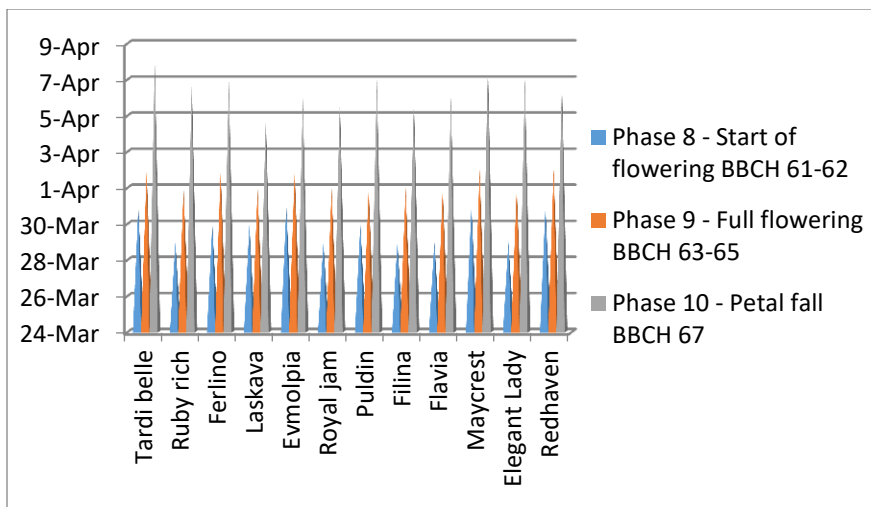


Fig.9 Peach cultivars phenological development in 2022

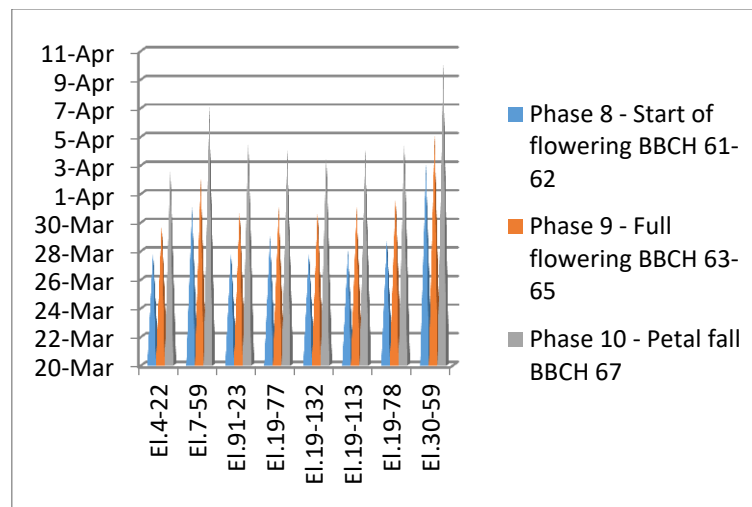


Fig.10 Peach elite phenological development in 2022.

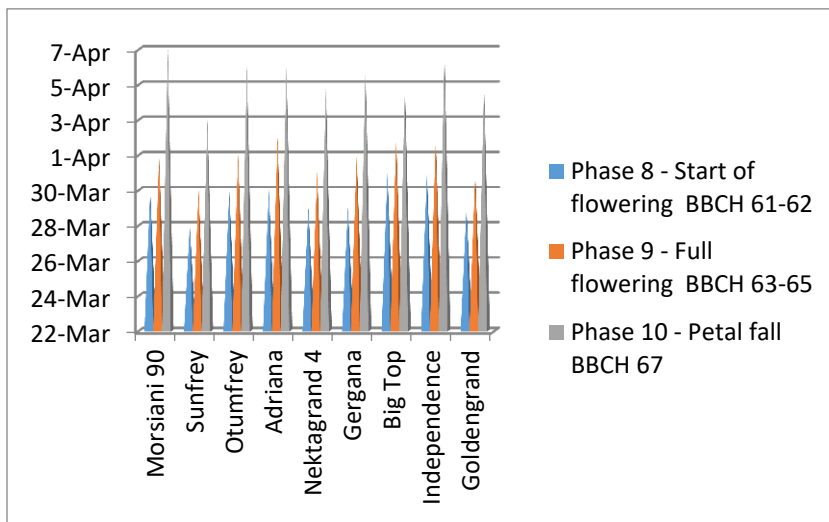


Fig.11 Nectarine cultivars phenological development in 2022.

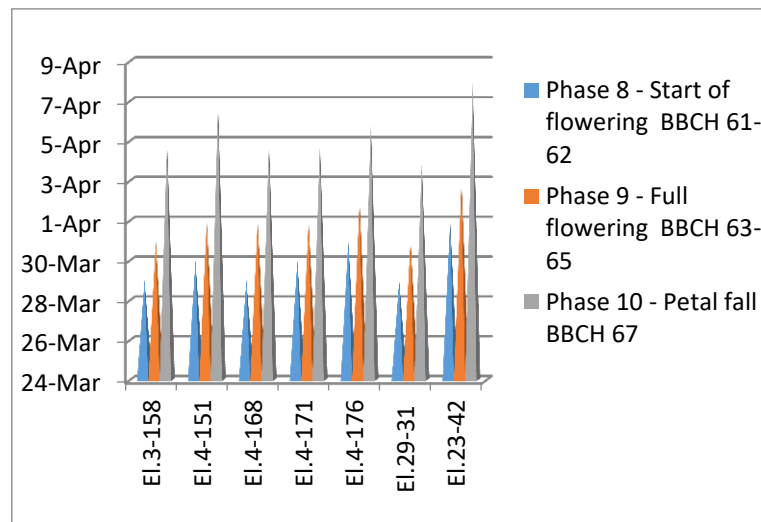


Fig.12 Nectarine elite phenological development in 2022.

Flower type, size, shape and coloration

The predominant type of flowers in the cultivars observed is the rose type. It is larger and contributes to attracting more bees and favours pollination. It has been found in 26 cultivars and elites and is predominant in nectarines. Bells flowers were found in the peach cultivars Ferlino, Laskava, Evmplpiya, Puldin, Filina, Maycrest, Elegant Lady, Redhaven, elite 7-59 and the nectarine cultivar Adriana.

The size of the flowers is indicated by the size of the petals. The values of the length of the bell-type flowers in peaches ranged from 9.3 mm. in elite 7-59 to 13.42 mm. in the cultivar Filina (Table 1). The petal lengths of the pink flowers ranged from 17.6 mm. in the Tardy Belle cultivar to 21.3 mm. in Royal Jam.

In nectarine cultivars and elites, only Adriana has bell-shaped flowers. In the rose types, the length varies from 18.63 mm to 20.85 mm.

According to the generally accepted methodology for studying plant resources in fruit plants, those with large bell-shaped flowers above (12 mm.) are Elegant Lady, Philina and Adriana. In Laskava, Ferlino, Maycrest, Eumolpiya, Redhaven, Puldin and Elite 30-59 the flowers are medium sized (10-12 mm). Only elite 7-59 has small flowers. The cultivars with pinkish flowers with the largest flowers over (19 mm) are 7 cultivars and elites in peaches and 11 in nectarines, with medium flowers of (17-19 mm) are Tardy Belle, Flavia and elite 19-132 in peaches. Big top, Sunfrey and elite 4-176 in nectarines. Petal width varies from 9.5 mm. in Filina to 6.1 mm. in elite 7-59 in cultivars with bell-shaped flowers. Of the cultivars with pinkish flowers, the values of this parameter range from 19.3 mm. in the case of peach elite 91-23 and 19.5 mm. in the case of nectarine elite 4-171. We consider that petal length is the determining factor for flower size, as it forms the diameter of the flower.

The greater the length: width ratio is, the wider the petal. The shape is defined relative to the length, with 8 being circular, 8 being medium elliptical and 4 being narrow elliptical.

Petal colour ranges from light pink to dark pink, with 14 of the peach cultivars and elites being dark pink and the remaining 6 light pink. In the nectarine cultivars and elites, 8 are dark pink and 7 are light pink. In the different years of the study, it was found that in peach cultivars and elites the petal width varied over the years, while the length not so much. In the observed nectarine cultivars and elites, the reported length and width indices were similar in all three years of the study (Table 2).

The peach cultivars with the largest pink flowers were Royal Jam, Ruby Rich and the elites 91-23, 4-22 and 19-77. The smallest rose-like flowers were found in 30-59.

Of the nectarines examined, the largest flowers were found in Gergana and elites 4-171 and 3-158, and the smallest in Sunfrey and 4-176.

Table 1 Flower type, petal size and petal shape in peaches - averaged over the period 2020-2022 (mm).

cultivar/elite	type of flower	length	width	(l/w)	petal shape
Royal jam	rose-shaped	21,32 a	17,45 abcd	1,22	circular
El.91-23	rose-shaped	21,23 a	19,37 a	1,10	circular
El.19-77	rose-shaped	20,95 ab	18,55 abc	1,13	circular
Ruby rich	rose-shaped	20,25 abc	18,57 abc	1,09	circular
El.19-113	rose-shaped	20,18 abc	14,22 e	1,42	medium elliptical
El.4-22	rose-shaped	20,07 abc	18,77 ab	1,07	circular
El.19-78	rose-shaped	19,88 abc	16,13 cde	1,23	circular
Flavia	rose-shaped	19,02 bcd	16,62 bcde	1,14	circular
El.19-132	rose-shaped	18,82 cd	14,47 e	1,30	medium elliptical
Tardi belle	rose-shaped	17,60 d	15,73 de	1,12	circular
Filina	bell-shaped	13,42 e	9,52 f	1,41	medium elliptical
Elegant Layd	bell-shaped	12,23 ef	8,50 fg	1,44	narrowly elliptical
Laskava	bell-shaped	11,75 efg	8,42 fg	1,40	medium elliptical
El.30-59	rose-shaped	11,48 fg	8,10 fg	1,42	medium elliptical
Ferlino	bell-shaped	11,20 fgh	8,57 fg	1,31	medium elliptical
Evmplyiya	bell-shaped	11,12 fgh	8,23 fg	1,35	medium elliptical
Meycrest	bell-shaped	10,63 fgh	7,48 fg	1,42	medium elliptical
Puldin	bell-shaped	10,17 gh	7,18 fg	1,42	medium elliptical
Redhaven	bell-shaped	10,08 gh	6,28 g	1,60	narrowly elliptical
El.7-59	bell-shaped	9,25 h	6,13 g	1,51	narrowly elliptical

Table 2 Flowers type, petal size and petal shape in nectarines - averaged over the period 2020-2022 (mm)

cultivar/elite	type of flower	length	width	(l/w)	petal shape
El.4-171	rose-shaped	20,85 a	19,50 a	1,07	circular
El.4-168	rose-shaped	20,60 ab	18,93 ab	1,09	circular
Gergana	rose-shaped	20,55 ab	19,32 a	1,06	circular
Goldengrand	rose-shaped	20,50 abc	18,97 ab	1,08	circular
Nektagrand 4	rose-shaped	20,27 abc	17,28 ab	1,17	circular
El.3-158	rose-shaped	20,23 abc	19,28 a	1,05	circular
El.29-31	rose-shaped	20,12 abc	17,47 ab	1,15	circular
Morsiani 90	rose-shaped	20,10 abc	17,77 ab	1,13	circular
Independence	rose-shaped	19,80 abc	17,23 ab	1,15	circular
Otumfrey	rose-shaped	19,73 abc	16,67 ab	1,18	medium elliptical
El.23-42	rose-shaped	19,30 abc	18,20 ab	1,06	circular
El.4-151	rose-shaped	19,17 abc	17,50 ab	1,10	circular
El.4-176	rose-shaped	18,88 bc	15,67 b	1,21	circular
Big top	rose-shaped	18,63 c	17,33 ab	1,08	circular
Sunfrey	rose-shaped	18,63 c	15,95 b	1,17	circular
Adriana	bell-shaped	13,90 d	9,53 c	1,46	narrowly elliptical

Strength of flowering

Over the three years of the study, the highest flowering strength was recorded in the peach cultivars Laskava and Ferlino and the nectarine cultivars Sunfrey, Independence and Goldengrand. The lowest flowering strength was found in the nectarine elite 4-176.

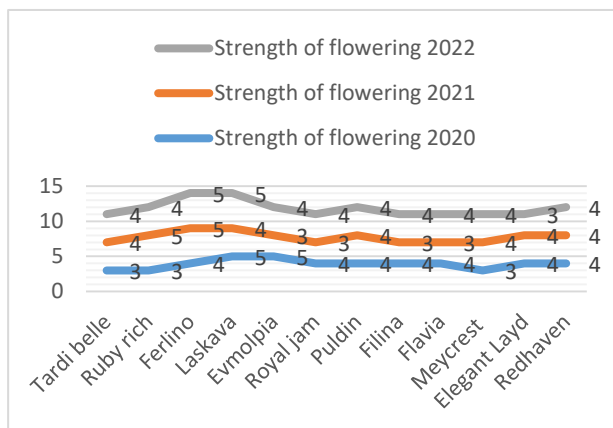


Fig. 13 Flowering strength in peach cultivars.

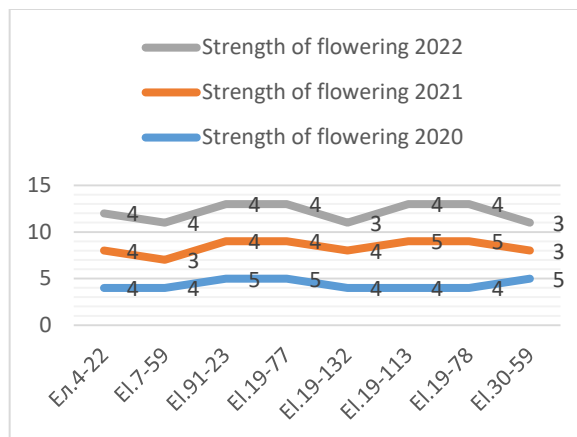


Fig. 14 Flowering strength in peach elites

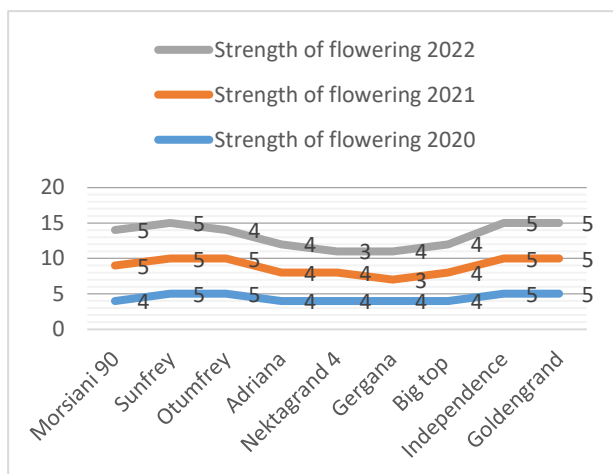


Fig. 15 Flowering strength in nectarine cultivars.

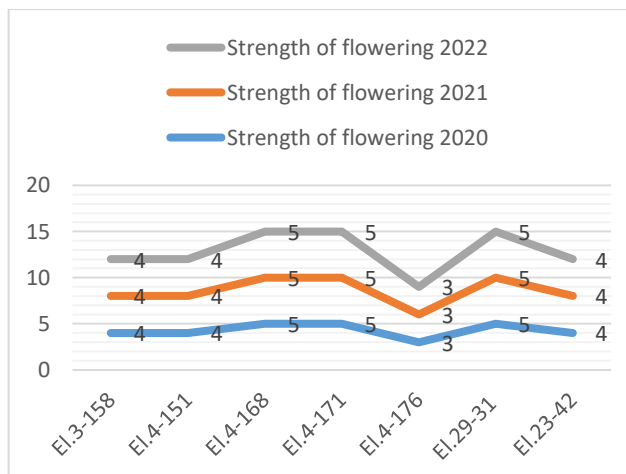


Fig. 16 Flowering strength in nectarine elites.

Ripening of the fruit

Flowering time and fruit ripening period are the main phenological characteristics of fruit cultivars. The fruit of the cultivars studied ripen, with some discontinuity in the sequence, over a period of three and a half months-usually beginning shortly after mid-June and ending by the end of September (Tables 3 and 4).

In the observed cultivars and elites, the earliest fruit ripening was in 2020, which is characterized by the earliest onset of spring and, consequently, the earliest flowering. In 2021, fruit ripening was one to nine days ahead in peaches and up to twelve days ahead in nectarines compared with the previous year. In 2022, the dates often coincide with the previous two years or are intermediate.

Flavia and Filina peach cultivars ripen earliest, beating the Maycrest standard by 1-2 days. The fruit of elite 19-78 ripens at the same time as Maycrest, and elite 19-113 ripens one day before the standard. One day behind the Maycrest, the fruit of elites 19-132 and 19-77 ripen. The cultivars commented on above form the group of earliest peaches.

One week before the main standard Redhaven, the fruit of the Royal Jam cultivar ripens, and 12 days before the standard, the fruit of the Ruby Rich cultivar ripens. The fruit of the Puldin cultivar ripens two days after those of the standard, and a week later the fruit of the Laskava cultivar ripens. Together with Redhaven, the cultivars discussed so far form the group of medium-early cultivars.

The group of late cultivars is represented by Ferlino and Elegant Lady. This group also includes the elites 7-59, 91-23, 4-22 and 30-59. The fruit of all these ripens at the end of August in a range of 4 days. By mid-September the fruit of the Eumolpia cultivar ripens, 49 days after that of the Redhaven. The last to ripen, at the end of September, are the fruits of Tardy belle. The last two cultivars are representatives of the very late group. In the sample of dessert peaches and elites studied, there are no representatives of the early, medium-late and late groups.

Among the nectarine cultivars and elites, the fruit of the Adriana cultivar ripens first, followed four days later by the fruit of the Gergana cultivar, and five days later by the fruit of elites 23-42. Arranged in this way they form the group of very early ripeners.

The early group ripens in mid-July and is represented by, elite 4-151 and the cultivars Big Top, Nectagrand 4 and Sunfrey.

With ripening fruit in late July and early August are Independence and Elite 4-176, which form a group of medium-late.

In the group of late ripening fruit are the elites 3-158 and 4-171, which ripen two or three days before the standard Goldengrand. Elite 4-168 ripens one day after Goldengrand and 29-31 two days after Goldengrand.

The cultivars Othamphrey and Morsiani 90 form the group of very late ripeners - after mid-September.

Table 3 Peach fruit ripening time versus 'Maycrest' and 'Redhaven' ripening sequence and cultivar grouping.

Cultivar/Elite	Ripening before (-) or after (+) standard	Average ripening dates	Grouping according to ripening period	Phenological phase BBCH 89 - Full ripening		
				2020	2021	2022
Meycrest	0	22.June	Very early	22.June	23.June	23. June
Flavia	-2	20.June	Very early	19.June	21.June	22. June
Filina	-1	21.June	Very early	20.June	22.June	23. June
EL.19-113	-1	21.June	Very early	19.June	23.June	22. June
EL.19-78	0	22.June	Very early	24.June	18.June	24. June
EL.19-132	+1	23.June	Very early	19.June	30.June	22. June
EL.19-77	+1	23.June	Very early	20.June	25.June	25. June
Redhaven	0	28.July	Medium early	30.July	31. July	25. July
Ruby rich	-12	16.July	Medium early	18.July	16. July	14. July
Royal jam	-7	21.July	Medium early	20.July	22. July	21. July
Puldin	+2	30.July	Medium early	31.July	30. July	29. July
Laskava	+9	6.August	Medium early	5.August	9.August	5.August
EL.7-59	+29	26.August	Late	24.August	1.Sep	24.August
Ferlino	+30	27.August	Late	25.August	3.Sep	24.August
EL.91-23	+30	27.August	Late	27.August	31.August	25.August
Elegant Lady	+31	28.August	Late	29.August	28.August	27.August
EL.4-22	+32	29.August	Late	30.August	1.Sep	26.August
EL.30-59	+32	29.August	Late	31.August	2.Sep	23.August
Evmplpiya	+49	13.Sep	Very late	15.Sep	14.Sep	10.Sep
Tardi belle	+66	30.Sep	Very late	2.Sep	1.Oct	28.Sep



Table 4 Nectarine fruit ripening time versus 'Goldengrand' ripening sequence and cultivar grouping.

Cultivar/Elite	Ripening before (-) or after (+) standard	Average ripening dates	Grouping according to ripening period	Phenological phase BBCH 89 - Full ripening		
				2020	2021	2022
Adriana	-56	26. June	Very early	24. June	30. June	24. June
Gergana	-52	30. June	Very early	30. June	1.юли	1.юли
El.23-42	-47	5. July	Very early	3. July	10. July	4. July
El.4-151	-36	16. July	Early	15. July	18. July	20. July
Big top	-31	21. July	Early	20. July	23. July	20. July
Nektagrand 4	-31	21. July	Early	20. July	23. July	22. July
Sunfrey	-30	22. July	Early	20. July		25. July
Independens	-22	29. July	Medium early	29. July	28. July	30. July
El.4-176	-7	14.August	Medium Late	11.August	20.August	13.August
El.3-158	-3	18.August	Late	22.August	17.August	14.August
El.4-171	-2	19.August	Late	24.August	18.August	15.August
Goldengrand	0	21.August	Late	21.August	21.August	21.August
El.4-168	+1	22.August	Late	24.August	18. August	26.August
El.29-31	+2	23. August	Late	18.August	30. August	22.August
Otumfrey	+26	16. Sep	Very late	15. Sep	17. Sep	16. Sep
Morsiani 90	+36	23. Sep	Very late	23. Sep	24. Sep	19. Sep

Characteristics of the fruit

In almost all the observed cultivars and elites, the degree of fruit skin bruising was moderate (Table 5). Only the cultivar Puldin is characterised by low skin cover. The fruit shape of all peach cultivars and elites is globular. Only two of the observed nectarine cultivars, Gergana, Independence and elite 23-42, are ovoid (Table 6). The fruits are symmetrical in shape. At the time of the observations, due to the freezing temperatures, some of the fruits were asymmetric in shape in 2020 and 2021. Fruit colouration is an important pomological and valuable commercial trait. It largely determines the appearance and commercial value of fruit production. The anthocyanin colouration of the skin varies to a large extent between cultivars and elites. The ecological conditions of the location of the plants are also important for the more intense colour.

The percentage of the fruit surface that is covered by blood colour varies widely depending on the cultivar. The least anthocyanic colouration occurs in the cultivar Ferlino -30-45%. In the Redhaven standard, 45 to 60 % of the surface of the fruit is covered by the opaque colour. A similar colour is also present in one of the observed cultivars and elites: Tardy Belle, Laskava, and elites 4-22, 7-59, 91-23,19-77, 19-113 and 30-59. With an anthocyanic skin colour of 60-75% is the standard Maycrest. A higher percentage of the fruit surface is covered with red rumen in the cultivars Eumolpia, Royal Jam, Elegant Lady and Elite 19-78. The entire surface of

the fruit is covered by blood red in the cultivars Puldin and Ruby Rich. The lowest percentage of fruit skin discoloration was found in cultivars Otumfrey and Elite 4-168 - 30-45%. With a higher percentage of 45-60% is also cultivar Morsiani 90. Big top and elite 29-31 have 65-70% anthocyanin colouration. In most of the observed cultivars and elites, the fruit skin is more deeply coloured, as in the standard Goldenrand - 75-90%.

The yellow colour of the fruit flesh in peaches and nectarines is known to have better resistance to handling and better transportability. In all observed cultivars and elites, fruit flesh colour is yellow.

The presence of anthocyanin staining from skin to stone varies from weak to strong.

Table 5 Fruit characteristics of peach cultivars and elites.

Cultivar/Elite	Degree of mastery	Shape of the fruit	Symmetry	Anthocyan skin colour (%)	Basic colouring of fruit flesh	Presence of anthocyanins in fruit flesh
Tardi belle	moderate	globular	symmetrical	45/60%	yellow	missing
Ruby rich	moderate	globular	symmetrical	90/100%	yellow	strongly
Ferlino	moderate	globular	symmetrical	30/40%	yellow	missing
Laskava	moderate	globular	symmetrical	45/60%	yellow	missing
Evmpliya	moderate	globular	symmetrical	75/90%	yellow	missing
Royal jam	moderate	globular	symmetrical	90/100%	yellow	strongly
Puldin	weakly	globular	symmetrical	90/100%	yellow	strongly
Filina	moderate	globular	symmetrical	60/75%	yellow	weakly
Flavia	moderate	globular	symmetrical	60/75%	yellow	weakly
Meycrest	moderate	globular	symmetrical	60/75%	yellow	weakly
Elegant Lady	moderate	globular	symmetrical	75/90%	yellow	missing
Redhaven	moderate	globular	symmetrical	45/60%	yellow	missing
El.4-22	moderate	globular	symmetrical	45/60%	yellow	missing
El.7-59	moderate	globular	symmetrical	45/60%	yellow	missing
El.91-23	moderate	globular	symmetrical	45/60%	yellow	missing
El.19-77	moderate	globular	symmetrical	45/60%	yellow	weakly
El.19-132	moderate	globular	symmetrical	60/75%	yellow	weakly
El.19-113	moderate	globular	symmetrical	45/60%	yellow	weakly
El.19-78	moderate	globular	symmetrical	75/90%	yellow	missing
El.30-59	moderate	globular	symmetrical	45/60%	yellow	missing

Table 6 Fruit characteristics of peach cultivars and elites.

Cultivar/Elite	Shape of the fruit	Symmetry	Anthocyan skin colour (%)	Basic colouring of fruit flesh	Presence of anthocyanins in fruit flesh
Morsiani 90	globular	symmetrical	45/60%	yellow	missing
Sunfrey	globular	symmetrical	75/90%	yellow	strongly
Otumfrey	globular	symmetrical	30/45%	yellow	missing
Ardiana	globular	symmetrical	75/90%	yellow	missing
Nektagrand 4	globular	symmetrical	75/90%	yellow	weakly
Gergana	ovate shape	symmetrical	75/90%	yellow	missing
Big top	globular	symmetrical	65/70%	yellow	missing
Independence	ovate shape	symmetrical	75/90%	yellow	strongly
Goldengrand	globular	symmetrical	75/90%	yellow	weakly
El.3-158	globular	symmetrical	75/90%	yellow	missing
El.4-151	globular	symmetrical	75/90%	yellow	missing
El.4-168	globular	symmetrical	30/45%	yellow	missing
El.4-171	globular	symmetrical	45/60%	yellow	missing
El.4-176	globular	symmetrical	75/90%	yellow	weakly
El.29-31	globular	symmetrical	65/70%	yellow	missing
El.23-42	ovate shape	symmetrical	75/90%	yellow	missing



Photo.1 Slight fruit flesh colouration in cultivar 'Meikrest'.



Photo.2 Strong fruit flesh colouration in cultivar 'Puldin'



Photo.3 Slight fruit flesh staining in elite 'El.4-176'



Photo. 4 Strong fruit flesh colouration in cultivar 'Independence'.

Biometric analysis of fruits

Along with fertility, the quality of fruit production is essential in determining the economic qualities of cultivars and elites. The external characteristics of the fruit - size, shape and skin colour - play a dominant role in this respect. In the range of peach and nectarine cultivars and elites observed, the difference in fruit mass is large and statistically proven between most cultivars. In peach fruit, the variation was from 151.07g in elite 19-78 to 345.95g in elite 7-59 (Table 7). In the nectarine fruit results presented, the variation was from 123.91g in elite 4-151 to 270.88g in Goldengrand (Table 8). The difference between the values is large, highlighting the need for differentiation of cultivars according to fruit mass.

Compared to those of Redhaven, the larger fruits are those of Ferlino, El. 30-59, El. 91-23, Puldin, El. 4-22, Ruby Rich, Tarde Belle, Maycrest, Royal Jam, and the last three El. 7-59, Eumolpia, and Laskava fall into the group of very large. The difference between Maycrest, Royal Jem, and Redhaven has not been proven. The same along with Tardy Bell fall into the medium small group. With the smallest fruits are Elegant Lady, El. 19-113 and El. 19-78.

Most nectarine cultivars are known to have smaller fruit than peaches. Only the Goldengrand cultivar has very large fruit. Morsiani 90, 3-158 and 29-31 are large-fruited and there is a proven difference between them. The smallest fruits are those of Nectagrande 4, Adriana and the elites 23-42, 4-151.

From a pomological point of view, peach and nectarine fruits have three spatial dimensions, and usually those with greater mass also have larger dimensions. Specific fruit dimensions can vary quite widely depending on a number of factors, the indices in turn demonstrating more similar values. In this sense they are more indicative in determining fruit shape and indicate the extent to which the fruit is more elongated than broader or stouter and at the same time the extent to which it is broader than stout.

The closer the values of the three indices are to 1, the closer the shape of the fruit is too globular, which is also called regular. Any movement of the value of any index away from 1 indicates a more or less distinct specific fruit shape. As the values of the height-width and height-thickness indices are greater than 1, the fruit is more elongated, and as they decrease by values less than 1, the shape of the fruit is increasingly flat. From the results obtained for peaches with the most regular shape are Ferlino, Elite 91-23 and Elegant Lady. In nectarines, the globe-shaped ones are Othumfrey, Goldengrandi and Elite 4-168. Elite 4-151 is also close to globular in shape. In most nectarines the values of the width-thickness index deviate within a close range, indicating that the shape of the equatorial section is close to circular.

Table 7 Average peach fruit biometrics averaged over 2020-2022.

Cultivar/Elite	Fruit-mass (g)		Rendeman of the fruit flesh (%)	Dimensions (mm)						Indexes		
				height		width		thickness		H/W	H/T	W/T
El.7-59	345,95	a	96,80%	83,68	a	87,58	b	84,8	a	0,96	0,99	1,03
Evmplpiya	343,81	a	96,99%	81,58	bc	90,59	a	84,31	a	0,90	0,97	1,07
Laskava	332,35	a	97,13%	80,27	cd	87,69	b	83,98	a	0,92	0,96	1,04
Ferlino	312,32	b	96,48%	82,81	ab	83,44	c	84,08	a	0,99	0,98	0,99
El.30-59	277,67	c	96,38%	77,18	e	79,96	d	81,68	b	0,97	0,94	0,98
El.91-23	274,45	c	95,93%	78,8	de	79,74	d	79,69	c	0,99	0,99	1,00
Puldin	241,11	d	97,06%	71,3	fg	77,38	e	76,82	d	0,92	0,93	1,01
EL.4-22	237,22	d	96,31%	72,87	f	73,47	gh	74,85	e	0,99	0,97	0,98
Ruby rich	234,92	d	97,05%	67,13	ijk	77,53	e	77,36	d	0,87	0,87	1,00
Tardi belle	214,21	e	96,05%	70,48	g	74,78	fg	73,46	ef	0,94	0,96	1,02
Royal jam	197,6	ef	96,85%	64,45	l	73,19	gh	73,26	ef	0,88	0,88	1,00
Meycrest	196,54	ef	96,24%	65,21	kl	74,45	gh	72,41	f	0,88	0,90	1,03
Redhaven	195,03	ef	95,77%	69,67	gh	72,13	h	71,94	fg	0,97	0,97	1,00
El.19-77	186,67	f	96,62%	65,66	jkl	76,86	ef	69,83	h	0,85	0,94	1,10
Filina	183,32	f	96,28%	67,61	ij	73,64	gh	68,82	h	0,92	0,98	1,07
El.19-132	182,7	f	96,60%	64,53	l	73,09	gh	70,03	gh	0,88	0,92	1,04
Flavia	180,68	f	95,97%	68,08	hi	74,82	fg	66,83	i	0,91	1,02	1,12
Elegant Lady	161,23	g	95,82%	61,48	m	61,4	j	62,83	j	1,00	0,98	0,98
El.19-113	154,28	g	95,96%	60,44	mn	68,1	i	65,94	i	0,89	0,92	1,03
El.19-78	151,07	g	96,69%	59,39	n	68,2	i	65,19	i	0,87	0,91	1,05

Table 8 Average nectarine fruit biometrics averaged over 2020-2022

Cultivar/Elite	Fruit-mass (g)		Rendeman of the fruit flesh (%)	Dimensions (mm)						Indexes		
										H/W	H/T	W/T
				height	width	thickness						
Goldengrand	270,88	a	95,02%	78,00	a	77,70	a	78,74	a	1,00	0,99	0,99
Morsiani 90	219,28	b	95,65%	71,73	cd	73,89	b	73,53	b	0,97	0,98	1,00
El.3-158	211,62	bc	95,49%	73,39	bc	71,98	bcd	71,44	c	1,02	1,03	1,01
El.29-31	206,26	bcd	95,39%	74,25	b	72,59	bc	69,45	def	1,02	1,07	1,05
El.4-168	201,98	cd	94,53%	71,18	d	70,7	cde	70,96	cd	1,01	1,00	1,00
Big top	198,98	cd	94,61%	67,97	ef	73,41	b	70,3	cde	0,93	0,97	1,04
Otumfrey	191,67	de	94,34%	69,00	e	69,21	ef	68,81	efg	1,00	1,00	1,01
Independence	178,28	ef	94,04%	72,11	cd	66,77	ghi	66,26	hi	1,08	1,09	1,01
El.4-176	172,44	f	95,21%	66,76	f	68,1	fgh	68,25	fg	0,98	0,98	1,00
El.4-171	169,58	f	94,87%	68,46	ef	70,03	def	65,98	hi	0,98	1,04	1,06
Sunfrey	165,82	fg	95,91%	62,77	gh	67,71	fgh	67,42	gh	0,93	0,93	1,00
Gergana	153,09	gh	94,94%	67,43	ef	68,99	efg	62,04	jk	0,98	1,09	1,11
Nektagrand 4	146,99	hi	94,88%	58,59	i	64,74	ij	64,62	i	0,91	0,91	1,00
Adriana	142,00	hi	94,10%	60,94	h	66,19	hi	62,44	j	0,92	0,98	1,06
El.23-42	135,54	ij	94,79%	64,16	g	63,72	j	60,56	k	1,01	1,06	1,05
El.4-151	123,91	j	93,80%	62,13	h	61,53	k	60,43	k	1,01	1,03	1,02

Chemical contents of fruit

From studies carried out on the chemical composition of 12 peach cultivars and 8 elites, it was found that the amount of soluble dry matter ranged from 6,40 °Brix to 17,20 °Brix. In peach fruit, sugars are the main component of dry matter. The content of total sugars in the different varieties and elites ranged from 3,76 % in elite 19-113 to 15,36 % in cultivar Eumolpia and generally followed the variation in soluble dry matter. The highest values were recorded in the cultivars Evmplpiya, Laskava and elite 91-23. The results obtained show significant differences in the amount of sucrose between the different cultivars and elites. In elite 19-113 this content was low – 1,24%, while in the cultivars Laskava, Evmplpiya, Ferlino and elites 91-23 and 7-59 it was quite high - from 9,54% to 11,23%, and these values were on average 2 to 4 times higher than the values for invert sugar.

The soluble solids, total sugars and sucrose content of peach fruit shows a relationship related to the ripening period. Late ripening cultivars Laskava, Evmplpiya and Elite 91-23 have the highest values.

Acids, as a mandatory natural balancer of sugars in the fruit of the selected cultivars and elites, ranged from 0,46% to 1,59%. Their content is the lowest in the fruits of the cultivar Filina. The cultivar with the highest acid content was Royal Jam. The elite 4-22 and the cultivars Eumolpia, Redhaven and Meikrest also had a high content.

The results for the active acidity (pH) of the cultivars and elites studied were in a close range of 3,14 to 4,30.

The chemical composition of 9 nectarine cultivars and 7 elites has been studied. The soluble dry matter content ranged from 9,80 °Brix to 23,7 °Brix, indicating a higher range of variation than that of peach fruit.

The total sugars content of the different nectarine cultivars and elites ranged from 9,82 % in the case of the cultivar Gergana and elite 4-151 to 15,44 % in the case of the cultivar Morsiani 90. In general, as in the case of peaches, variation in soluble dry matter follows. Of the sugars in nectarine fruit, sucrose is again predominant. The amount of sucrose varies from 4,94 % to 9,82 % among the different cultivars and elites. High sucrose content was recorded in the varieties Goldengrand, Ottumfrey, Nectagrand 4, Morsiani 90 and in elite 23-42. It is noteworthy that the content in Goldengrand variety (9,82%) and in elite 23-42 (9,63%) was more than 3 times higher than that of invert sugar (3,22%, 2,88%).

Acid values in the fruit of the studied cultivars and elites ranged from 0,45% to 1,54%. The lowest acidity was found in the fruit of the cultivar Gergana. The cultivars with the highest acid content were Adriana and Sunfrey. The cultivars Morsiani 90, Goldengrand and the elites 3-158, 29-31, 4-168 and 4-171 also had high contents. The higher the sugar content and the lower the acid content, the sweeter the taste of the fruit. Of the cultivars and elites studied, only elite 23-42 was distinguished by high sucrose values. It also had relatively lower acidity values.

The active acidity (pH) of the cultivars and elites studied varied within a narrow range, from 3,06 to 4,19.

Organoleptic evaluation

During the study period, multiple sensory analyses were performed by a committee of trained professionals. The sensory characteristics of all fruits were evaluated on a scale of 1 to 9. The final scores were obtained based on the average of the overall scores of each consumer. The appearance of the fruit, its aroma, its flavour, how balanced it is, its texture and the juiciness of the fruit flesh were assessed. The scores for peaches ranged from 'good' - 5 to 'very good' - 7, and for nectarines from 'good' - 5 to 'excellent' - 8. In the case of peaches and nectarines intended mainly for fresh consumption, the appearance is of great importance.

It is determined by the size, shape, colour and uniformity of the fruit. With the most attractive appearance was excellent elite 7-59 - (1,70) . In nectarines this index was highest in elite3-158- (1,73). The cultivar with the most attractive aroma was Laskava and the most intense was elite 30-59. In the case of nectarines, the highest average score for both indicators was elite 29-31. The organoleptic assessment of the fruit is determined by the taste - sweet, sour, bitter and the balance between them, the consistency of the fruit flesh and its aroma. The highest score for sweetness was again elite 30-59. Close to it were Laskava, Puldin, Elegant Lady, Redhaven, elites 4-22 and 7-59.

In nectarine cultivars and elite with the most pronounced sweet taste is elite 29-31. Slightly lower scores were obtained by Sunfrey, Big Top, Goldengrand and elites 3-158,4-151, 4-168, 4-176, and 23-42. Sourness as a balancer of sweetness in fruit flesh was most pronounced in the Eumolpia cultivar for peaches and in Adriana for nectarines. The bitter taste, as undesirable in fruit flesh, is highest in the Royal Jam and Elite 19-132, and in the Nectarine Elite 4-176. The elites 30-59 and 3-158 had the best balance of flavours. Texture and juiciness scores for all cultivars and elites were above one and again the highest scores were for elites 30-59 and 3-158.

The peach cultivars and elites with an overall score of "good" were Tardi Belle, Ruby Rich, Ferlino, Redhaven, Royal Jam, Filina, Flavia and elites 91-23, 19-77, 19-78, 19-132, 19-113. With a "very good" rating are: Laskava, Eumolpia, Puldin, Maycrest, Elegant Lady and elites 4-22 and 7-59. The highest overall score was received by elite 30-59. In the nectarine cultivars and elites, Morsiani 90, Sunfrey, Otumfrey, Gergana, Adriana, Nectagrande 4, elites 4-171 and 4-176 were rated 'good'. Big Top, Independence, Goldengrand and elites 4-151, 4-16, 29-31 and 23-42 were rated "very good". Nectarine elite 3-158 had the highest overall score of "excellent" - (8.28).

Fruit yield

Yield is a key economic indicator. It is influenced by a number of factors, but is primarily determined by the biological characteristics of each cultivar. The average yield of peach and nectarine cultivars is considered to be high if it exceeds 60-70 kg per tree. During the study period, spring frosts occurred during and after flowering, which led to a reduction in yields. Therefore, the reported yields were also lower.

After processing the data with one-factor analysis of variance, it was found that the cultivar with the highest yield and statistically proven difference was Ferlino with 49.256 kg/tree (Table 9). Lower yields per tree were also recorded for cultivar Eumolpia with 40.148 kg/tree,

elite 7-59 with 36.541 kg/tree and elite 4-22 with 27.856 kg/tree. All have a proven statistical difference. The later flowering cultivars avoid the negative spring temperatures, which affects the amount of yield. The Redhaven standard yielded 19,041 kg/tree, which was significantly lower than the yields of Tardy Bel, Puldin, Laskava and the elites 30-59, 4-22.

The standard for early ripening cultivars, Maycrest, has an average yield of 15,992 kg/tree, and slightly higher than this is the early ripening elite 19-132- 17,988 kg/tree. A cultivar with a similar yield to Maycrest is Elegant Lady - 15,155 kg/tree. Lower yields were recorded for cultivars and elites that had earlier flowering and were affected by spring temperatures. Despite the lower yields obtained, influenced by abiotic factors, it can be argued that the later cultivars also had higher yields.

Yield was recalculated in kilograms per hectare based on average yield per tree and 67 trees per hectare. The resulting values follow the same trend.

In nectarine cultivars and elites, the highest average yield per tree is the Goldengrand cultivar - 34,570 kg/tree. With a slightly lower yield was elite 29-30- 29,145 kg/tree (Table 10). The two values obtained have a statistically proven difference. The values of Morsiani 90, Otumfrey and elites 4-171 and 3-158 have no proven statistical difference. The statistical difference between Big Top, Independence, Sunfree and elite 4-168 is also not proven. With the yield values thus obtained, we can state that nectarines follow the same trend as peaches. The early ripening cultivars have lower yields than the late ones. The cultivars Adriana, Gergana and Elite 23-42 are early ripening and their yields are among the lowest. The lowest reported yield is elite 4-151- 9,985 kg/tree.



Table 9 Average yield per tree and yield per acre in kilograms of peach cultivars and elites.

Cultivar/Elite	Average yield kg/tree	Yield kg/dk
Ferlino	49,2 a	3300
Evmpliya	40,1 b	2689
El.7-59	36,5 c	2448
El.91-23	30,3 d	2035
El.4-22	27,8 de	1866
Laskava	28,2 de	1890
Puldin	24,7 ef	1657
El.30-59	22,1 fg	1486
Tardy belle	20,5 gh	1373
Redhaven	19,0 ghi	1275
El.19-132	17,9 hij	1205
Meycrest	15,9 ijk	1071
Elegant Lady	15,1 jk	1015
Royal jam	13,0 kl	877
Flavia	13,4 kl	898
El.19-77	12,3 klm	830
Ruby rich	12,1 klmn	812
Filina	10,5 lmn	707
El.19-113	10,4 mn	578
El.19-78	10,3 n	560

Table 10 Average yield per tree and yield per acre in kilograms of nectarine cultivars and elites.

Cultivar/Elite	Average yield kg/tree		Yield kg/dk
Goldengrand	34,5	a	2316
El.29-31	29,1	b	1952
Morsiani 90	22,2	c	1492
El.4-171	21,7	c	1455
Otumfrey	21,6	c	1452
El.3-158	20,8	cd	1399
El.4-176	17,8	de	1199
Big top	17,1	ef	1148
El.4-168	15,5	ef	1038
Independence	14,8	efg	997
Sunfrey	14,4	efg	966
Nektagrand 4	13,7	fg	921
El.23-42	11,6	gh	778
Gergana	10,9	hi	599
Adriana	10,6	hi	582
El.4-151	9,9	i	467

Indices of fertility

The biological possibilities of individual cultivars can be judged from the fertility indices. They show how much fruit is produced from 1 cm² of trunk cross-sectional area, from 1 m³ of crown volume and from 1 m² of crown projection. The variation of the data from year to year shows the following trend. The yield per unit cross-sectional area of the trunk decreases each year as the trunk grows, which is mainly due to the anticipatory increase in cross-sectional area. This trend persists for the other volume and crown projection indices calculated. When larger values of yield and smaller values of trunk cross-sectional area and crown volume were recorded, larger indices of fertility were observed.

The Stone Characteristics of the stones

The shape, colour and relief of the stone are typical pomological characteristics of each cultivar. They can therefore be used to identify cultivars with a high success rate. In the cultivars and elites we observed, the predominant stone shape is elliptical (Table 11). There were 11 cultivars and elites with this shape. The stones of: Ferlino, Royal Jam, Maycrest, Laskava and elites 19-77 and 30-59 are round. Only Flavia, Filina and elite 19-132 have elongated shapes. The stone colour ranges from light brown, brown to dark brown. It can be seen by observing the change in colour that the transition from the earlier-ripening cultivars to the later-ripening cultivars is accompanied by a transition from lighter to darker stone colour. Light-stoned is the early standard Maycrest, as well as the early ripening Flavia, Filina and the elites 19-113, 19-132, 19-77 and 19-78. The stone of the standard Redhaven and the ripening cultivars just before and after it Royal Jam, Ruby Rich and Laskava are brown. All other cultivars and elites ripening after mid-August have dark coloured stone. There are two types of stone, pitted or grooved. Twelve of the peach cultivars and peach elites have dimples and the rest have grooves. The predominant stone shape in nectarines is elliptical (Table 12). Round-shaped are Sunfrey, Otumfrey and elite 4-151. Only Adriana and elite 4-171 have an elongated stone. The colouration of the stone follows the same trend as in peaches. All the early ripening cultivars have a light stone, such as Adriana, Gergana and elite 23-42. The mid-season ripening peaches have a brown stone colour: Independence, Nectagrande 4 and Sunfrey. All late ripening cultivars, such as Goldengrand, Ottumfrey, Morsiani 90 and Elite 29-31, have dark brown stones. The surface of most of the observed nectarine cultivars and elites is covered with grooves. Only Sunfrey, Nectagrand 4, and elites 4-168 and 4-176 have pitting on the stone surface.

Table 11 Stone characteristics in peach cultivars and elites.

Cultivar/Elite	Shape	Coloration	Relief
Flavia	elongated	light brown	dimples
Filina	elongated	light brown	dimples
Ferlino	round	dark brown	dimples
Tardi belle	ellipsoidal	dark brown	dimples
Ruby rich	ellipsoidal	brown	dimples
Royal jam	round	brown	dimples
Redhaven	ellipsoidal	brown	dimples
Puldin	ellipsoidal	dark brown	grooves
Meycrest	round	цветло к-ва	dimples
El.30-59	round	dark brown	grooves
Laskava	round	brown	dimples
Elegant Lady	ellipsoidal	dark brown	grooves
Evmpliya	ellipsoidal	dark brown	grooves
El.91-23	ellipsoidal	dark brown	grooves
El.19-132	elongated	light brown	grooves
El.19-113	ellipsoidal	light brown	dimples
El.19-78	ellipsoidal	light brown	dimples
El.19-77	round	light brown	dimples
El.7-59	ellipsoidal	dark brown	grooves
El.4-22	ellipsoidal	dark brown	grooves

Table 12 Stone characteristics in nectarine cultivars and elites.

Cultivar/Elite	Shape	Coloration	Relief
Goldengrand	ellipsoidal	dark brown	grooves
Morsiani 90	ellipsoidal	dark brown	grooves
El.3-158	ellipsoidal	dark brown	grooves
El.29-31	ellipsoidal	dark brown	grooves
Big top	ellipsoidal	dark brown	grooves
El.4-168	ellipsoidal	dark brown	dimples
Outmfrey	round	dark brown	grooves
Independence	ellipsoidal	brown	grooves
El.4-176	ellipsoidal	brown	dimples
El.4-171	elongated	dark brown	grooves
Sunfrey	round	brown	dimples
Gergana	ellipsoidal	light brown	grooves
Nektagrand 4	ellipsoidal	brown	dimples
Adriana	elongated	light brown	grooves
El.23-42	ellipsoidal	light brown	grooves
El.4-151	round	light brown	grooves



Photo. 5 Round stone, light coloured with dimples.



Photo. 6 Elliptical drupe, darkly coloured with grooves.



Photo. 7 Elongate stone, light coloured with grooves.



Photo. 8 Elliptical drupe, darkly coloured with grooves.

Biometric analysis of stones

The values of the biometric parameters for the stones are significantly more constant from year to year. According to a number of authors, peach and nectarine cultivars can also be identified by the characteristics of the stone. In general, the pits of the cultivars studied were of normal size in relation to the total fruit mass/stone ratio. Peach stone weights ranged from 5,00 g in Elite 19-78 to 10,82 g in Ferlino (Table 13). In nectarines, these values were more elevated and ranged from 6.65g for Sunfrey to 13.14g for Goldengrand (Table 14). Analyzing the results for the averages for stone mass, considering the demonstrability of the differences between the averages, we adopted the following cut-off values for our proposed groups.

Classification of drupes in pomological description of peach and nectarine cultivars:

- cultivars and elites with small stone - up to 5g
- cultivars and elites with medium-sized stone - from 5,1g to 7g
- large stone cultivars and elites - 7,1g to 9g
- cultivars and elites with very large stone - over 9g

The height at the stone is the largest of the three sizes. Width is significantly smaller than height and thickness. In most cases, the heavier stone corresponds to the larger size.

There was a trend of increasing endocarp mass with increasing fetal mass. The percentage ratio between them shows significant differences. This means that this indicator is an important pomological characteristic which gives certain advantages to certain varieties. For a more rational systematisation of cultivars according to this trait, the percentage ratio between the weight of the endocarp and that of the whole fruit is considered to be low when its arithmetic mean is below 6% medium -6.1% to 7% and high - over 7%. From the values obtained for peaches, in all the cultivars and elites presented, the percentage ratio is below 6%, which means that it is low in all variants. The percentage ratio of stone weight to fruit weight was low in Ferlino, Eumolpia, Laskava, 30-59, 91-23 and 7-59, which exhibited large fruit and stones.

In nectarine cultivars and elites, only elite 4-151 has an average percentage (6.20%), although, it also has the smallest average fruit mass. The difference between its mean and that of each cultivar and elite with low percentage is proven. The cultivars Goldengrand, Big Top and Ottumfrey and 4-168 have the highest stone mass but have a low percentage ratio.

Table 13 Average biometrics of peach pits for the period 2020-2022.

Cultivar/Elite	mass (g)	Relative share (%)	Height (mm)	width (mm)	Thickness (mm)
Ferlino	10,82 a	3,52 def	42,03 b	22,62 a	29,56 ab
Evmplpiya	10,18 ab	3,01 ghi	39,92 c	22,85 a	28,97 bc
EL.91-23	10,53 ab	4,07 ab	41,82 b	22,60 a	29,69 ab
EL.7-59	10,72 ab	3,20 fgghi	44,02 a	22,30 a	30,12 a
EL.30-59	9,96 bc	3,62 cde	40,30 c	23,08 a	30,28 a
Laskava	9,32 c	2,87 i	37,78 d	20,21 bc	28,22 c
Redhaven	8,10 d	4,23 a	38,23 d	19,99 bcd	27,18 d
EL.4-22	8,14 d	3,69 bcde	38,01 d	19,23 cde	27,09 d
Tardi belle	8,35 d	3,93 abc	37,06 de	19,54 bcde	26,39 d
Flavia	7,11 e	4,03 ab	33,39 fg	19,55 bcde	24,60 e
Meycrest	7,19 e	3,76 bcd	32,58 gh	19,43 bcde	25,23 e
Elegant Lady	6,64 ef	4,18 a	36,25 e	19,52 bcde	26,42 d
Ruby rich	6,73 ef	2,95 hi	33,64 fg	20,41 b	24,95 e
Filina	6,76 ef	3,72 bcd	34,09 f	18,53 e	24,31 e
Puldin	6,80 ef	2,94 hi	33,98 f	19,43 bcde	24,09 e
EL.19-132	6,08 f	3,40 def	32,94 fgh	19,60 bcde	24,10 e
EL.19-113	6,12 f	4,04 ab	31,73 h	18,82 e	24,80 e
EL.19-77	6,12 f	3,38 defg	27,59 j	19,02 de	21,09 g
Royal jam	6,19 f	3,15 fgghi	33,89 fg	19,93 bcd	25,02 e
EL.19-78	5,00 g	3,31 efgh	30,22 i	18,71 e	22,29 f

Table 14 Average biometrics of nectarine stones for the period 2020-2022.

Cultivar/Elite	mass (g)	Relative share (%)	Height (mm)	width (mm)	Thickness (mm)
Goldengrand	13,14 a	4,98 defg	43,39 c	25,76 a	30,98 a
El.4-168	10,87 b	5,47 bcd	43,30 f	23,32 b	30,07 ab
Otumfrey	10,62 bc	5,66 abc	43,56 a	21,90 c	29,57 b
Big top	10,42 bc	5,39 bcde	38,53 cd	21,74 c	27,93 c
Independence	9,87 cd	5,96 ab	39,21 c	20,23 efg	25,76 fg
Morsiani 90	9,26 de	4,35 hi	40,99 b	24,85 a	27,60 cd
El.29-31	9,00 ef	4,61 fghi	42,95 a	21,75 c	26,82 de
El.3-158	8,93 ef	4,51 ghi	39,23 g	21,55 cd	28,12 c
El.4-171	8,54 ef	5,13 cdefg	37,86 ef	20,48 def	26,50 ef
Adriana	8,21 fg	5,90 ab	37,18 cd	20,34 efg	25,46 g
El.4-176	8,13 fg	4,79 efgh	37,33 de	20,57 de	25,45 g
El.4-151	7,64 gh	6,20 a	35,88 f	19,42 efgh	25,30 g
Gergana	7,62 gh	5,06 cdefg	39,04 c	19,99 efgh	25,91 efg
Nektagrand 4	7,33 ghi	5,12 cdefg	34,64 a	19,22 gh	25,09 g
El.23-42	6,92 hi	5,21 cdef	35,54 d	19,33 fgh	25,24 g
Sunfrey	6,65 i	4,09 i	31,68 a	19,01 h	26,85 de

LEAF Leaf petula

The length of the leaf spot in the peach cultivars and elites studied varied from 143.62 mm. in elite 19-113, to 164.62 mm. in the cultivar Laskava. The cultivars Maycrest, Puldin and Flavia also had longer leaf petulae. The cultivars with relatively shorter leaf blades are Redhaven, Tardy Bel and the elites 19-132, 4-22, 30-59 and 19-113. Leaf petal width ranged from 36.30 mm for elite 19-132 to 45.68 mm for Maycrest. Only a statistically proven difference exists between them. The shape of the leaf spot in the main part of the peach sample studied is lanceolate. Broadly lanceolate in shape are the leaf petulae of the cultivars Laskava and Maecrest, and narrowly lanceolate in the elites 30-59 and 19-113.

Of the nectarines studied, the leaf spot of cv. Sunfrey was the longest at 157.45 mm, followed by that of cv. Otumfrey at 156.33 mm. The shortest leaf spot was that of cv. Big Top - 121.92 mm and relatively short was that of cv. Elite 4-176 - 132.25 mm. The values of the first two mentioned cultivars have statistically proven difference compared to the two lowest values.

The size of leaf spot width in nectarines varies from 37.10 mm in elite 29-31 to 43.72 mm in elite 4-171. The leaf petulae of cultivar Sunfrey are also wider at 42.93 mm, followed by those of elites 4-168, 3-158 at 42.67 mm. The shape of the leaf petula in all observed nectarines is lanceolate, except that of cv Big Top, Morsiani 90 and elite 4-151 which is narrowly lanceolate.



Leaf glands - presence, count, shape and location

Leaf glands are a pomological trait playing a role in descriptions and identification of cultivars. They are an indicator of susceptibility to powdery mildew and leaf curl. The predominant gland type in peaches and nectarines of the groups studied is the kidney-shaped. The rounded gland types in peaches were Filina, Maycrest and Elite 4-22. Of the nectarines are Otumfrey, elites 4-176, 4-151, 29-31, with two of the elites 4-171 and 4-168 completely lacking in the nectarines. During the annual examination of the leaves, it was found that the glands located on the petiole were larger in size compared to those on the periphery of the leaf petula. The average total number of glands in peaches ranged from 1,73 in Maycrest to 4,25 in Puldin. For nectarines, these numbers range from 2.17 for elite 29-31 to 4.12 for elite 23-42. Large differences in the mean number of glands were not observed within the samples of cultivars studied. The majority of the leaf glands were located on the petiole and fewer towards the base of the leaf blade. The number of glands located on the periphery of the petura was very small compared to on the petiole. In the presence of leaf glands it can be said that the plants of the cultivars studied are not so susceptible to disease.



Photo. 5 Rounded glands



Photo. 6 Kidney glands



Photo. 7 Without glands

Length of leaf stalk and serration of the leaf petula

During the study period, it was found that leaf petiole dimensions did not vary widely. In the case of peaches, the average values obtained for the different years were between 9 and 10 mm. The average results for 2020-2022 show that only elite 19-113 (13,32mm) has a statistically proven difference. Elites 19-77 and 19-132 are close to its value. The shortest shank was found in elite 30-59- 8.85mm, and its value was statistically proven against the values of all other variants. In nectarine cultivars and elite it is seen that the values vary in a wider range from 7 mm to 10 mm. Independence and elite 23-42 had the longest petioles over the entire study period. From the results obtained, we can state that leaf petiole sizes in nectarines are smaller than those of peaches. The periphery of the leaf petula in peaches is shallowly cut in eight variants, while in the rest it is only cut. In nectarines it is cut in ten of the variants, shallowly cut in four. Only two of the elites are deeply sliced.



Photo. 8 Shallow cut



Photo. 9 Deep-cut

CHARACTERISTIC OF TREES

Length and structure of annual increment

Throughout the study period, the largest percentage in the structure of annual increment was formed by mixed branches in both peach and nectarine trees. The values in all three years were above 50% for all, which implies that these are the main branches forming the annual increment. With slightly smaller percentages than mixed are the precocious twigs. The proportions of bouquet and flowering are the third largest contributors to the annual increment structure. Woody twigs occupy the smallest percentage, and the laccomers are almost absent, occupying only 0.20% to 1.49% of the annual increment structure.

Volume of crown

The smaller size of the trees makes it possible to increase their number per unit area, which in turn leads to an intensification of fruit production. Crown volume is the indicator that

combines all the dimensions of the crown and in this sense it is the most indicative in determining the growth performance of the cultivar and the habit of the crown. The average values for the study period for peaches ranged from 3.28 for elite 30-59 to 11.46 for elite 19-77. In nectarines, the mean values for crown volume over the whole period ranged from 4.88 for elite 4-151 to 9.48 for the cultivar Gergana.

Morphological characterization of the mixed branch

The averages obtained for mixed twig length in peaches over the three-year period varied widely from 39.2 cm in elite 4-22 to 48.9 cm in Redhaven. The mean values for internode length ranged from 1.6 cm for elite 30-59 to 2.1 cm for 7-59, 19-77 and Redhaven. The difference between the values of the two groups mentioned is only 0.5 cm, but we can still say that there is a relationship between the length of the mixed branch and the length of the internodes. The average number of nodes for the period ranges from 47.6 to 62.5, as the same is related to the length of the internode. The smaller the internodes the more nodes there are per linear meter. Redhaven, elites 7-59, 19-77 have the lowest average number of nodes as they have the largest inter-node spacing. The highest number of nodes per linear meter were obtained in Puldin, Tardy Belle, Ruby Rich and elite 30-59. A large number does not always guarantee a large number of fruit buds. A high number of nodes has been found on Ruby Rich, but the average number of flower buds per mixed branch is 16.7 and 39.9 per linear metre. The average number of fruit buds per mixed branch ranged from 14 in elite 4-22 to 23.8 in elite 30-59. Correspondingly, per 1 m, 4-22 formed 35.4 pc and 30-59 had 62.2 pc, indicating that in our results elite 30-59 had the highest number of nodes and the highest number of fruit buds.

The average length of the mixed branch in nectarines ranges from 39.5 cm. in Big Top to 49.6 cm. in Gergana. The average internode length in nectarines ranged from 1.7 cm. in Adriana and Big Top to 2.3 cm. in Gergana, elite 23-42, Sunfrey, elite 4-168 and elite 3-158 with a difference of 0.6 cm. As with peaches, longer mixed branches also have larger internodes. The average number of nodes per linear metre ranged from 43.5 to 58.8. The average number of flower buds per mixed branch ranges from 11 in Big Top to 24,9 in Adriana. It is interesting to note that in our results of the two varieties with the most nodes, one had few fruit buds and the other had the most. The Big Top variety with 11.6 flower buds per mixed branch has 28.9 flower buds per 1m.

The cultivar Adriana with 24.9 flower buds per mixed branch has 56.8 flower buds per 1m. The lowest number of fruit buds was found in Independence, which has an average number of nodes per 1m.- 47,6 pcs, but flower buds per mixed branch are 11,5 pcs and per 1 linear meter are 24,3 pcs. By the average number of flower buds per linear metre we can judge the biological potential for fruit load and the flowering strength of individual varieties. The most common grouping of flower buds by node that we observed was - leaf-fruitful (LF), fruitful-leaf-fruitful (FLF) and fruitful only (F). In most of the peach cultivars and elites, the largest percentage of the mixed branch was occupied by FLF.

RELATION TO ABIOTIC AND BIOTIC STRESSORS

Resistance to late spring frosts

Critical spring temperatures were recorded in 2020 and 2021 of the study. In 2022, the impact of freezing temperatures resulted in natural flower thinning. In 2020, four dates with critical negative temperatures were recorded, which coincided with the phenological phases of flower initiation and full bloom in most of the observed cultivars and elites. The lowest recorded temperatures were on 16 March at -2.6°C , and 17 March at -4.9°C . Over the next two days, temperatures reached -2.4°C on 18 March and -1.6°C on 19 March. The degree of damaged flowers ranged from 59% in the Eumolpia variety to 99.67% in Redhaven. The degree of damage is influenced not only by the negative temperature, but also by its duration and the phenological phase of the trees. Due to its later phenological development, elite 30-59 has 74.67% damaged flowers, and the same applies to the variety Eumolpia - 59%.

In 2021, the recorded freezing temperatures compared to the previous year are not so low, and they are in late March and early April. The lower temperatures coincide with the phenological phases of mass petal display and the start of flowering on 27 March $-2,8^{\circ}\text{C}$ and on 28 March $-1,2^{\circ}\text{C}$. This year, full flowering in all variants occurred between 3 and 6 March and coincided with the low temperatures recorded on 4 April at $-0,8^{\circ}\text{C}$ and on 6 April at $-0,4^{\circ}\text{C}$. The greatest flower damage was found in the cultivar Royal Jam 99%, which was in full bloom on 4 April.

In 2020, nectarine varieties and elites were also reported to suffer flower damage. The negative values in Table 40 show that they range from 84% for the Morsiani 90 variety to 100% for the Sunfree cultivar. Compared to peaches, frost percentages were higher in nectarines. At the onset of freezing temperatures, all cultivars and elites are in the onset of flowering or full flowering phenophase. In 2021, reported percentages of flower frost ranged from 73.33% for Goldenrand to 100% again for the cultivar Sunfree (Table 41). In the latter, due to earlier phenological development, mass dieback of all flowers was observed in both years. In the period of negative temperature recordings on 4 April at -0.8°C and on 6 April at -0.4°C , all observed cultivars and elites were in full bloom. The most susceptible flowers were those of the cultivar Sunfree, where 100% frost was observed.

Relation to peach leaf curl disease (Taphrina deformans)

The collection plantation is cultivated under conventional plant protection and therefore the damage reported was not extensive or completely absent in some of the cultivars and elites. The disease attack is expressed in early spring with the first leaves, which are completely deformed or partially, acquiring a purple-red colouration with characteristic thickening of the leaves. Deformations or cracks are observed on the damaged fruit. At the time of the study, the necessary treatments were carried out after leaf fall and before bud burst. For this reason, during the three-year period under consideration, we cannot state definitively the presence of resistance or susceptibility of a given cultivar or elite.

In 2020, weak spring disease events were reported in Tardy Belle, Maycrest, Filina, Redhaven, Eumolpiya, and in elites 19-78, 19-113, 19-132, and 30-59. Slightly higher leaf

damage was recorded in 2021 in the cultivars Elegant Lady, Tardy Belle and both elites 19-77, 19-132. In 2022, low leaf damage was found on Maycrest, Puldin, Tardy Bel and elites 4-22 and 19-77. On average over the entire period, weak damage was recorded on: Tardy Belle, Elegant Lady, Filina and three of the elites 4-22, 19-77 and 19-132. Over the entire study period, no leaf damage was observed on elite 91-23 alone.

In nectarines, the damage recorded for the entire study period was slight and moderate. In 2020, weak failures were recorded in Morsiani 90, Independence, 4-168 and 3-158. In 2021, moderate foliar damage was recorded in Sunfrey and Otumfrey. Leaf damage was less severe on Morsiani 90, Big Top, Goldengrand and two of the elites 3-158, 23-42. In 2022, leaves of Sunfrey, Otumfrey and two of the elites 3-158 and 4-168 were slightly damaged. On average over the period, slight damage was found on Morsiani 90, Big Top, Sunfree, Ottumfree, Independence, 3-158 and 4-168. It is noteworthy that in the cultivars Nectagrande 4 and 29-31, no damage by peach leaf curl disease was found during the entire period of the study.

Infestation by green peach aphid (Myzus persicae (Sulzer))

The plantation is grown under conventional crop protection therefore the presence and density of aphids varies. In such a situation it cannot be said that a cultivar is not attacked or is preferred. The categories 'no' infestation, 'slight' infestation and 'medium' to 'strong' infestation were used in the visual recording of infestation during the three years of the study. Green peach aphid infestation in 2020 was completely absent in Ferlino, Philina, 91-23, 19-132, and 19-113. Light infestation was reported at Maycrest, Redhaven, Eumolpiya, 4-22, 7-59, 19-77, 19-78, and 30-59. Medium offense was posted by Laskava, Flavia, Royal Jam, Puldin and Elegant Lady. Strong attack was recorded in Tardy Belle and Ruby Rich. In 2021, there was little or no attack. It was weak in Tardy Belle, Lascova, Maycrest, Filina, Redhaven, Elegant Lady, Eumolpiya, Royal Jam, Puldin, 4-22, 7-59, 19-78 and 30-59, and absent in the other cultivars observed. In 2022 almost no attacks were detected, only Ruby Rich, Elegant Lady, Puldin and 30-59 were weakly attacked. For the entire period of the survey, no damage by the pest was recorded in Ferlino, 91-23, 19-132, 19-113.

In nectarines, the reported attack in the three-year period was of average or absent completely. In the first year, average attack was recorded in Morsiani 90, 3-158 and 4-151. Poorly attacked were Big Top, Independence, Goldengrand, 23-42, 4-168 and 29-31. There was a lack of offense at Sunfrey, Otumfrey, Adriana, Nectagrand 4, Gergana, 4-171 and 4-176. In 2021, weak attacks were recorded on young shoots at Morsiani 90, Big Top, Otumfrey, Independence, 3-158, 4-151, 23-42, 4-168, 4-176 and 29-31. The other options were completely lacking. In 2022, as with peaches in the same year, weak failures were found only in Goldengrand, Gergana and 4-176.

COMPLEX AGROBIOLOGICAL ASSESSMENT

As a result of the three-year agrobiological studies, a comprehensive agrobiological evaluation of the studied cultivars and elites of dessert peaches and nectarines can be made, allowing their classification into categories of varying degrees of importance. The complex evaluation is based on the main characteristics that the cultivar or elite should meet - high fertility, rich sensory profile of fruits, high content of main chemical components in fruits, high

degree of resistance to biotic and abiotic stress factors, possibilities for cultivation under reduced technology, etc.

We identified 7-59 and 91-23 as the most promising of the peach elites, and Laskava and Eumolpiya as the most promising of the cultivars. Of the nectarine varieties and elites, Big Top, Independence, Goldengrand, 3-158, 4-168, and 29-31. All of them were distinguished by large fruit, attractive appearance, very good taste and good chemical composition.

Promising are the cultivars Puldin, Ferlino, Maycrest, Elegant Lady and the peach elites 4-22 and 30-59, and the nectarines 4-176, 4-171, Gergana, Adriana and Otumfrey, corresponding to a lesser extent to the above indicators.

Very interesting peaches are the Tardy Belle - because of the late ripening period. The Ruby Rich, Royal Jam and Redhaven varieties - for their large fruit and attractive appearance, and the Morsiani 90 nectarines - for their late ripening and large fruit. Nectagrande 4 and Sunfrey - for their very good flavour and attractive appearance.

Interesting are the elites 19-77, 19-132 and the cultivars Filina and Flavia - due to the early ripening period of the fruit. Of the nectarines, elites 23-42 and 4-151 are interesting. These have an early ripening period. This group has smaller fruit sizes but has a good appearance, a rich chemical composition and a good sensory profile.

Of average interest are the 19-78 and 19-113 elites. Again, they have an early ripening period, but their fruit is the smallest and the flavour is not as good.

For the purposes of the breeding programme for new peach and nectarine cultivars, we propose that the Laskava and Eumolpiya cultivars be included in the hybridisation plan, as are the elites 7-59 and 91-23. For nectarines, we propose to include the elites 3-158, 4-168 and 29-31

BRIEF POMOLOGICAL DESCRIPTIONS OF THE PEACH AND NECTARINE ELITES STUDIED

Elite 19-113

It was created by a controlled cross from the parent combination Fayette x Maycrest. The tree has moderate growth. The flowers are pink, the petals are dark pink, with a medium elliptical shape. Flowering is medium early. The fruit ripens very early - 20-25 June. They are small with a mass ranging between 150-170 g. The shape is globular. The skin is moderately soft. The surface colouration is 45-60 %. The flesh is tender, yellow with a slight reddish tinge, juicy, sweet with a slight acidity. The stone is medium-sized,



light brown.

Elite 19-132

It was created by a controlled cross from the parent combination Fayette x Maycrest. The tree has moderate growth. The flowers are pink, the petals are light pink and round in shape. Flowering is medium early. Fruits ripen very early- 20-25 June. They are small with a mass varying between 170 - 180 g. The shape is globular. The skin is moderately soft. The skin colouration is 60-75 %. The flesh is tender, yellow with a slight reddish tinge, juicy, sweet with a slight acidity. The stone is medium-sized, light brown.



Elite 19-77

It was created by a controlled cross from the parent combination Fayette x Maycrest. The tree has moderate growth. The flowers are pink, the petals are dark pink and round in shape. Flowering is medium early. Fruits ripen very early 20 - 25 June. They are small with a mass ranging between 180 - 190 g. The shape is globular. The skin is moderately soft. The colouring covers 45-60 % of the surface. The flesh is tender, yellow with a slight reddish tinge, juicy, sweet with a slight acidity. The stone is a medium-large light brown, semi-detached from the flesh.



Elite 19-78

It was created by a controlled cross from the parent combination Fayette x Maycrest. The tree has moderate growth. The flowers are pink, the petals are dark pink with a medium elliptical shape. Flowering is medium early. Fruits ripen very early- 20-25 June. They are small with a mass ranging between 150-170 g. The shape is globular. The skin is moderately soft. The colouring covers 75-90 % of the surface. The flesh is tender, yellow, juicy, sweet and sour. The stone is small, light brown, semi-separable from the flesh.



Elite 7-59

It was established by selection in a population derived from open pollination of the variety Ionetta. The tree has moderate growth. The flowers are bell-shaped, the petals are dark pink with a narrow elliptical shape. Flowering is medium early. The fruit ripens late - 20-25 August. They are very large 320 - 350g. The shape is globular. The skin is moderately smooth, the covering colour occupies 45-60 % of the surface. The flesh is tender, yellow, juicy, very sweet. The stone is very large, dark brown, separating from the flesh.



Elite 91-23

It was established by selection in a population derived from open pollination of an F1 hybrid selected from the parental combination Halle x *P. davidiana*. The tree has moderate growth. The flowers are pink, the petals are light pink, round in shape. Flowering is medium early. The fruit ripens late - 25-30 August. They are on average 260-280g. The shape is globular. The skin is moderately smooth, the covering colour occupies 45-60 % of the surface. The flesh is tender, yellow, juicy, sweet and sour. The stone is very large, dark brown, separating from the flesh.



Elite 4-22

It was established by selection in a population derived from open pollination of the Somerset variety. The tree has moderate growth. The flowers are pink, the petals are dark pink and round in shape. Flowering is medium early. The fruit ripens late - 25-30 August. They are medium sized 210-240g. The shape is globular. The skin is moderately smooth, the covering colour occupies 45-60 % of the surface. The flesh is yellow, tender, juicy, sweet and sour. The stone is large, dark brown, separating from the flesh.



Elite 30-59

It was created by selection in a population obtained from open pollination of the variety Lascava. The tree has moderate growth. The flowers are bell-shaped, the petals are dark pink with a narrow elliptical shape. Flowering is late. Fruits ripen late - 25-30 August. The shape is globular. The skin is moderately smooth, the covering colour occupies 45-60% of the surface. The flesh is yellow, tender, juicy, sweet and sour. The stone is large, dark brown, separating from the flesh.



Elite 23-42

He was created by controlled crossbreeding from the parent combination Goldendgrand x Aureliogrand. The tree has moderate growth. The flowers are pinkish, the petals are light pink with a rounded foma. Flowering is medium early. Fruits ripen very early 1-5 July. They are small 130-150g. The shape of the fruit is ovoid. The skin is shiny and the covering colour covers 75-90% of the surface. The flesh is tender, yellow, juicy, sweet and sour. The stone is medium-sized, light brown.



Elite 4-151

It was established by selection in a population derived from open pollination of the cultivar Independence. The tree has moderate growth. The flowers are pink, the petals are dark pink and round in shape. Flowering is medium early. Fruits ripen early 10-15 July. They are small 120 - 140g. The shape is globular. The skin is shiny and the covering colour covers 75-90% of the surface. The flesh is tender, yellow, juicy, sweet and sour. The rind is large, light brown, separating from the flesh.



Elite 4-176

It was established by selection in a population derived from open pollination of the cultivar Independence. The tree has moderate growth. The flowers are pink, the petals are light pink and round in shape. Flowering is medium early. The fruit ripens on average late- 10-15 August. They are medium sized 160-180g. The shape is globular. The skin is shiny and the covering colour covers 75-90% of the surface. The flesh is tender, yellow, juicy, sweet and sour. The rind is large, brown, separating from the flesh.



Elite 3-158

It was established by selection in a population derived from open pollination of the Goldengrand variety. The tree has moderate growth. The flowers are pink, the petals are dark pink and round in shape. Flowering is medium early. The fruit ripens late - 15-20 August. They are very large 210-230g. with globular shape. The skin is shiny and the covering colour covers 75-90% of the surface. The flesh is tender, yellow, juicy, sweet and sour. The stone is large, brown, separating from the flesh.



Elit 4-171

It was established by selection in a population derived from open pollination of the cultivar Independence. The tree has moderate growth. The flowers are pink, the petals are light pink and round in shape. Flowering is medium early. Fruits ripen late 15-20 August. They are medium-sized with a mass of 160-180g. The shape is globular. The skin is shiny and the covering colour covers 45-60 % of the surface. The flesh is tender, yellow, juicy, sweet and sour. The stone is large, dark brown, separating from the flesh.



Elit 4-168

It was established by selection in a population derived from open pollination of the cultivar Independence. The tree has moderate growth. The flowers are pink, the petals are dark pink and round in shape. Flowering is medium early. Fruits ripen late- 20-25 August. They are medium-sized with a mass of 200-220g. The shape is globular. The skin is shiny and the covering colour covers 30-45 % of the surface. The flesh is tender, yellow, juicy, sweet and sour. The stone is very large, dark brown, separating from the flesh.



Elite 29-31

It was created by Assoc. S. Dubov The tree has moderate growth. The flowers are pink, the petals are dark pink, round in shape. Flowering is medium early. Fruits ripen late 25-30 August. They are large 200-220g. The shape of the fruit is globular. The skin is shiny and the covering colour occupies between 65-70 % of the surface. The flesh is tender, yellow, juicy, sweet and sour. The stone is very large, dark brown, separating from the flesh.



CONCLUSIONS

1. The earliest onset of vegetation during the study period occurred in 2020. The beginning of the growing season occurs latest in the peach cultivars Eumolpiya and Elite 30-59.
2. Late flowering of the peach sample studied was characterised by Eumolpiya and elite 30-59. Of the nectarines, elite 23-42 had the latest flowering. The peaches with the earliest flowering were Flavia and Filina, and the nectarines Sunfrey.
3. The largest of the rose type is the diameter of the blossom in the peach elite 91-23, and of the bell type, that of the nectarine cultivars Adriana.
4. The peach cultivars Laskava and Ferlino and the nectarine cultivars Sunfrey, Independence and Goldengrand show the greatest flowering power.
5. The earliest ripening peach fruits are of the Flavia cultivar and the latest of the Tardy belle. Of the nectarines, the earliest to ripen are the fruits of the cultivar Adriana and the latest the fruits of the Morsiani 90.
6. The highest average fruit mass was demonstrated by elite 7-95 peaches and by Goldengrand nectarines. The smallest fruits were those of the peach cultivar Elegant Lady and elites 19-78, 19-113. Of the nectarine sample, the cultivars Adriana, Nectagrande 4 and the elites 4-151, 23-42 had the smallest fruit.
7. In the presence of 90-100% fruit skin colour in peaches, strong anthocyanin colouration of the fruit flesh is also observed. The highest percentage of anthocyanin colour is found in the skin and flesh of the cultivars Puldin and Royal Jam.
8. The highest values of yield per tree and per acre are for the peach cultivar Ferlino and the nectarine cultivar Goldengrand.
9. The content of the main chemical components soluble solids, total sugars and sucrose in the fruit of the two pomological groups is directly related to the ripening period. The fruit of late-ripening cultivars and elites have the richest chemical composition. The only exception is the early nectarine elite 23-42, whose fruit is high in sucrose.
10. With the best sensory profile are the fruits of the nectarine elite 3-158 and the peach cultivar Laskava.
11. The smallest pits are elite 19-78 of peaches and Sunfrey of nectarines. The relative proportion of pits of the Laskava and Sunfrey cultivars is lowest. Ferlino and Goldengrand have the largest pits, with Redhaven and Elite 4-151 having the highest relative proportion.

12. The leaf petals of the peach cultivar Laskava and the nectarine cultivar Sunfree have the largest area, and the leaf petioles of peaches are longer than those of nectarines.
13. Only nectarine elites 4-171 and 4-168 do not form leaf glands. The peach cultivars Filina, Maycrest and elite 4-22 as well as the nectarine elites 4-176, 4-151, 29-31 and the cultivar Otumfrey have rounded glands. The predominant group of peaches and nectarines studied had kidney-shaped leaf glands.
14. The main share in the structure of annual growth in peaches and nectarines is occupied by mixed branches, with the highest share in the cultivars Adriana and Nectagrand 4. Mixed twigs account for the smallest proportion in the cultivars Ferlino and Filina. However, the same is quite sufficient for optimum yield.
15. The longest branch is the mixed branch of Redhaven peach and Gergana nectarine.
16. The greatest average number of flower buds per mixed branch and per 1 linear meter of the same forms the peach elite 30-59 and the nectarine cultivar Adriana. The predominant grouping of buds at the nodes of the mixed branch in both pomological groups is (flower-leaf-flower) followed by (flower-leaf).
17. The duration of the growing season is shortest in the Maycrest cultivar and 23-42. With the longest vegetation period are the cultivars Tardi bel and Morsiani 90.
18. The most resistant to late spring frosts are the flowers of the cultivars Eumolpiya and Goldengrand.
19. Green peach aphid is least attacked by Ferlino and elite 91-23, 19-113 and 19-132 of peaches, and by Sunfrey, Adriana, Nectagrande 4 and elite 4-171 of nectarines.
20. The main peach leaf curl disease affects the peach cultivars Tardy Belle, Elegant Lady, Filina and elites 4-22, 19-77 and 19-132 least severely, and only elite 91-23 had no leaf damage throughout the study period. In nectarines, Morsiani 90, Big Top, Sunfrey, Otumfrey, Independence and elites 3-158, 4-168 were slightly attacked. For the whole period, no lesions were found in the cultivars Nectagrand 4 and 29-31.

SCIENTIFIC AND APPLIED CONTRIBUTIONS

Original contributions

1. For the first time in our country, complex agrobiological studies of dessert peach elites obtained as a result of long-term breeding activity have been conducted, which is practically the final stage of the breeding process. As a result, two new candidate cultivars 7-59 and 91-23 were selected.
2. In the nectarine pomological group, again for the first time in Bulgaria, the agrobiological characteristics of seven nectarine elites created under the nectarine breeding program were

studied comprehensively, resulting in the selection of three candidate cultivars 3-158, 4-168 and 29-31.

3. Complex agrobiopomological studies were conducted on the new for our country dessert peach varieties Tardy Belle, Ruby Rich, Ferlino and Royal Jam and nectarine varieties Morsiani 90 and Big Top.
4. To update the breeding programme for new peach and nectarine cultivars, it is proposed to include the elites 7-59 and 91-23 in the new hybridization plan. In nectarines, it is proposed to include the elites 3-158, 4-168 and 29-31 as donors of valuable traits.

Scientific - applied contributions

1. As a result of three years of complex research, thirteen peach cultivars and eight elites selected from the dessert group were studied. For the purposes of the breeding programme, it was recommended to continue using the cultivars Laskava and Eumolpiya.
2. During the same period, complex studies on nine nectarine cultivars and seven elites were carried out and a proposal was made to include elites 3-158, 4-168 and 29-31 in the breeding programme.
3. For widespread use in production we recommend the very early peach cultivars Flavia and Filina, as well as the disease-resistant Lascava and Eumolpia. Of the nectarine cultivars, the most suitable for farmers are Big Top, Goldengrand and Morsiani 90.

Contributions of a confirmatory nature

1. Most of the peach and nectarine groups studied, with the exception of Eumolpiya, elite 30-59 and Sunfrey, have a medium flowering period.
2. The most cold-hardy are the flowers of the Eumolpiya cultivar and the nectarine cultivar Goldengrand.
3. The basic distribution of buds on the mixed branch in peaches and nectarines is flower-leaf-flower, followed by leaf-flower.
4. Early ripening cultivars and elites have a light stone colour. With the transition to late ripening the stone turns dark.
5. With the transition from early to late ripening, the content of the main chemical components in the fruit becomes richer.

Publications related to the dissertation

1. Zhivondov, A., S. Savchovska, S. Pandova, D. Petkova, P. Doykina, I. Manolov, 2021, Biometric data of peach and nectarine fruit and stones, Agricultural science and technology, vol.13, No 3, pp. 240-244.
2. Keranova, N., A. Zhivondov, S. Savchovska, 2021, Study of blossom freezing in peaches by mathematical and statistical methods, Series B, Horticulture. Vol. LXV, No. 1, pp.149-155.
3. Savchovska S., Keranova N.,2020, Grouping and evaluation of peach cultivars according to biometric data of petals, Ecology and Health pp. 23-26.
4. Savchovska S., 2022, Results of average biometric data of peach fruits and stone, Science, tehnology, innovation, business, pp.96-99