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THE EFFECT OF FROST AND HALE ON THE PEACH TREE CULTIVARS FROM R.S.F.G. CONSTANȚA

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Abstract

One of the problems which occurred during the last years concerning all fruit-growing species is determined by climate changes. Some phenomena related to climate stress occur in a chronic manner (low fertility, weak structuring of soils, etc.) or periodically (droughts, excess of humidity in the soil, etc.) or occasionally (early or late frosts, hale, etc.); their unfavourable influence depends both on the intensity and the duration of the stress as well as on the specific phenophase of crop plants. Due to the climate changes which occurred during the last couple of years, it was observed that the resistance of peach tree cultivars differs greatly from one year to the next. The present studies were carried out over a period of three years on plantations of ripe peach trees and nectarine trees from R.S.F.G. Constanța. Branch samples belonging to 7 peach tree cultivars ('Springcrest', 'Springold', 'Collins', 'Cardinal', 'Redhaven', 'Southland' and 'Jerseyland') and 3 nectarine tree cultivars ('Cora', 'Delta' and 'Romamer2') were harvested and analysed three days after the frost occurred. The paper presents the manner in which certain peach tree and nectarine tree cultivars reacted to the effect of the frost which occurred in 2012, 2013 and 2014 and the effect of hale (July 11th, 2014) on the peach tree production. The greatest losses caused by frost were recorded in the winter of 2012: 90% fruit buds affected at the 'Springold' cultivar, 94% fruit buds affected at the 'Springcrest' cultivar and 62% fruit buds affected at the 'Redhaven' cultivar. The losses caused by the hale which occurred on the 11th of July 2014 reduced the production of the 'Redhaven' cultivar by 40% and that of the 'Southland' cultivar by 80%. The carried out studies and the obtained results demonstrate both the importance of choosing the assortment of cultivars according to favourable areas as well as the importance of placing anti-hale nets upon establishing fruit-growing plantations.

Key words: *climate changes, late frosts, Prunus persica, 'Redhaven', 'Southland'.*

INTRODUCTION

In this paper is presented the manner in which the frost and the hail influenced the fruit production of certain peach tree and nectarine tree cultivars cultivated in Dobrogea between 2014-2014.

The frosts which occur in March and April after a relatively warm period are more dangerous than those which occur during the obligatory resting period (December-January). The fruit buds in the pink button stage can resist to temperatures as low as -3.9°C for 2-3 hours; the opened flowers can tolerate a temperature of -2.8°C, while the newly tied fruits can resist to temperatures as low as -1.1°C (Chira et al., 2005). Nevertheless, the major climatic changes which have taken place during the last few years have had a significant negative influence over the triggering of the flowering, the tying of the fruit and, evidently, over the peach tree and nectarine tree production. The climate changes problems should not be ignored in this case and might be a relevant subject for further researches.

Previous research papers have revealed that the impact of climatic changes upon fruit-growing species can already be felt. For instance, by the end of the 90's, the flowering of the trees in Germany occur several days earlier (Chmielewschi et al., 2004 and 2005). The vegetative season in Europe became longer by 10 days in the past 10 years (Chmielewschi and Rotzer, 2002).

Due to the early flowering of the trees, in certain regions of Europe there was an increase in the risk of damage caused by late frosts (Anconelli et al., 2004; Sunley et al., 2006; Legave and Clazel, 2006; Legave et al., 2008; Chitu et al., 2004 and 2008) or by the disorders

in the pollination and fruit setting processes (Zavalloni et al., 2006).

According to the estimations of the weather forecasts, there have been presented in the frame of the 4th report of the International Committee for Climatic Changes in 2007, the whole Europe and implicit Romania will face in future with a process of global warming, characterized by increasing of temperatures with -0.5 - 1.5° C for the period 2020 – 2029 and with -2 – 5° C for the period 2029 – 2099. In the 2090-2099 periods, Romania will confront with pronounced drought during the summer time. Researches from many countries, in the frame of climatic research methodology have the approached aspects regarding climatic changes effects on growth and development of some fruit tree species (Chmielewski and Rotzer et al., 2002; Olensen 2002; Sunley et al.2006, Chitu et al., 2010; Sumedrea et al, 2009). Climatic changes occurred also in Romania, they have determined meteorological phenomena, which are manifesting with augmented amplitude and intense frequency (severe drought, intense flooding, tornados and hail).

MATERIALS AND METHODS

The research was carried out in the period 2012-2014 at R.S.F.G. Constanţa in Valu lui Traian. The studied material was represented by the experimental plots from R.S.F.G. Constanţa, where the peach tree and nectarine tree cultivars can be found. A number of 10 such cultivars were studied (with a different ripening period), out of which 7 were peach tree cultivars – 'Springold', 'Springcrest', 'Cardinal', 'Collins', 'Redhaven', 'Southland', 'Jerseyland' and 3 were nectarine tree cultivars – 'Cora', 'Delta' and 'Romamer 2'. The trees were planted in 1986, the utilised parent stock being *Prunus persica*; the planting density is of 625 trees/ha (planting scheme 4m x 4m) and the trees' shape of the head is that of a free palmette. As far as the soil concern on which the plantation is situated is a calcareous cernoziom with a claylike texture and only slightly alkaline pH (8.2) throughout its entire profile. In addition, the overall climatic conditions were favourable to the growth and fructification of the trees, with exception of the years 2012 – 2014, when a very strong frost was registered in both January and February, leading to the loss of some of the fruit buds, while the hail on July 11th, 2014 affected the production of the 'Redhaven' and 'Southland' cultivars. With regard to these cultivars we observed the main fructification phenophases: the beginning of the blossoming, upon the appearance of the pink button; the beginning of the flowering, upon the appearance of the first open flowers; the ending of the flowering, when most of the flowers have lost their petals. The duration of the flowering phenophase at a certain cultivar can vary according to the action of the maximum temperatures during the day and the intensity of the wind, correlated with the degree of differentiation of the trees (i.e. the amount of flowers per tree). The intensity of the flowering was ranked on scale from 0 to 5, 0 being used when the cultivars displays no flowers at all, while 5 is used when the cultivar displays a plethora of flowers. The hardening of the core was determined by means of piercing it with a needle at regular intervals, usually 2 days. The process was carried out progressively, in the same day for all the observed cultivars. The harvesting maturity is largely influenced by a series of climatic and agro-technical factors, such as: temperature, drought, quantity of fruit per tree, shape of the head, density of the trees, etc. The observations and determinations were carried out 3-5 days after the climatic accidents recorded in 2012, 2013 and 2014, respectively and the production was assessed after the hail occurrence on July 11th, 2014. The hail, with a dimension of approximately 5-20 mm, seriously damaged the fruit production of some of the peach tree cultivars, more exactly those who had not been harvested until July 11th, 2014. The climatic data were recorded with the aid of an automatic meteorological station (the WatchDog type) and were processed as daily averages. We observed the manner in which certain peach tree and nectarine tree cultivars reacted to the change in the climatic conditions recorded during the winter of the previously mentioned years. We noticed that the resistance of peach tree cultivars differs from one year to the next because of the climatic changes that have occurred during the past few years and it depends on the gravity of climatic accidents.

The minimum and maximum temperatures during winter alternate and together with the gravity of climatic accidents lead to the weakening of the trees.

RESULTS AND DISCUSSIONS

The triggering of the main fructification phenophases in the years 2012-2014 occurred between rather wide limits, according to the characteristics of the cultivar and the climatic characteristics of the studied years.

In the period 2012-2014, the blossoming of the fruit buds of the peach trees occurred between the following limits: between 18.03 and 29.03 for the 'Springold' cultivar, between 21.03 and 27.03 at the 'Springcrest' cultivar, between 24.03 and 30.03 at the 'Collins' cultivar, between 24.03 and 29.03 at the 'Cardinal' cultivar, between 28.03 and 03.04 at the 'Redhaven' cultivar, between 24.03 and 03.04 at the 'Jerseyland' cultivar and between 27.03 and 04.04 at the 'Southland' cultivar. The blossoming at the peach tree occurred between 18.03 and 04.04 (17 days) in the studied years 2012-2014. (Table 1).

The beginning of the flowering. For all the studied cultivars the beginning of the flowering in the period 2012-2014 was recorded; however, the cultivars entered this phenophases at different times, albeit not necessarily significant (a few days from one cultivar to the next), so that cross pollination was fully ensured. The limits for this phenophase were 26.03 and 21.04.

Table 1. The main stages of peach fructification in the 2012-2014 periods

No.	CULTIVAR	Year	The swelling of the flowering buds	The flowering			Intensity	The hardening of the stone	Harvesting maturity
				Beginning	Ending	Duration (days)			
1	SPRINGOLD	2012	18.03	26.03	16.04	20	2	04.06	26.06
		2013	25.03	06.04	21.04	15	2	10.06	27.06
		2014	29.03	03.04	12.04	9	4	07.06	01.07
		Limits	**18.03-29.03**	**26.03-06.04**	**12.04-21.04**	**9-20**	**2-4**	**04.06-10.06**	**26.06-01.07**
2	SPRINGCREST	2012	21.03	29.03	16.04	19	2	04.06	28.06
		2013	27.03	08.04	24.04	22	4	08.06	07.07
		2014	22.03	05.04	16.04	12	3	10.06	**09.07**
		Limits	**21.03-27.03**	**29.03-08.04**	**16.04-24.04**	**12-22**	**2-4**	**04.06-10.06**	**28.06-09.07**
3	COLLINS	2012	24.03	30.03	11.04	12	3	02.06	18.07
		2013	29.03	08.04	21.04	13	4	10.06	16.07
		2014	30.03	09.04	20.04	11	3	12.06	27.07
		Limits	**24.03-30.03**	**30.03-09.04**	**12.04-30.04**	**11-13**	**3-4**	**02.06-12.06**	**16.07-27.07**
4	CARDINAL	2012	26.03	04.04	17.04	13	2	06.06	13.07
		2013	29.03	09.04	23.04	14	3	10.06	18.07
		2014	24.03	20.04	28.04	8	2	08.06	25.07
		Limits	**24.03-29.03**	**04.04-20.04**	**10.04-28.04**	**8-14**	**2-3**	**06.06-10.06**	**13.07-25.07**
5	REDHAVEN	2012	02.04	05.04	20.04	12	4	08.06	29.07
		2013	28.03	11.04	19.04	8	5	10.06	02.08
		2014	03.04	20.04	30.04	10	4	07.06	12.07
		Limits	**28.03-03.04**	**05.04-20.04**	**19.04-30.04**	**8-12**	**4-5**	**07.06-10.06**	**12.07-02.08**
6	JERSEYLAND	2012	24.03	05.04	18.04	13	4	07.06	17.07
		2013	29.03	09.04	16.04	7	5	09.06	15.07
		2014	03.04	18.04	27.04	9	4	10.06	19.07
		Limits	**24.03-03.04**	**05.04-18.04**	**16.04-27.04**	**7-13**	**4-5**	**07.06-10.06**	**15.07-19.07**
7	SOUTHLAND	2012	27.03	06.04	13.04	7	5	09.06	04.08
		2013	29.03	08.04	17.04	9	5	11.06	30.07
		2014	04.04	21.04	27.04	6	5	07.06	06.08
		Limits	**27.03-04.04**	**06.04-21.04**	**13.04-27.04**	**6-9**	**5**	**07.06-11.06**	**30.07-06.08**

The ending of the flowering. In the studied period 2012-2014 the ending of the flowering occurred between 12.04 and 21.04 for the 'Springold' cultivar, between 16.04 and 24.04 for the 'Springcrest' cultivar, between 12.04 and 30.04 for the 'Collins' cultivar, between 10.04 and 28.04 for the 'Cardinal' cultivar, between 19.04 and 30.04 for the 'Redhaven' cultivar, between 16.04 and 27.04 for the 'Jerseyland' cultivar, between 13.04 and 27.04 for the 'Southland' cultivar. The dates were recorded as the days when the flowers lost their

last petals. The duration of the flowering at the peach tree (average for the three studied years) expressed in number of days varied between 6 days (the 'Southland' cultivar in 2014) and 22 days (the 'Springcrest' cultivar in 2013).

The intensity of the flowering. In 2012 the following cultivars displayed a weak intensity of the flowering: 'Springold' - 2, 'Springcrest' - 2, 'Cardinal' - 2 and 'Collins' - 3.

The hardening of the core. This phenophase occurred in the first half of the month of June (between the 6th and the 11th) in the years 2012, 2013 and 2014.

The harvesting maturity. Each ripening period had large variation limits from one year to another, depending on how the climatic factors determine the type of vegetation in a specific year: early, late or extra late. The harvesting maturity of the fruit had as variation limits the 26th of June and the 6th of August.

At the nectarine trees, the blossoming occurred between 16.03 and 04.04 (Table 2).

Table 2. The main stages of nectarine fructification in the 2012-2014 periods

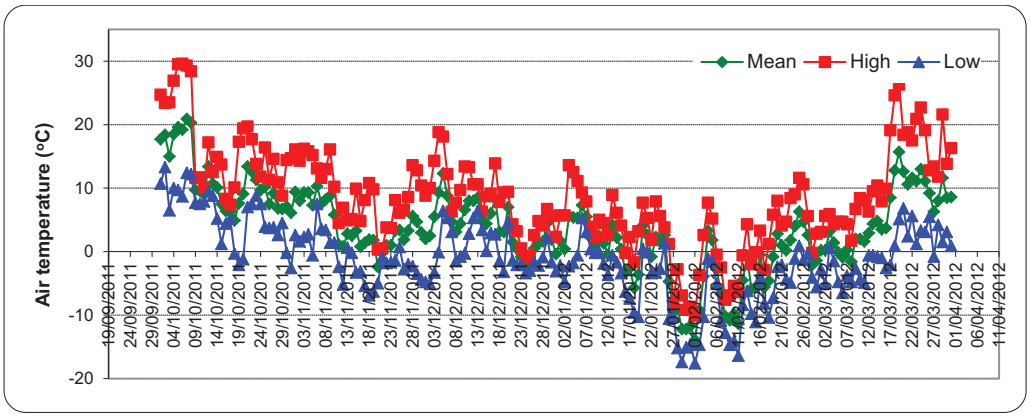
No.	CULTIVAR	Year	The swelling of the flowering buds	The flowering			Intensity	The hardening of the stone	Harvesting maturity
				Beginn-ing	Ending	Duration (days)			
1	CORA	2012	16.03	29.03	14.04	15	5	05.06	19.06
		2013	27.03	06.04	23.04	17	5	11.06	27.06
		2014	25.03	10.04	28.04	18	5	07.06	28.06
		Limits	**16.03-27.03**	**29.03-10.04**	**14.04-28.04**	**15-18**	**5**	**05.06-11.06**	**19.06-28.06**
2	DELTA	2012	20.03	29.03	16.04	19	5	04.06	23.06
		2013	29.03	08.04	30.04	22	5	08.06	20.06
		2014	21.03	05.04	16.04	12	5	10.06	06.07
		Limits	**20.03-29.03**	**29.03-08.04**	**16.04-30.04**	**12-22**	**5**	**04.06-10.06**	**20.06-06.07**
3	ROMAMER 2	2012	24.03	28.03	11.04	13	5	04.06	08.07
		2013	04.04	06.04	30.04	24	5	10.06	11.07
		2014	30.03	02.04	24.04	22	5	14.06	13.07
		Limits	**24.03-04.04**	**28.03-06.04**	**11.04-30.04**	**13-24**	**5**	**04.06-14.06**	**08.07-13.07**

The limits for the beginning of the flowering in the studied years 2012-2014 were 29.03 and 08.04. The duration of the flowering (average for the three analysed years) expressed in number of days varied between 12 days (the 'Delta' cultivar in 2014) and 24 days (the 'Romamer 2' cultivar in 2013). All the studied cultivars displayed a large abundance of flowers and obtained the grade 5 in all the three studied years. The hardening of the kernel occurred in the first half of the month of June (between the 4th and the 14th). The harvesting maturity of the fruit had as variation limits the 19th of June and the 13th of July, period in which there are no other nectarine types on the market. This constitutes a great advantage for retailers through the income that can be realised. The cultivars become ripe at a difference of 3-5 days one from the other.

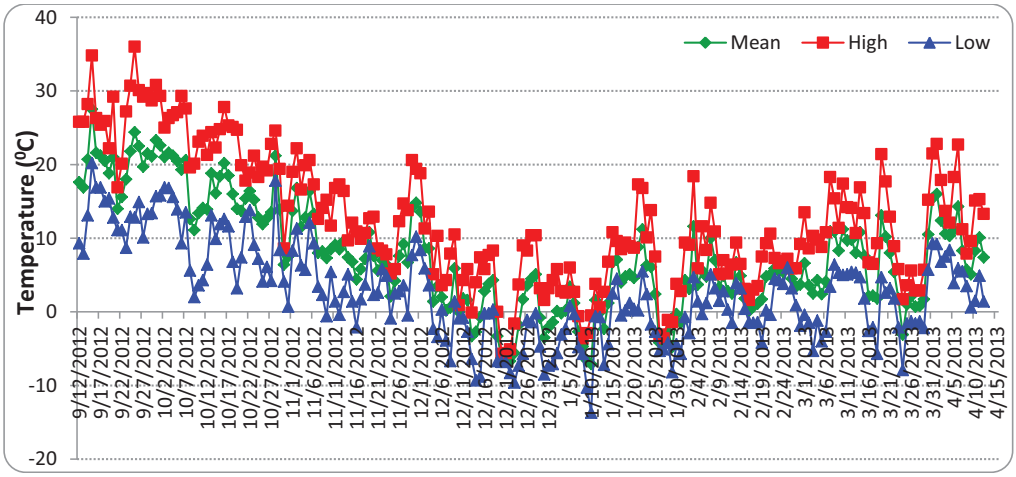
As we can notice in Figure 1a, January of 2012 was the coldest month, during which 9 days recorded daily average temperatures ranging from -10.2 °C and -17.6 °C. These values, together with those that were extremely varied in February (7 days with daily average temperatures -10.4 -16.4 °C la °C) and 8 consecutive days of hoarfrost, the ice on the branches caused the loss of 19% - 94% of the fruit buds at the studied cultivars**.**

Figure 1b. reveals the fact that the coldest month in the period September 2012 - April 2013 was January 2013, when the recorded values were as low as -13.7°C (January 10th, 2013). These values did not significantly influence the loss of fruit buds at the peach tree cultivars (local observations).

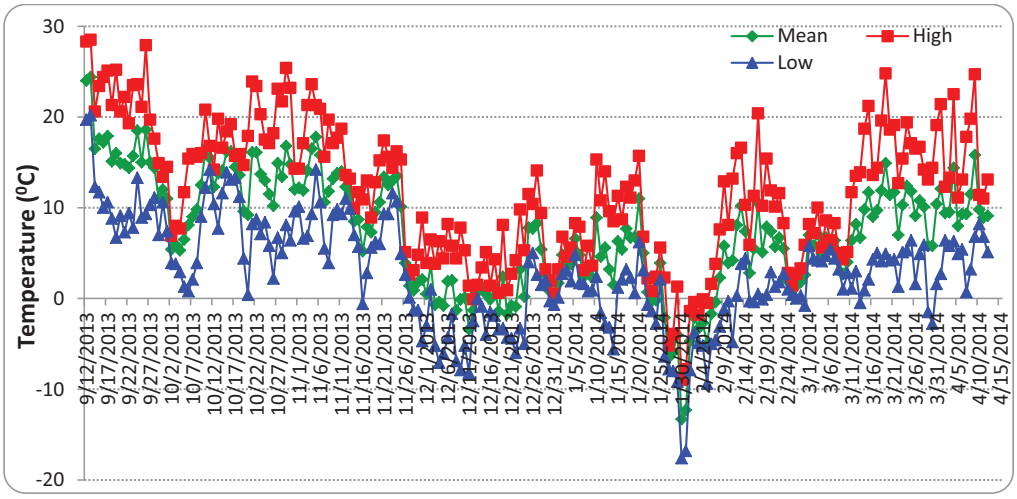
In the period October 2013 - March 2014 (Figure 1c.) the lowest temperature was recorded in January: -17.6 °C (January 30th, 2014); another day when the recorded temperature was low (-9.4° C) was February 5th, 2014. The low temperatures recorded during this period affected the 'Cardinal' cultivar (57%) and the 'Jerseyland' cultivar (70%).



1 a



1b



1c

Figure 1. a,b,c,. Air temperature (°C) in the cold period October 2011 – March 2012 (a), October 2012 – March 2013 (b), October 2013 – March 2014 (c) at Valu lui Traian, Constanţa

The observations were carried out with the aim of assessing the losses of fruit buds because of temperature variations during winter and the low temperatures during the day.

Thus, for the 'Springold' cultivar the losses recorded for 2012 were of approximately 90%, 14% for 2013 and 49% for 2014, there being difference from one cultivar to another. The winter frost caused losses for the 'Springcrest' cultivar of 94% in 2012, 21% in 2013 and 48% in 2014.

For the 'Cardinal' cultivar, the losses were of 66% in 2012, 19% in 2013 and 57% in 2014. We must bear in mind the fact that the losses caused by the winter frost of 2012, together with those caused by hoarfrosts and late frosts were very severe, taking also into account the surface of the Station's orchards cultivated with this cultivar.

These losses were also caused by the warm period before the frost – in the first three weeks of January 2012 the average temperature of the air was positive, of approximately 5 °C.

For the 'Collins' cultivar the losses were of 54% in 2012, 29% in 2013 and 53% in 2014. The 'Redhaven' cultivar recorded losses of 62% in 2012, 15% in 2013 and 56% in 2014. The 'Jerseyland' cultivar recorded losses of 63% in 2012, 27% in 2013 and 70% in 2014. For the 'Southland' cultivar the recorded losses were of 48% in 2012, 21% in 2013 and 49% in 2014.

The losses caused by frost recorded by the nectarine tree cultivars were rather small: for the 'Cora' cultivar they were of 23% in 2012, 19% in 2013 and 28% in 2014, for the 'Delta' cultivar, 21% in 2012, 17% in 2013 and 14% in 2014, while for the 'Romamer 2' cultivar, the losses were of 19% in 2012, 9% in 2013 and 29% in 2014 (Figure 2).

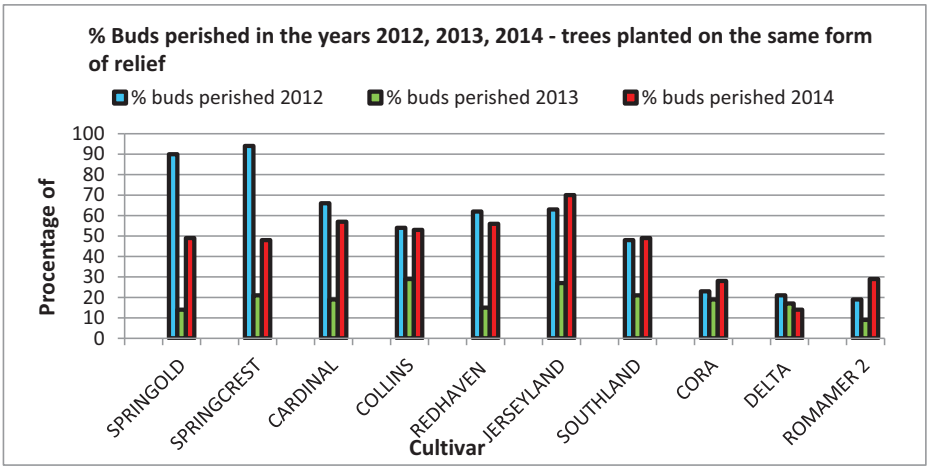


Figure 2. Procentage of peach and nectarine tree flowering buds perished due to frosts during the winter of 2012,2013 and 2014 at Valu lui Traian, Constanța

A good resistance to frost during the winter of the three studied years was remarked at the nectarine cultivars, with the following percentages: 'Cora' - 23%, 'Delta' - 17% and 'Romamer 2' - 19% (Figure 3).

In these conditions, the 'Springold' and 'Springcrest' cultivars were more than 50% damaged, while other cultivars such as 'Redhaven' and 'Southland' were less affected, the percentages being 44% and 39%, respectively. The climatic accidents recorded in January and February 2012 (sudden temperatures of -16.4°C, minimum temperature during the day) and 8 days of hoarfrost caused the damaging of the production for the early cultivars 'Springold', 'Springcrest' and 'Cardinal', while the 'Redhaven', 'Collins' and 'Southland' were only partially affected.

At R.S.F.G. Constanţa, in the second week of June 2014, more exactly on July 11th, the amount of precipitations was accompanied for 10 minutes by hail, which affected 80% of the fruit production for the 'Southland' cultivar (the fruit were just beginning to ripe) and 40% for the 'Redhaven' cultivar (Figures 4 and 5).

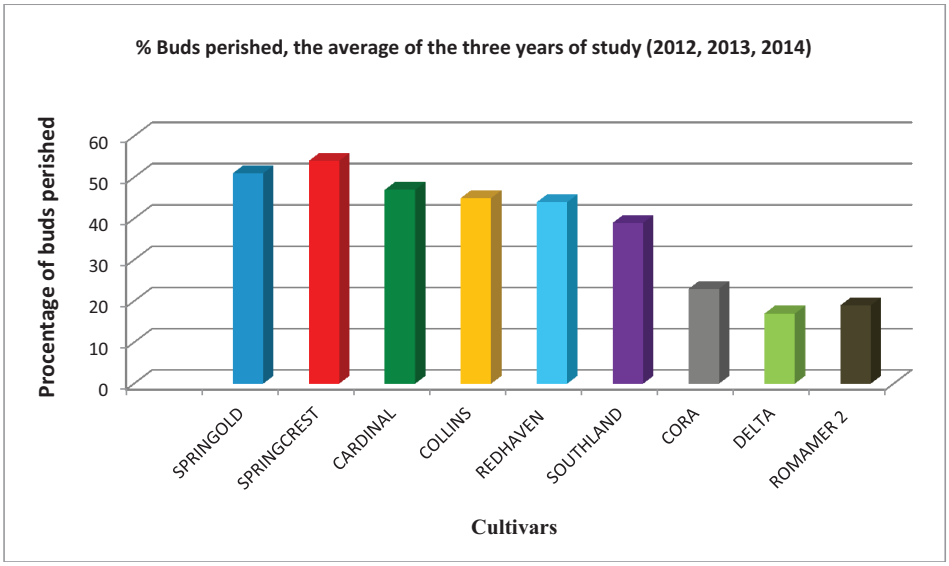


Figure 3. Procentage of peach and nectarine tree flowering buds affected by frosts (average over the three years), Valu lui Traian

Figure 4. Fruit of the 'Southland' cultivar affected by the hail on July 11th, 2014

Figure 5. The 'Redhaven' cultivar affected by the hail on July 11th, 2014 (full maturity)

The hail bruised the fruit, shoots and stems, thus creating an environment for future infections and diseases. The bruises on the fruits, despite some of them becoming scars, diminished the commercial aspect and the quality of the production.

Although the south-eastern part of Romania is generally considered favourable to the culture of the peach tree, the specie has suffered greatly over the past decade because of climatic variations which manifested themselves mainly through the aggressiveness of low temperature in alternation with maximum positive temperatures. The peach tree encountered considerable losses because of temperature variations which occurred during the dormand period, in the climatic conditions of 2012, 2013 and 2014; the losses were also caused by late hoar frosts in spring, especially in the second half of March and in April, as well as by hail occurrences.

CONCLUSIONS

The novelty brought forward by the results is represented by the fact that the winter frosts from 2012, 2013 and 2014 affected the peach tree and the nectarine tree to various extents, according to the cultivar (approximately 9-94%).

The greatest production losses were recorded in 2012 – 94% for the 'Springold' cultivar and 90% for the 'Springcrest' cultivar.

The smallest losses during the three studied years were recorded by the nectarine tree cultivars 'Cora', 'Delta' and 'Romamer 2'.

The hail from July 11th, 2014, which lasted for only 10 minutes, affected the 'Redhaven' cultivar (40%) and the 'Southland' cultivar (80%).

In order to protect the trees from hail occurrences we recommend that the orchards be equipped with anti-hail nets.

Moreover, when choosing the assortment of cultivars to be cultivated in a specific area one must make sure that particular area is favourable to the setting up of fruit-growing plantations.

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