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# THE INFLUENCE OF CLIMATIC CONDITIONS ON PHENOLOGICAL PHASES IN INTENSIVE APPLE VARIETIES

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## ABSTRACT

*In this article presented the data about phenological observations of apple varieties grown on local and introduced M-IX rootstock that is being studied in the condition of Tashkent region. Apple varieties with long flowering period included foreign brought varieties, such as, Liberty Zimniy, Pristin, Williams Pride, Gondrash and Stark Earliest (9 – 14 days). By the maturation time of fruits the local summer Rustamiy variety was included to early autumn group and Williams Pride variety was included to late summer group of varieties. Among winter varieties the control local variety gave an early yield, in comparison with it foreign brought (Japan) Musu and Fudji varieties started producing yield in the third (in 2018.) year, that is, these varieties were found to have a bit later yield even if they were planted in dwarf rootstocks.*

**KEYWORDS:** *intensive garden, local and introduced varieties, phenology, sum of useful temperature, beginning of vegetation, climatic conditions.*

## INTRODUCTION

For the creation of intensive garden it is important to consider climatic condition of the area, water supply, groundwater surface, selection of appropriate rootstock and varieties as well. In order to use varieties effectively in horticulture the study of their important biological features and farm traits, such as, yielding time, fruit maturation, fertility, resistance to cold, diseases and pests, continuation of living period of trees, ability of self-pollination, fruit taste, product qualities and acceptability for processing – is of great importance for recommending the varieties to produce. Apple fruit ranks a leading place in the provision of population with fresh fruits the whole year. High and qualitative yield of apple mostly depends on proper selection of varieties and their espacement in the areas. The varieties should be selected in such way that the fruits can mature turn by turn in the season in order to supply the population with fruit products regularly.

When environmental conditions change and at the periods of growth and hibernation the morphological traits and physiological functions may also change in fruit trees. These phenomena which are related to the plants is called *phenological phases* or *phenological stages*. They repeat every year [2].

It is important to conduct phenological observations agro-measures (irrigation, fertilization, disease and pest control, formation) in time and with quality in order to define harvesting time and to select pollutants properly.

Considering biological features of apple varieties grafted on dwarf M-IX rootstock the aim of the research consists of the followings:

- dividing the varieties into groups according to fruit maturation time;
- comparing introduced varieties with local varieties and studying their adaptation to climatic conditions;
- studying the periodicity in apple varieties;
- dividing the varieties into short, medium and long groups according to continuation of phenological stages in varieties;
- determining useful temperature sum in the varieties by the observations.

## MATERIALS AND METHODS

The experiments were conducted on 35 types of local and introduced varieties samples that were planted according to the scheme 4,0×2,5 m (in 2014) and grafted on intensive apple rootstock M-IX. The varieties were studied by dividing into summer, early autumn. The varieties were studied by dividing into

summer, early autumn, late autumn and winter variants as per their maturation time.

For phenological observations 15 typical trees were selected out and the following phenological stages were observed on them in all years of the research:

- bud formation: formation of leaf buds, formation of flower buds; (beginning of vegetation)
- beginning of flowering, full blooming and ending of flowering;
- beginning and ending of falling of leaves (vegetation ending).

Bud opening and fruit maturation time were observed every other day, flowering time – every day, ending of shoots growth, beginning and ending of leaf falling in every 5<sup>th</sup> day.

## RESULTS AND DISCUSSION

Uzbekistan is featured with its continental subtropical climate, long hot and dry summer and less cold winter with less snow as well. The abundant heat and sunlight allow to cultivate the varieties that mature in different times in the republic and to obtain qualitative yield from them. Climatic changes, early or late beginning of spring influence on phenological phases occurrence [3].

The beginning of growing period and flowering times are inheritable features of the trees and their varieties. Bud formation and opening in spring may start when the temperature and soil moisture reach to certain degree. Blooming and flowering time may begin and continue early or late depending on plants species, their features, environmental factors and agro-technical measures implementation.

According to phenological observation data the variants are classified as the followings:

1. by the beginning time of vegetation (early, medium and late growing),
2. by flowering phase continuation (short, medium and long),
3. by fruit maturation time (early summer, summer, late summer, early autumn, autumn, late autumn, early winter, winter and late winter).

All phenological stages require certain environmental condition – heat, soil, air humidity and others. Under the environmental influence they may change.

According to the data by meteorology of horticulture, viticulture and winemaking research institute after academician Makhmud Mirzaev, in winter months of 2016 it was rather warm, that is, in January the temperature was average 12,8°C degree, low air temperature was -7°C degree. The precipitation mostly was in the form of rain and made 69,2 mm. February month was also a bit warmer, maximal cooling of air showed -9,5°C degree (February 13), in the third decade the temperature was rather hot that varied from 21,0°C to 26,5°C in degree. Such warming of air temperature caused to early beginning of growth period of apple varieties under the study in that year.

In the result of observations conducted in the years the beginning of vegetation time in Mantet (Canada) and Stark Earliest (USA) varieties was noted earlier while in Rustamiy (Uzbekistan) variety it was later

compared to control variant of summer varieties under the study. By the continuation of flowering period, this indication was shorter in Rustamiy variety than in control, while in Mantet and Stark Earliest varieties 1-2 days difference was observed compared to control. Flowering continuation was long in control variant of summer varieties, in Rustamiy variety it was short, while in Mantet and Stark Earliest varieties was medium.

In early autumn varieties the beginning of vegetation occurred late almost in all varieties compared to control variety and considering this, autumn control variety Red Delicious was included to the group of early growing varieties according to the beginning time of vegetation. Late growing group included Isroil (Uzbekistan), Pamyat Yasaula, Pristin and Gondrash (Ukraine) varieties. Flowering period continuation in early autumn varieties was observed longer in control and Williams Pride, Pristin varieties, in Pamyat Yasaula variety shorter, in remaining varieties it was medium (Table 1). In Bolajon variety flowering phase wasn't observed in 2018.

**Table-1**  
**Phenological indications of apple varieties with different maturation time**

Varieties	Beginning of vegetation			Beginning of flowering			Ending of flowering			Continuation of flowering (day)		
	in 2016	in 2017	in 2018	in 2016	in 2017	in 2018	in 2016	in 2017	in 2018	in 2016	in 2017	in 2018
<b>Summer varieties</b>												
<b>Pervenets Samarkanda (control)</b>	19/II	13/III	09/III	14/III	10/IV	27/III	25/III	21/IV	07/IV	12	12	12
<b>Rustamiy</b>	23/II	15/III	12/III	22/III	18/IV	09/IV	31/III	25/IV	18/IV	10	8	10
<b>Mantet</b>	15/II	07/III	02/III	09/III	31/III	30/III	18/III	11/IV	09/IV	10	12	11
<b>Stark Earliest</b>	17/II	09/III	05/III	11/III	03/IV	02/IV	22/III	13/IV	12/IV	12	11	11
<b>Early autumn varieties</b>												
<b>Red Delicious (control)</b>	20/II	10/III	07/III	19/III	12/IV	03/IV	31/III	24/IV	13/IV	13	13	11
<b>Bolajon</b>	23/II	13/III	09/III	19/III	13/IV	-	30/III	20/IV	-	12	8	-
<b>Isroil</b>	17/II	15/III	12/III	19/III	14/IV	10/IV	30/III	24/IV	20/IV	12	11	11
<b>Pamyat Yasaula</b>	19/II	15/III	12/III	18/III	17/IV	16/IV	23/III	21/IV	20/IV	6	5	5
<b>Williams Pride</b>	18/II	13/III	09/III	14/III	03/IV	28/III	25/III	14/IV	07/IV	12	12	11
<b>Pristin</b>	23/II	20/III	17/III	16/III	10/IV	03/IV	28/III	21/IV	13/IV	13	12	11
<b>Gondrash</b>	19/II	15/III	12/III	19/III	13/IV	11/IV	29/III	21/IV	20/IV	11	9	10
<b>Late autumn varieties</b>												
<b>King David (control)</b>	22/II	13/III	09/III	23/III	17/IV	10/IV	30/III	24/IV	16/IV	8	8	7
<b>Prikubanskoye</b>	19/II	13/III	09/III	22/III	14/IV	06/IV	29/III	24/IV	16/IV	8	11	11
<b>Renora Zimnaya</b>	19/II	15/III	12/III	16/III	14/IV	07/IV	23/III	21/IV	13/IV	8	8	7
<b>Liberty Zimniy</b>	19/II	13/III	09/III	19/III	07/IV	02/IV	30/III	20/IV	13/IV	12	14	12
<b>Vagnera Prizovoye</b>	19/II	09/III	06/III	19/III	14/IV	06/IV	26/III	21/IV	13/IV	8	8	8
<b>Winter varieties</b>												
<b>Nafis (control)</b>	23/II	15/III	06/III	22/III	12/IV	09/IV	30/III	21/IV	16/IV	9	10	8
<b>Musu</b>	25/II	15/III	12/III	-	-	13/IV	-	-	17/IV	-	-	5
<b>Fudji</b>	24/II	15/III	12/III	-	-	10/IV	-	-	19/IV	-	-	10

**Table- 2**  
**Useful temperature sum of apple varieties with different maturation period**

Varieties	Fruit maturation						Fruit maturation continuation (day)			Useful temperature sum (°C)		
	beginning			ending			in 2016	in 2017	in 2018	in 2016	in 2017	in 2018
	in 2016	in 2017	in 2018	in 2016	in 2017	in 2018						
<b>Summer varieties</b>												
<b>Pervenets Samarkanda (control)</b>	05/VI	16/VI	12/VI	11/VI	22/VI	18/VI	7	7	7	722,4	783,0	749,1
<b>Rustamiy</b>	11/VII	14/VII	14/VII	18/VII	21/VII	21/VII	8	8	8	1336,3	1324,8	1324,3
<b>Mantet</b>	31/V	07/VI	09/VI	04/VI	12/VI	14/VI	6	6	6	652,7	692,0	672,2
<b>Stark Earliest</b>	30/V	09/VI	08/VI	06/VI	15/VI	14/VI	7	7	7	628,4	703,8	657,9
<b>Early autumn varieties</b>												
<b>Red Delicious (control)</b>	22/VIII	25/VIII	25/VIII	27/VIII	30/VIII	30/VIII	6	6	6	2177,6	2131,1	2126,7
<b>Bolajon</b>	01/VII	07/VII	-	09/VII	15/VII	-	9	9	-	1211,6	1216,8	-
<b>Isroil</b>	22/VIII	25/VIII	18/VIII	02/IX	04/IX	28/VIII	11	11	11	2175,6	2140,7	2112,0
<b>Pamyat Yasaula</b>	07/IX	15/IX	20/IX	14/IX	22/IX	28/IX	8	8	9	2468,3	2468,2	2464,6
<b>Williams Pride</b>	20/VI	22/VI	23/VI	28/VI	30/VI	02/VII	9	9	10	951,2	964,1	946,1
<b>Pristin</b>	01/VII	06/VII	05/VII	09/VII	14/VII	16/VII	9	9	10	1182,4	1161,5	1155,9
<b>Gondrash</b>	03/IX	08/IX	17/IX	12/IX	18/IX	26/IX	11	11	10	2402,7	2388,0	2393,2
<b>Late autumn varieties</b>												
<b>King David (control)</b>	13/VIII	19/VIII	18/VIII	19/VIII	25/VIII	25/VIII	7	7	8	2008,2	2027,4	2029,9
<b>Prikubanskoye</b>	18/VIII	23/VIII	21/VIII	25/VIII	30/VIII	29/VIII	8	8	8	2094,8	2094,0	2098,4
<b>Renora Zimnaya</b>	19/VIII	25/VIII	27/VIII	25/VIII	31/VIII	03/IX	7	7	8	2150,3	2147,3	2142,0
<b>Liberty Zimniy</b>	22/VIII	28/VIII	29/VIII	29/VIII	04/IX	05.IX	8	8	8	2188,7	2168,5	2168,5
<b>Vagnera Prizovoye</b>	06/IX	11/IX	13/IX	12/IX	18/IX	19/IX	7	8	7	2467,3	2435,5	2432,9
<b>Winter varieties</b>												
<b>Nafis (control)</b>	08/IX	12/IX	24/IX	16/IX	20/IX	02/X	9	9	9	2451,8	2458,4	2448,3
<b>Musu</b>	-	-	18/IX	-	-	28.IX	-	-	11	-	-	2427,9
<b>Fudji</b>	-	-	17/IX	-	-	25.IX	-	-	9	-	-	2410,7

In late autumn varieties the beginning of vegetation was observed earlier in Vagnera Prizovoye variety compared to control variety, according to the beginning time of vegetation the group of late growing varieties included Renora Zimmaya variety. Other remaining varieties were found to include to medium growing group. By the continuation of flowering period in Liberty Zimniy variety this phase was found to be long (12-14 days).

During the observation years the beginning of vegetation occurred a bit earlier in summer apple varieties compared to other group varieties and according to the indications of all phenological stages summer Rustamiy variety was determined to be included to the group of early autumn varieties.

Fruit maturation time in summer apple varieties was earlier in Mantet and Stark Earliest varieties compared to control variety, while in Rustamiy variety it started late. So Mantet and Stark Earliest varieties were found to be included to early summer group of varieties. According to fruit maturation continuation it was defined that the fruits of Rustamiy variety mature during a long period (8 days). In early autumn varieties compared to control variety the continuation of fruits maturation of Isroil, Gondrash varieties lasted a long (10-11 days). The beginning of fruits maturation time was observed at the same time in Isroil variety relative to control variety. In Bolajon variety it was determined that this indication started rather early. In winter varieties the control local variety accumulated yield earlier, compared to it foreign brought Musu and Fudji (Japan) varieties started to give yield in the third year (in 2018). Fruits maturation time in these varieties also began earlier compared to control variety. Continuation of fruits maturation lasted the same in Fudji variety as in control variety (Table-2).

For normal growth and development of plants it is required to have the temperature in necessary rhythm in growing periods and the heat in different amount in phenological stages. For example, the roots of fruit trees grow at 2,5-5,4°C degree, the buds open at 5,0 – 10,0°C degree, fruit buds differentiate at 15,0 – 25,0°C degree.

The air and soil temperature which are important for active growth, development and yield production of plants are considered as effective (useful) temperature. For placing crop types, varieties and hybrids throughout the regions active and effective temperature indications are regarded in counting the level of the supply of crops with heat. Therefore, it is recommended to plant them in northern, southern and central regions of the Republic.

Effective temperature is equal to the subtraction of mean daily temperature of the air (active temperature) with certain biological minimum temperature. In its turn, it helps to determine a share of each day for the development of the plant. The sum of effective temperature is calculated by combining daily temperature over 10°C degree for vegetation period or its certain part. The effectiveness of this temperature depends on soil moisture [4].

The useful temperature sum of the varieties studied at the research is determined by combining daily mean temperature over 10°C degree from the ending time of flowering phase to the beginning of fruit maturation.

Accordingly in summer control variety the sum of useful temperature made 722,4 – 783,0°C degree, while in introduced Mantet and Stark Earliest varieties it was lower (628,4 – 703,8°C) compared to control, local Rustamiy variety presented high (1324,3 – 1336,3°C) indication.

In early autumn varieties the Williams Pride variety could accumulate the least useful temperature sum for fruit maturation (946,1 – 964,1°C). It was observed that control variety and hybrid Isroil variety required almost the same norm of temperature sum for their fruits maturation, Pamyat Yasaula and Gondrash varieties as early autumn varieties required the most useful temperature sum.

## CONCLUSION

According to the data obtained during the observation years, the beginning time of vegetation was observed to be earlier in studied summer varieties and therefore these varieties were included to the group of early growing varieties, considering more continuation of compulsory hibernation period of early autumn variety Pristin compared to others it can be said that this feature of its can be used in selection.

The varieties group with long continuation of flowering period included foreign brought Liberty Zimniy, Pristin, Williams Pride, Gondrash and Stark Earliest (9-14 days) varieties. By the fruits maturation time local summer Rustamiy variety was included to early autumn group, while foreign brought Williams Pride variety was found to be related to late summer group.

Foreign brought Renora Zimmaya and Liberty Zimniy varieties which mature in October in their origin country, were observed to mature almost at the same time with late autumn varieties in the condition of research.

Due to short compulsory hibernation period of Bolajon variety, vegetative changes (buds formation) were observed in this variety in the result of warm temperature in winter, and in February the cold damaged their flower buds, in result the flowering wasn't noticed in this variety in 2018. From winter varieties the control local variety accumulated the yield earlier, compared to it foreign brought (Japan) Musu and Fudji varieties started to give the yield in the third year (in 2018), that's why, these varieties were determined to give the yield late even though they are planted on dwarf (M-IX) rootstock.

As per observations the sum of useful temperature may increase or decrease depending on the end of flowering phase and the beginning of fruits maturation, that is, this indication is required less in summer varieties and more in autumn and winter varieties. According to the requirement for the sum of useful temperature the varieties are to be recommended to the regions of the republic.

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