

PERIODS OF TRANSITION OF PHENOLOGICAL PHASES OF APPLE VARIETIES

Boboyeva Xilola Abdurakhmonovna 1,

Fayziyev Jamoliddin Nasirovich 2,

Karakhodjayeva Gulchexra Mirsobirovna 3

Research Institute of Horticulture, Viticulture and Winemaking named after

Academician Makhmud Mirzaev, 111118 Tashkent, Uzbekistan

Email: xilolaboboyeva87@gmail.com

Abstract

The article presents data on the analysis of growth phenophases in local and introduced apple varieties in the conditions of the Tashkent region. Information is provided on the summer Pristin, which begins the growth period the latest (16-18/III), the early autumn Kandil Sinap, Bolazhon, Israil, Prikubanskoe, Limonny, Renora winter varieties II-X-31 hybrid, the autumn Kubanskoe Bagryanoe, winter Fuji varieties, the flowering phase begins the latest (8-10/IV) Israil, Limonny, Prikubanskoe and Renora winter varieties, and the earliest (13-17/VII) ripening varieties Kizil Jonaki, Mantet, Stark Erlist, and the latest (24/IX) ripening winter Goldrash varieties.

Keywords: Apple varieties, collection, phenophase, total active temperature, vegetation, seasonality.

Introduction

The climate of Uzbekistan is characterized by long, hot, dry summers and mild, snowy winters. The favorable climatic conditions of the republic allow for the cultivation of fruit varieties that ripen at different times and the production of high-quality fruits. Different climates, early or late spring, affect the passage of phenological phases [2; 104–109-p.], [6; 1419–1423-p.].

Over the years, changes in the phenological phases of apple trees have occurred under the influence of the external environment during long-term evolution. The timing of the start of vegetation is one of the most important agrobiological characteristics of a variety. One of the important factors of the economic justification of varieties is the degree of compliance of ecological growth conditions with biological requirements, the expediency of growing them in a certain area in order to show the specific positive characteristics of certain varieties of fruit crops (fruit quality, productivity).

Phenological observations are the most convenient and effective method for studying the characteristics of plant development under certain environmental and climatic conditions, allowing us to determine their vegetation period, the duration of phenophases, as well as the stability and productivity of various varieties under these conditions [9; 38–40-p.]. Fruit trees go through phenological phases during growth, the onset and duration of which depend on the genetic characteristics of the variety and environmental conditions [7; 357-p.].

The beginning of vegetation in trees is an important phenological stage, which mainly determines the degree of adaptation of the variety to specific soil and climatic conditions. Its early or late onset is related to a complex of soil and climatic factors, the most important of which are the air



temperature at the beginning of the growing season, its relative humidity, the conditions for wintering trees, and sudden changes in air temperature in summer and winter, which are harmful to fruit trees, such as a drop in temperature to a minimum in spring.

The average long-term air temperature in Tashkent region is 25.0-27.0°C in July, and -0.4+4.6°C in January.⁰ According to long-term data, early autumn frosts begin on the fifth day of November, with an average duration of October 22, and the end of spring frosts occurs no later than April 22, with an average duration of March 31.

Spring is rainy, humid, and variable in temperature. Cloudy, rainy days alternate with sunny ones. The most negative aspect of the spring season is the occurrence of frosty spring frosts. Such days end at the end of February and beginning of March, and in some cases it can be in the middle or even at the end of April, and then many fruit trees can be damaged by frost.

Selection of varieties suitable for soil-climate conditions in increasing productivity and fruit quality of apple varieties is currently relevant. In order not to be damaged by spring frosts, the apple varieties with a late start of the growing season, late flowering and a long duration of the flowering period are especially important.

Research Methodology:

Phenological observations were conducted on 35 local and introduced apple varieties grafted on M-IX rootstock and planted in 2014 in a 4.0x2.5 m plot.

Apple trees are grown in palmettos, shaped in the palmette method, the size of the experimental area is 5250 m². Observations on 12 trees from each variant, durations of phenological phases in 4 replications: The beginning of budding is when split buds appear on the trees and the tips of green leaves appear above them. This date was recorded separately for flower and plant buds. The beginning of flowering is when 5-10% of the flowers on the trees have opened, and the end of flowering is when 90% of the flowers on the trees have bloomed, meaning that 75% of the flowers have shed their petals or have developed buds and turned brown. The onset of fruit ripening was determined when they reached the normal size and color of the variety, according to the ease of separating the fruits, the starch content and the redness of the seeds. The end of branch growth - when the majority of the branches located on the upper branches of the crown formed three buds, the beginning of defoliation - when up to 25% of leaves were shed, the end of defoliation - when 75% of the trees were defoliated.

The beginning of buds and the ripening period of fruits were observed every other day, the period of flowering - every day, the end of the period of growth of branches, the beginning and the end of autumn period were observed every five days [1; 267–269-p.].

Determining the maturity of fruits - N.A. Tseluyko [10; 75 p.] method, determination of starch in fruits was carried out using potassium iodide solution (1 g per 1 l of distilled water). The absence or small amount of starch residue indicates the fruit's shelf life. 1.0-2.0 points of the amount of starch in the ripening summer varieties; corresponds to the indicator of early fall and autumn, 2.0-3.0 points, and winter varieties - 3.0-4.0 points.

Research results and their analysis:

The phenological phases of local and introduced apple varieties were studied during 2020-2024 (Table 1).



Observations have shown that the beginning of budding in trees of apple varieties depends more on the characteristics of the variety.

Apple varieties were divided into early, medium, late, and very late-growing groups based on the start of the growing season. The onset of bud burst in the varieties that emerged from the dormant phenophase the earliest occurred on average on 6-8/III in the local varieties Kyzyl Jonaki and the introduced varieties Mantet, Stark Earlist, and Renda. It should be noted that there was a significant effect of the air temperature on the beginning of vegetation in the studied varieties in the second-third of February and the first-twelfth ten days of March.

In varieties that began bud bursting in the middle period (11-12/III), the sum of active air temperatures above 5°C was 186.4°C. This group includes summer varieties Pervenets Samarkanda (st.), Elena, Rustamiy, Williams Pride, Vadimovka, early autumn Farangiz, Wagnera Prizovoe, autumn Pamyat Esaulu.

With the late onset of bud break (13-15/III), the following summer varieties stood out: Aydin, Dayton, early autumn Red Delicious (st.), Starking Delicious, Remo, Sunprice, Liberty winter varieties, II-X-11 hybrid, autumn King David (st.), Florina, winter Nafis (st.), Mutsu, Goldrush varieties, and early autumn II-X-11 hybrid. The sum of active temperatures in these varieties was 207.0°C.

The active temperature sum for varieties that began their growing season no later than 16-18/III was 227.2°C. According to this indicator, the summer varieties Pristin, early autumn Kandil Sinap, Bolazhon, Israil, Prikubanskoe, Limonny, Renora winter varieties, II-X-31 hybrid, autumn Kubanskoe Bagryanoe, and winter Fuji varieties stood out.

The beginning of flowering and its duration depend on the characteristics of the type and variety of fruit trees, external environmental conditions (air temperature 8°-12°), topography of the place, and agrotechnical measures.

The flowering phase is of great importance during the growth phenophase in cultivated fruit crops, and the separate stages of this phase are the swelling of flower buds and the shedding of petals [3; 51–90-p.].

According to P.G. Schitt (1958), its duration is related to the protection of plants from cold and repeated cold, as well as to the provision of appropriate pollinators [11; 446-p.].

A number of scientists divide the flowering phase into the awakening of flower buds and flowering. At this stage, plants require high temperature (5°<). The onset and duration of these phenophases vary depending on the time of year and meteorological conditions and are a biological characteristic of the genotype. The later and slower the budding and flowering occurs, the more resistant the variety is to repeated frosts and spring frosts [5; 453–454-p.].

Varieties of the same species bloom at different times. Depending on these characteristics, they are divided into early, medium and late flowering groups, and according to the duration of the flowering period, they are divided into short, medium and long-lasting groups.

According to data obtained from studying the flowering characteristics of apple varieties, it was observed that the average flowering phase began from March 25 to April 10 over the years. Varieties that began flowering on March 25-29 were included in the group of early-flowering varieties. Renda, Kizil Jonaqi, Pervenets Samarkanda (st), Mantet, Sanprice varieties were included in this group. The varieties Aydin, Stark Erlist, Williams Pride, Pristine, Bolajon, Starking Delicious, Remo, Liberty Winter, and Pamyat Esaulu, which begin flowering in the





middle term, began their flowering phase on 30/III-1/IV.

Table 1 Transition periods of the phenological phase of apple varieties (2020-2024)

Varieties	Budding period, day, month	Flowering period			Beginning of fruit ripening, day, month	Duration of fruit formation, days	FHY until fruit ripening, °	beginning of the leaf fall, day, month	Expiry date of leaf fall, day, month	Vegetation duration, days
		start, day, month	Expiration, day, month	duration, day						
Summer varieties										
Pervenets in Samarkand (st.)	12/III	28/III	9/IV	11	18/VII	105	1375,9	24/X	5/XI	238
Oydin	13/III	2/IV	12/IV	10	28/VII	106	1673,2	31/X	13/XI	245
Elena	11/III	6/IV	13/IV	9	25/VII	105	1612,1	27/X	7/XI	241
Kizil Jonaki	6/III	27/III	3/IV	8	13/VI	71	764,7	20/X	29/X	237
Rustami	11/III	5/IV	14/IV	9	28/VII	107	1531,4	29/X	13/XI	247
Mantet	6/III	28/III	4/IV	8	14/VI	71	819,8	24/X	01/XI	239
Stark Erlist	8/III	1/IV	9/IV	8	17/VI	70	784,9	27/X	4/XI	241
Williams Pride	12/III	1/IV	10/IV	11	26/VII	107	1650,2	27/X	5/XI	238
Pristine	17/III	1/IV	11/IV	11	22/VII	104	1460,3	28/X	6/XI	234
Dayton	13/III	6/IV	14/IV	9	26/VII	104	1619,4	28/X	8/XI	240
Vadimovka	11/III	5/IV	13/IV	9	26/VII	105	1669,7	26/X	7/XI	240
Early autumn varieties										
Red Delishes (st.)	14/III	5/IV	15/IV	11	8/VIII	116	1904,1	31/X	11/XI	242
Renda	8/III	25/III	1/IV	9	22/VII	112	1649,6	25/X	7/XI	245
Candil Sinap	16/III	6/IV	14/IV	9	21/VIII	130	2151,4	01/XI	16/XI	245
Bolajon	16/III	4/IV	14/IV	8	13/VIII	124	2038,5	28/X	11/XI	240
Israel	18/III	8/IV	16/IV	9	6/VIII	113	1857,8	27/X	7/XI	235
Farangiz	11/III	6/IV	13/IV	8	18/VIII	129	2116,2	24/X	6/XI	239
Prikubanskoe	17/III	10/IV	18/IV	9	6/IX	139	2326,2	9/XI	18/XI	247
Starking Delishes	13/III	4/IV	14/IV	11	8/VIII	116	1916,9	3/XI	16/XI	247
Limonium	18/III	8/IV	18/IV	11	21/VIII	126	2097,6	5/XI	20/XI	247
winter Renora	16/III	9/IV	17/IV	9	24/VIII	130	2174,4	30/X	13/XI	242
Remo	15/III	3/IV	13/IV	11	16/VIII	126	2058,7	27/X	10/XI	240
Sunprice	14/III	29/III	6/IV	9	12/VII	96	1376,6	30/X	8/XI	240

winter Liberty	15/III	3/IV	13/IV	11	28/VIII	138	2300,3	31/X	13/XI	244
Wagner prizovoe	12/III	9/IV	16/IV	8	21/VIII	133	2154,3	25/X	6/XI	240
II-X-31	17/III	6/IV	13/IV	8	2/VIII	112	1817,7	25/X	5/XI	233
II-X-11	13/III	7/IV	15/IV	9	28/VIII	136	2259,9	1/XI	16/XI	248
Autumn varieties										
King David (st.)	15/III	5/IV	13/IV	9	16/VIII	125	2052,3	1/XI	13/XI	244
Kubanskoe bagryanoe	16/III	7/IV	15/IV	9	31/VIII	138	2256,9	7/XI	18/XI	248
Pamyat Esaulu	12/III	3/IV	10/IV	8	26/VIII	139	2275,2	27/X	7/XI	235
Florina	13/III	6/IV	15/IV	10	29/VIII	136	2280,3	2/XI	14/XI	244
Winter varieties										
Nafis (st.)	13/III	6/IV	14/IV	9	21/IX	164	2630,3	3/XI	18/XI	250
Fuji	16/III	6/IV	14/IV	9	15/IX	156	2502,7	30/X	13/XI	243
Mutsu	14/III	6/IV	13/IV	8	17/IX	158	2521,9	30/X	15/XI	246
Goldrush	14/III	5/IV	15/IV	11	24/IX	163	2625,5	4/XI	17/XI	248

In the late-starting varieties Elena, Rustamiy, Dayton, Vadimovka, Red Delicious (st), Kandil Sinap, Israel, Farangiz, Prikubanskoye, Limonny, Renora winter, Wagner Prizavoe, King David (st), Kubanskoye bagryanoye, Florina, Nafis (st.), Fuji, Mutsu, Goldrush and hybrids II-X-31, II-X-11, this phase began on 5-10/IV.

How long the flowering phase lasts is often dependent on weather conditions and can last from 3 days to 2 weeks, observations have shown that the duration of this phase also depends on the variety. It was found that the short-term flowering varieties Kizil Jonaki, Mantet, Stark Erlist, Bolazhon, Farangiz, Wagner Prizavoe, Pamyat Esaulu, Mutsu and II-X-31 hybrids had a flowering duration of 8 days, the medium-term flowering varieties Elena, Rustamiy, Dayton, Vadimovka, Rrenda, Kandil Sinap, Prikubanskoye, Israel, Renora winter, Sunprice, King David (st), Kubanskoye bagryanoye, Nafis (st.), Fuji varieties, II-X-11 hybrids had a flowering duration of 9 days, and the long-term flowering varieties Pervenets Samarkanda (st), Aydin, Williams Pride, Pristin, Red Delicious (st), Starking Delicious, Limonny, Remo, Liberty winter, Florina and Goldrush had a flowering duration of 10-11 days.

The ripening time of the fruits depends on the characteristics of the orchard, the age of the tree, soil, humidity, climatic conditions, light intensity, and agrotechnical activities carried out in the orchard. This process begins with fertilization, that is, the formation of a zygote, and ends with the ripening of the fruit in early varieties, and with the harvesting of the fruit in autumn and winter varieties.

It is known that the period of fruit ripening varies depending on the geographical area of growth of the variety. When moving from north to south, fruit ripening accelerates [8; 144-p.]. Therefore, it is possible to divide varieties into groups (summer, autumn, winter) only for a certain area. According to the effect of climate on fruit ripening, the sequence of fruit ripening in different

varieties under different conditions is largely preserved.

The period of fruit ripening is an important biological and economic characteristic of the variety. It also determines their distribution in regions and the nature of their use [4; 40–76-p.].

In the researches, fruit ripening period was divided into early summer, summer, late summer, early autumn, autumn, late autumn, early winter, winter, late winter groups. The number of days from the flowering period to the fruit ripening period and the sum of the active temperature from this period to the fruit ripening period of 10°C were calculated. The beginning of the fruit ripening period was recorded after the fruits of the summer varieties were ready for consumption, and the autumn and winter varieties reached normal size and entered the color characteristic of the variety. In summer varieties, the fruit ripening period was observed from 13/VI to 28/VI, and the number of days from the flowering period to the fruit ripening period was 70-107 days. The sum of active temperatures before fruit ripening was $784.9-1673.2^{\circ}$. According to the results obtained over the years in research, the Renda and Sunprice varieties studied in the early autumn variety group appeared to be summer varieties in terms of fruit ripening time, that is, their fruit ripening time averaged 12-22/VII.

In autumn varieties, the average fruit ripening period was observed between 2-28/VIII, and the number of days from flowering to fruit ripening was 112-139 days. The sum of effective temperatures until the period of fruit ripening was $1817.7-2326.2^{\circ}$

In winter varieties, fruit ripening began on September 15-24, and the number of days from flowering to fruit ripening was 156-164 days. The sum of effective temperatures before fruit ripening was $2502.7-2630.3^{\circ}$.

The end of the growing season in apple trees depends on the genotypic characteristics of the variety, besides, like all fruit orchards, apple orchards can end the growing season early, middle and late due to growing conditions.

During the observation years, it was found that the onset of stable frosts ($5.7-4.4^{\circ}\text{C}$) began on November 4-8 in some years, while in years with warmer temperatures, this indicator began on December 7. It was observed that the duration of frostbite varied from 8 to 18 days between cultivars depending on the decrease in moderate temperature.

Analysis of the data obtained as a result of observations shows that the end of the growing season for all varieties lasted on average from October 29 to November 20, and according to this indicator, the varieties that ripen mainly in summer terms, such as Kyzyl Jonaki, Mantet, Pervenets Samarkanda (st), Stark Erlist, Williams Pride, Pristine varieties and the II-X-31 hybrid, ended their growing season early, from October 29 to November 5.

The end of the growth phenophase in the summer varieties Aydin, Elena, Rustamiy, Pristin, Dayton, Vadimovka, early autumn Red Delicious (st), Renda, Bolajon, Israel, Farangiz, Remo, Sunprice, Wagner Prize, autumn King David (st), Pamyat Esaulu, and winter Fuji, which completed the growing season in the middle term, fell on 6-13/XI. The latest to complete this phenophase were the early autumn varieties Kandil Sinap, Prikubanskoe, Starking Delicious, Limonny and the II-X-11 hybrid, the autumn Kubanskoe Bagryanoe, Florina and the winter varieties Nafis (st.), Mutsu, Goldrash, which completed the vegetation period on 14-20/XI.

The vegetation period in the studied varieties was 234-250 days, and the shortest vegetation period - 235-239 days in the summer varieties Kyzyl Jonaki, Mantet, Pervenets Samarkanda (st), Williams Pride, autumn Farangis and autumn Pamyat Esaulu, in varieties with early and medium-





term beginning and end of the vegetation phase.

It was found that the longest period of 246-250 days was observed in the early autumn varieties Kandil Sinap, Prikubanskoe, Starking Delicious, Limonny, autumn Kubanskoe Bagryanoe, and winter Nafis (st.), Mutsu, and Goldrash, which had the late and latest onset of the vegetation phase.

Conclusion

The study of phenological phases in local and introduced varieties of apple allows timely implementation of agrotechnologies carried out in each phenophase of the varieties.

The summer Pristin variety, which begins its growing season the latest (16-18/III), the early autumn Kandil Sinap, Bolajon, Israil, Prikubanskoe, Limonny, Renora winter varieties II-X-31 hybrid, the autumn Kubanskoe Bagryanoe, and the winter Fuji varieties stood out.

The varieties Israel, Limonny, Prikubanskoye and Renora winter stood out for their valuable characteristic of starting the flowering phase the latest (8-10/IV).

According to the ripening period of the fruits, the earliest (13-17/VII) ripening varieties of Qizil jonaki, Mantet and Stark Earlyst, and the latest (24/IX) ripening winter variety Goldrush stood out.

Based on the assessment of growth phenophases according to the main economic and biological characteristics of apple varieties, it can be used for planting orchards in the northern and southern regions of the Republic.

References

1. "Program and methodology for studying varieties of fruit, berry and nut crops" Orel: Publishing house of the All-Russian Research Institute for Fruit Crops Selection, 1999, 267–269 p.
2. Boboeva Kh.A. The influence of climatic on phenological phases in intensive apple varieties. // International journal of research & development, (IJRD), 2019, –Vol.4, Issue-8, pp.104-109. (№ 23, SJIF,IF=6.260).
3. Farrant, J. Mechanisms of desiccation tolerance in angiosperm resurrection plants. In Plant Desiccation Tolerance / J.Farrant, M. Jenks, A. Wood eds. // Blackwell Publishing, Iowa, USA, – 2002. – P. 51–90.
4. Vazhov, V.I. Climate and its role in the distribution and productivity of fruit crops / V.I. Vazhov // Ecology of fruit crops. -K.: Agrarian science. - 1998. - P. 40-76.
5. Dubravina I. V., Chepinoga I. S., Gorlov S. M. Phenotypic characteristics of promising apple varieties in the conditions of the foothill horticultural zone of Krasnodar // Scientific Journal of KubSAU. - 2011. - No. 66. - P. 453-454.
6. Karakhodzhaeva, G. M. (2016). Sod-humus system of maintaining row spacing of apple orchards in the conditions of the Tashkent region. Current ecological state of the natural environment and scientific and practical aspects of rational nature management (pp. 1419-1423).
7. Matveeva R.N., Butorova O.F., Moksina N.V., Repyakh M.V. Apple tree selection in the Vs.M. Krutovsky Botanical Garden. Krasnoyarsk: SibSTU, 2006. 357 p.
8. Moksina N.V. Fruiting of large-fruited apple varieties of different geographical origins in the conditions of the S. M. Krutovsky Botanical Garden // Plant biology and horticulture: theory, innovation. - 2017. - No. 144-1. URL: [https://cyberleninka.ru/article/n/plodonoshenie-](https://cyberleninka.ru/article/n/plodonoshenie)



- krupnoplodnyh-sortovyabloni-razlichnogo-geograficheskogo-proishozhdeniya-v-usloviyah-botanicheskogosada-im-vs-m (date of access: 11.04.2021).
9. Sadygov A.N. Phenology of apple varieties bred by the Azerbaijan Research Institute of Horticulture and Subtropical Crops in the agroclimatic conditions of the Quba-Khachmaz zone of the Azerbaijan Republic // Agrarian Scientific Journal. 2014. No. 8. P.38-40.
 10. Tseluyko N. A. Determination of the time of harvesting of pome fruits. - Moscow: Kolos, 1969. - 72 p.
 11. Schitt, P.G. The doctrine of the growth and development of fruit and berry plants / P.G. Schitt. - M.: Selkhozgiz, 1958. - 446 p.