




DETERMINATION OF PHENOLOGICAL STAGES OF *Malus kirgishorum* APPLE SPECIES IN CENTRAL ANATOLIAN ECOLOGICAL CONDITIONS

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ABSTRACT. Many different fruit species can be grown in the Central Asian region due to topographic and ecological conditions. Among these species are some apple species native to this region. In this research, studies were carried out to reveal the phenological diversity of *Malus kirgishorum*, one of the species in Central Asia. Bud swelling, bud burst, half-inch green, pink bud, beginning of flowering, full flowering, end of flowering and leaf fall dates of 20 *M. kirgishorum* genotypes were determined in Central Anatolia ecological conditions. According to the results of the research, bud swell in genotypes took place on March 17 - April 8, bud burst on March 20 - April 12, half-inch green on March 26 - April 15. Flowering did not occur in 4 genotypes due to the young age of the trees. In the flowering genotypes, the beginning of flowering was between April 15-26 and the end of flowering was between April 28 and May 10. Leaf fall on the trees occurred between the first and last weeks of November. The findings can be used in apple breeding programs.

Keywords: Apple, characterization, *Malus spp.*

INTRODUCTION

Apple is the most cultivated species of temperate zone fruit in the world and its annual production is approximately 87 million tons [1]. There are many species and varieties spread in different parts of the world [2]. It has been reported that the origin centers of apples in the world are East Asia, Central Asia, West Asia-Europe and North America [3].

Apple is generally grown between 30-50° latitudes in the world. High light intensity provides very good color formation in apples. The apple tree is also resistant to hard winters with low temperatures. During the winter dormancy, the wood parts can withstand temperatures up to -40°C, blooms from -2,2°C to -2.3°C, and small fruits to -1.1°C to -2.2°C. Apple also does not like high summer temperatures. When the temperature exceeds 40°C, growth stops, and at higher temperatures, various damages are observed [4].

Central Asia is gaining importance with its rich plant diversity in the world. There are many endangered and protected plant species in this region. Some apple species are also included in these species. It has been reported that wild apple genetic resources in Central Asia are of critical importance. It has been stated that apple populations in Central Asia are an important resource that will contribute to overcoming some other problems (resistance to biotic and abiotic stress conditions, fruit quality characteristics, tree growth form, etc.) [5]. In the Central Asian region, Kyrgyzstan is one of the important apple origin centers and has significant natural apple populations. However, it has been reported that there are intense human-induced losses in these materials and that these genetic resources are lost in the process [6]. There are three apple species

naturally found in Kyrgyzstan. These are *Malus sieversii* (Ledeb.) M. Roem (known as the origin of cultivated apples), *Malus kirgishorum* and *Malus niedzwetzkyana* (Dieck). Schneid. CK. species. It has been emphasized that there is generally a narrow genetic basis in cultivated apples, and it is imperative to preserve species that will increase genetic diversity at ex situ and in situ levels [7].

Phenological and pomological studies on apple varieties are carried out in many countries to determine the varieties suitable for ecology [11]. Various studies are carried out in our country to determine the performance of new cultivars and different rootstocks [12,13,14,15,16,17,18].

Depending on the climate, the time and duration of the development phases of the same plant differ from region to region. Observations made to determine these stages are called phenological observations. Environmental conditions have a great influence on phenological observations. For this reason, it is not possible to adapt the studies carried out in one region or a small number of varieties in all fruit-growing regions. For this reason, researches should be done in different regions and many plant species and varieties [19].

In this study, phenological stages were investigated in 20 *Malus kirgishorum* genotypes originating from Kyrgyzstan. This study is the first study on this species in Turkey. The study revealed differences between the genotypes in terms of stages from bud swelling to leaf fall.

MATERIALS AND METHODS

In the study, 20 *Malus kirgishorum* genotypes originating from Kyrgyzstan were used. The plants were grafted on the MM111 rootstock and were planted in the field of Erciyes University Faculty of Agriculture in Kayseri in 2016. Studies were carried out in March 2019 to reveal the phenological diversity in these materials. The characteristics examined in the phenological observations of the genotypes are explained below [20, 21, 17] and are shown in Fig. 1.

Bud swell: It is the period when the flower buds swell significantly.

Bud burst: It is the period when the buds open slightly and the leaf tips are seen.

Half-inch green: It is the period when the leaves are seen more prominently but collectively.

Formation of pink buds: It is the period when the flowers swell like a balloon and turn pink.

Flowering start date: It is the period when 5% of the flowers open.

Full bloom: It is the period when 70-80% of the flowers are opened.

Shedding of the petals (end of flowering): It is the period when more than 95% of the petals are shed.

Defoliation: It is the time when the leaves start to turn yellow and 90% of them fall off.



Fig. 1. Images of the phenological stages examined in the study (a: Bud swelling; b: Bud burst; c: Half-inch green; d: Pink bud stage; e: Beginning of flowering; f: Full bloom; g: End of flowering)

RESULTS AND DISCUSSION

According to the results obtained in the study, variations in phenological characteristics were determined among the genotypes used. According to the data obtained during the research, bud swell in genotypes took place between 17 March and 8 April. While genotypes 6, 10 and 28 perform this stage the earliest whereas the material with the latest bud swell is genotype 8. The bud burst period among the genotypes took place between 20 March and 12 April. While genotypes 27 and 28 are the first to enter this period, the latest genotype is genotype 8. The half-inch green stage took place between 26 March and 15 April. The first genotype to enter the period is again genotype 27, the latest genotypes that form leaves in the shape of half-inch greens are genotypes 8 and 29. Among all individuals studied, the bud bloom, bud burst, and

half-inch green phases lasted approximately 20 days.

Flowering did not occur in 4 genotypes (genotypes 1, 8, 11 and 17) due to the young age of the trees in the year of the study. In the flowering genotypes, the beginning of flowering is between April 15-26 and the end of flowering approximately 10 days, varying between April 28 and May 10 (Table 1).

Table 1. Phenological characteristics obtained in *M. kirgishorum* genotypes

G.N.	B.S	B.B.	H.G.	P.B.S.	B.F.	F.B.	E.F.	L.F.
1*	04.04.2019	06.04.2019	09.04.2019					21.11.2019
2	23.03.2019	03.04.2019	07.04.2019	10.04.2019	15.04.2019	24.04.2019	07.05.2019	19.11.2019
3	05.04.2019	08.04.2019	11.04.2019	24.04.2019	26.04.2019	30.04.2019	07.05.2019	19.11.2019
4	20.03.2019	24.03.2019	27.03.2019	04.04.2019	15.04.2019	24.04.2019	09.05.2019	15.11.2019
5	20.03.2019	30.03.2019	04.04.2019	09.04.2019	15.04.2019	24.04.2019	07.05.2019	14.11.2019
6	17.03.2019	27.03.2019	30.03.2019	04.04.2019	15.04.2019	24.04.2019	07.05.2019	21.11.2019
8*	08.04.2019	12.04.2019	15.04.2019					21.11.2019
10	17.03.2019	20.03.2019	27.03.2019	05.04.2019	15.04.2019	24.04.2019	07.05.2019	19.11.2019
11*	05.04.2019	08.04.2019	11.04.2019					18.11.2019
12	20.03.2019	04.04.2019	07.04.2019	15.04.2019	20.04.2019	25.04.2019	05.05.2019	21.11.2019
13	20.03.2019	01.04.2019	04.04.2019	08.04.2019	15.04.2019	24.04.2019	07.05.2019	20.11.2019
14	20.03.2019	30.03.2019	02.04.2019	06.04.2019	17.04.2019	24.04.2019	04.05.2019	16.11.2019
15	20.03.2019	27.03.2019	09.04.2019	18.04.2019	21.04.2019	30.04.2019	07.05.2019	19.11.2019
16	20.03.2019	27.03.2019	07.04.2019	10.04.2019	20.04.2019	24.04.2019	07.05.2019	20.11.2019
17*	27.03.2019	30.03.2019	04.04.2019					15.11.2019
18	29.03.2019	4.04.2019	07.04.2019	12.04.2019	15.04.2019	20.04.2019	28.04.2019	21.11.2019
19	20.03.2019	30.03.2019	06.04.2019	08.04.2019	19.04.2019	24.04.2019	07.05.2019	22.11.2019
27	18.03.2019	20.03.2019	26.03.2019	06.04.2019	15.04.2019	24.04.2019	07.05.2019	16.11.2019
28	17.03.2019	20.03.2019	30.03.2019	10.04.2019	15.04.2019	24.04.2019	07.05.2019	19.11.2019
29	01.04.2019	05.04.2019	8.04.2019	14.04.2019	17.04.2019	24.04.2019	10.05.2019	19.11.2019

G.N: Genotype No; B.S: Bud swelling; B.B: Bud burst; H.G: Half-inch green period; P.B.S: Pink bud stage; B.F: Beginning of flowering; F.B: Full bloom; E.F: End of flowering; L.F: Leaf fall; (* There was no flowering in these genotypes)

In the study carried out in 1995-1996 on the phenological and pomological characteristics of many apple species grown in the Çoruh Valley, it was determined that the full blooming of apple varieties grown in the region was between 8-22 May, the end of the flowering period was 12-27 May, and the earliest fruit ripening period was in Fındık (9 August) in the latest species Limon (October 13) [22]. Uysal and Bakır [23] carried out studies with Starking Delicious and Golden Delicious apple varieties in Bucak, Uluborlu, Burdur regions. Researchers reported that full flowering occurred on May 6 in the Bucak region, May 1 in the Burdur region, and May 8 in the Uluborlu region. It was determined that the time from full bloom to harvest was 145 to 150 days in Burdur and Bucak regions, 155 to 160 days in Uluborlu region, for Golden Delicious variety; 150 to 155 days in Uluborlu and Bucak region, 155 to 160 days in Burdur region for Starking Delicious variety, In the research conducted with 10 local apple cultivars (Alyanak, Arapkizi, Demir, Eksi Apple, Elifli, Gelin Apple, Pehrizoglu, Tavar,

Yaglikizil and Yam apple) grown in the central district of Tokat, their phenological-pomological characteristics were determined based on the years 2004-2005. According to the data of the research; the full bloom period was between 9-25 April, and the ripening of the fruits took place between 26 July-25 September [21]. In a study performed on Golden Delicious, Mondial Gala and Fuji apple cultivars grafted on M9 rootstock, yield, growth patterns and some phenological and pomological characteristics of the trees were investigated. According to the findings of the research, the varieties started to bloom on 25-30 April in 2007, when the experiment was carried out. The flowering period was longer (11 days) in Mondial Gala than in other species [14]. In the study on Fuji, Granny Smith, Golden Delicious, Starking, Delicious and Red Chief apples, bud swelling, bud burst, beginning of flowering, full bloom, end of flower and harvest date were determined. According to the research data, full bloom is 20-24 April for 2009; it took place on 12-16 April for 2010. Harvest dates were observed from September 15 to October 8 in the first year, and September 5 to 26 in the second year [24]. Karakaya et al., [16]; The pomological and phenological characteristics of 29 apple genotypes obtained by selection from Yaglidere district were investigated. The first flowering period of the genotypes included in the study was between April 2 and May 11, and the number of days from full flowering to harvest was between 138-188 days. The defoliation phase took place between the first and last weeks of November. The earliest deciduous genotype was genotype 5, while the latest deciduous genotype was genotype 19. There are some differences between the above-mentioned studies and our study in terms of phenological parameters. It is predicted that these differences are related to ecological conditions and materials used.

The findings obtained in the study are important in terms of revealing the phenological stages of *M. kirgishorum* in Central Anatolian conditions. Repeating these studies for a few more years is important in terms of obtaining more precise information. These findings are guiding for the breeding and cultivation techniques studies to be carried out on this species.

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