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Determination of Phenological Properties and Effective Heat Summation Requirements of Some Apples Varieties in Ankara (Kalecik) Conditions

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ABSTRACT

In this study, the phenological characteristics of some apple varieties grown in the Kalecik district of Ankara province, the number of days between effective heat summation requirements, and phenological phases were determined. The research was conducted on Royal Gala, Granny Smith, Jersey Mac, Spur Golden and Red Chief apple varieties. The threshold temperature of +10°C was accepted as the temperature value for the determination of the heat summation requirements of the varieties. The effective heat summation above +10°C during the growing season of varieties was determined as 819.1-1986.3°C days in 2015 and 865.1-2031.2°C days in 2016. The number of days from full bloom to harvest was 85-75 days in 2015 and 132-219 days in 2016.

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Introduction

Since our country, as with many kinds of fruit, is located in the gene origin of apples and due to the suitability of growing conditions, growing has been carried out since ancient times. According to the FAO's 2014 data, world apple production is 84.630.275 tons (Anonymous, 2014). China has a percentage of 48,3% with 40,923,200 tons of production. The other countries are USA (5.185.078 t), Poland (3.195.299 t), India (2.497.680 t) and Turkey (2.480.444 t), respectively (Anonymous, 2014).

Because of the high number of varieties and high adaptation ability of apples, the growing is carried out in almost every region of our country, and it takes the first place among pome fruit species regarding production amount. The most suitable cultural origins are in North Anatolia parallel to the spreading area of its wilderness.

In economic apple growing, it is important to choose the variety most suitable for the region. In terms of development, yield and fruit quality of fruit trees, the temperature is the most important factor limiting economic fruit growing in a region. In the development period of fruit trees, the summation of the heat above a certain temperature level is of great importance regarding growing. Thus, it is important to know the effective heat summation requirements of the varieties and the region for selecting the species and variety suitable for the region.

Notably, to determine the cooling and heat requirements in parents' selection to obtain early flowering varieties in breeding activities is significant (Alburquerque, et al., 2008). Also, the effective heat requirement of fruit tree for bloom is important, especially when spring frost is concerned (Rahemi and Pakkish, 2009).

After getting out of dormancy, deciduous mild climate fruit species start to develop when the heat rises to a certain level (base temperature). The monitoring of these stages development (phenological observations) is of great importance in terms of fruit growing.

Guleryuz, et al. (2001) performed phenological observations of Granny Smith, Golden Delicious and Starking Delicious, and regional Sakı apple varieties located in the Erzincan plains have determined the full bloom dates of the Sakı variety as May 6th, the Starking Delicious as May 8th, and the Granny Smith and Golden Delicious as May 9th; while the duration of full bloom to harvest was determined as 155-165 days in the Sakı variety, 160-170 days in the Starking Delicious, 162-172 days in the Golden Delicious, and 166-176 days in Granny Smith the variety.

Karsi and Aslantas (2016) reported that the full blooming dates of some apple varieties grown in the Erzurum ecology are between May 13th (White Saki and Yazlik) and May 20th (Granny Smith), and that the harvest dates are between August 12th (Vista Bella) and October 29th (Granny Smith), while the duration of full bloom to harvest of the varieties ranged from 89 days (Vista Bella) to 162 days (Granny Smith). Researchers noted that the varieties in the summer and autumn groups should be preferred in ecologies with a short vegetation period such as Erzurum.

Yield, quality and yield-development relationships of Mondial Gala, Skyline Supreme, Lutz Golden and Granny Smith varieties grown on M9, M26, MM106 and MM111 apple clone rootstocks with different growth potency were examined. The budding of the varieties in the conditions of Egirdir was from March 20th to March 25th, full bloom from April 23th to May 1st, and harvest from August 25th to November 5th (Ozongun, et al., 2016).

The phenological calendar in fruit growing may vary according to species and varieties. Also, climate and soil characteristics affect the growth and productivity of the plant.

In this study, the number of days between the beginning of the buds of some apple varieties grown in Ankara (Kalecik), conditions and the phenological characteristics between maturation dates, the effective heat summation requirements, and the phenological phases were determined. The varieties used in this study are varieties grown in many regions of our country, Turkey. The contribution of the present research is that the promising findings provide valuable insights and could guide growers in choosing the suitable varieties for their regions in accordance with the determined heat summation requirements.

Material and Method

Material

The study was conducted between March 2015 and October 2016 in Ankara (Kalecik). Royal Gala, Granny Smith, Jersey Mac, Spur Golden and Red Chief apple varieties were studied in the experiment.

Method

The following phenological observations were made on the three trees of each variety and on the three branches selected in different directions in each tree during the duration of budding to harvest (Westwood, 1978; Karasakal,1990; Unver ve Celik, 1996).

- *Silver tip*: The period the bud has yet begun to swell and the tip of the beam starts to subtly become visible between the brown bud scales.
- *Green tip*: The period the green tip is seen.
- *Half-inc green*: The period the green tip reaches a certain length (approximately 1.25 cm).
- *Tight cluster*: The period the visible flowers in the beam are attached to each other.
- *First pink*: The period the end of the buds burst and the petals are visible.
- *Full pink*: The period the petals are well developed.
- *First bloom*: The period the flowers bloom 5%.
- *Full bloom*: The period the flowers bloom 60-70%.
- *Post bloom*: The period the flowers bloom 95%, and the petals start to fall. In this period, pollination and fertilization have come to an end, and the fruit set has taken shape.
- *Harvest*: The period the fruit is matured.

The study also determined the effective heat summation requirements and the number of days between full bloom, fruit set and harvest stages starting from the budding.

Different threshold temperatures are recommended by the researchers Ageevo (1984) +5ºC, +6ºC, Jackson (1986) +10ºC, Munoz et al. (1986) +2,5ºC, +4,4ºC, Ryugo (1988) +7ºC for the determination of the effective heat summation requirements. In our study, the necessary threshold temperature for the calculation of the effective heat summation was accepted as +10°C for the pome fruit species (Unver and Celik, 1996). The daily average temperature values used in the calculations were taken from Turkish State Meteorological Service records. In determining the effective heat summation requirements, by subtracting the threshold temperature from the average daily temperature above the threshold temperature (Celik vd 1988, Galletta and Himelrick 1990, Ryugo 1988, Unver and Celik, 1996), the effective heat summations were calculated as "degree-days" (°C-days) according to the number of days between each and every phenological phase. Temperature ratings below the threshold temperature were not considered.

Results and Discussion

In this study, the phenological stages of some apple varieties grown in Ankara (Kalecik) conditions during the vegetation period, the number of days between these stages and the effective heat summation were calculated on the basis of daily average temperature values.

Phenological Properties

In 2015 and 2016, five different apple varieties had witnessed chilling and the resting period had ended, and difference of phenological parameters among the apple varieties could be observed.

According to the data obtained from the Turkish State Meteorological Service, the phenological calendar in the Kalecik and Ankara provinces started earlier in 2016 than 2015 and this difference was reflected in other observations (Table 1ve Table 2).

The first observation (silver tip) in the varieties examined was made in the Jersey Mac, Spur Golden and Red Chief varieties on March 5th, 2015 and March 1st, 2016. The first varieties to enter the full bloom stage were the Red chief (April 22th) in 2015 and the Royal Gala and Jersey Mac (April 6th) in 2016 (Table 3, Figure 1).

In the orchards, matching of blooming can help to achieve a good degree of fruiting. Due to this reason, it is important to know the flowering time of the varieties.

Table 1 The values daily average temperature for the years 2015 in Ankara conditions (°C)

Day/Month	1	2	3	4	5	6	7	8	9	10	11	12
1	4	11.6	8.5	10.3	14.2	17.1	21	27.8	21.8	18.8	8.5	4.4
2	3.5	11.1	6.6	10.8	14.2	19.1	22.4	27	23.9	18.4	5.9	5.1
3	2.8	9.2	5.8	6.6	14.1	19	22.2	24.8	23.5	18.2	6.1	1.9
4	3.7	5.2	6.5	5.3	15.7	16.3	22	26.2	26.5	17.9	7.2	3.7
5	3.2	5.1	2	4.5	14.4	16.3	23	25.7	25.5	18.4	8.1	-0.1
6	-0.2	4.4	3.9	9.5	17.8	16.4	23.3	24.8	25	16.5	8.5	-1.7
7	-1.9	6.5	6	12.5	17	20.1	22.7	25.7	25.2	15.8	8.4	-0.4
8	-7.3	3.7	8.3	8.9	17	21.1	22.9	26.3	25.2	16.4	8.9	0
9	-13.2	4.5	9.7	6.3	16.1	20.2	23.6	26.9	22.3	15.6	7.5	0.8
10	-8.1	0.7	11.2	3	14.8	17.8	26.4	27.4	23	13.7	8.3	0.2
11	-9.2	1.5	10	3.8	14.3	17.7	24.5	28.3	26.5	15	10	-0.4
12	-0.7	2.5	7.6	5.7	14.9	18.3	23.6	25	24.5	17.4	12.5	0.4
13	1.5	3	5.9	9.7	14.3	19.9	22.2	28.1	21.5	17.7	10.3	-0.1
14	-1.8	4.1	5.9	9.7	15.3	20	22.3	28.7	22.4	16.8	8.5	3.2
15	-3.5	3.5	8.6	11.7	17.2	21.1	23.1	26.5	22.9	15.2	7.5	-1.6
16	-2.2	1.5	9.5	10.8	20.5	21	23.8	24.3	23.7	14.6	7.7	0.2
17	-4.1	-0.1	6.6	13.8	21.4	20.3	22.7	25.7	23.5	14.3	9	2.4
18	-1	-4.1	5.5	17	21.2	21	22.6	27.8	22.3	15.8	3.3	2.5
19	-0.2	-2	4.3	17.6	22.7	20.3	22.8	26.4	21.4	16.4	5.6	-1.9
20	0	0.6	4.3	9.7	23.8	19.6	23.4	26.4	22.8	16.1	5.4	-1.3
21	-0.6	-2.7	3.6	7.4	22.1	20.6	24.6	24.6	22.9	15.1	6.7	-0.5
22	-0.3	-3.1	6.7	5.3	21.6	22.3	24.5	25.1	22.6	16.8	11.4	-0.9
23	-2.4	-2	7.4	5.5	19.6	20	24.6	25.2	23	15.3	8.4	0
24	-3.2	2.1	7.7	7.2	20	19.9	26.8	23.6	22.4	16.1	6.8	0.2
25	0.2	4.5	7.2	10.5	20.8	19.8	28.8	20.8	21.8	12.7	6.7	0
26	2.2	6.2	8.5	10.7	20.4	20.5	26.8	20.1	22.8	10.8	6.4	0.8
27	2.1	6.8	11.8	13.9	17.1	18.9	26.2	21.4	22	9.1	9.8	-0.3
28	3.9	9.6	11.1	15	17.4	18.5	27.6	21.5	21.5	10.5	10.1	-0.8
29	6.9		11.7	18.6	15	18.9	27.9	21.8	24	9.5	10.6	-0.8
30	3.8		10.1	16.8	14	19.9	28.8	22.5	18.9	9	7.7	0.4
31	7.2		9.2		15.3		30.9	22.8		10.7		-3.7

Table 2 The values daily average temperature for the years 2016 in Ankara conditions (°C)

Day/Month	1	2	3	4	5	6	7	8	9	10	11	12
1	-5.3	3.7	11.2	12.7	14.9	21.3	23.4	26.4	22.9	15.1	4.6	2.3
2	-7.0	6.7	11.6	14.3	16.0	22.9	24.7	28.1	21.6	16.4	4.1	2.0
3	-4.2	3.2	11.4	12.5	18.2	22.2	24.7	28.0	20.0	17.8	4.5	3.9
4	0.9	3.5	8.8	10.7	13.6	19.9	25.2	27.0	20.8	17.9	6.5	-0.1
5	4.1	6.9	6.6	12.6	11.9	19.0	24.2	26.4	21.3	18.7	9.8	-1.2
6	4.5	5.0	7.2	15.0	11.4	19.8	24.6	26.9	22.7	19.4	9.9	-2.4
7	7.1	1.8	7.0	16.1	12.2	19.8	24.6	27.3	25.3	19.2	11.2	-1.5
8	6.7	-0.7	9.2	15.2	13.9	14.1	23.7	27.4	22.3	18.3	12.7	0.0
9	4.5	0.2	10.2	16.8	15.3	14.1	21.0	27.4	22.4	19.3	12.1	-1.7
10	2.2	1.1	10.2	16.7	14.0	16.9	22.5	27.8	23.8	16.5	15.5	3.7
11	7.2	4.2	10.2	15.1	12.2	19.4	22.7	28.7	23.9	16.8	11.3	3.7
12	9.0	8.7	7.7	12.0	14.0	21.7	23.3	25.5	23.7	20.2	9.8	4.2
13	8.7	8.9	10.3	14.0	19.0	22.5	25.5	20.4	22.2	21.3	10.0	6.0
14	4.4	10.6	10.6	17.5	20.9	22.3	27.7	21.2	19.4	15.0	11.9	-0.9
15	1.5	11.3	4.4	17.3	20.8	20.5	29.6	20.0	19.0	11.9	7.9	-4.3
16	2.5	10.5	4.5	16.4	18.7	21.1	30.6	21.3	18.9	11.5	5.4	-1.1
17	6.2	11.2	3.5	20.7	18.1	23.8	30.6	22.8	18.7	11.8	1.5	-3.1
18	5.6	11.0	4.8	17.9	14.9	23.2	30.5	24.5	18.9	9.2	-0.2	-4.1
19	1.1	12.2	6.4	24.0	15.2	25.0	25.9	26.0	21.3	7.3	0.9	-5.3
20	-2.8	10.7	7.2	20.2	15.7	26.8	24.6	26.0	21.9	9.0	2.0	-6.5
21	-1.4	7.7	7.7	13.6	17.6	26.6	24.6	28.3	18.2	11.0	1.7	-5.1
22	-0.4	5.1	9.5	9.1	17.7	27.0	24.0	28.2	17.4	11.1	1.5	-0.6
23	-3.0	4.3	16.6	12.3	13.7	27.4	24.9	26.6	14.5	11.3	1.1	1.1
24	-4.3	6.8	16.6	17.8	16.2	26.9	24.1	27.7	12.1	13.9	-0.3	0.8
25	-8.3	9.8	12.0	16.5	16.5	26.1	23.2	25.6	12.3	13.7	-1.3	2.7
26	-10.9	9.8	7.5	12.3	15.3	27.2	24.2	23.8	12.8	8.2	-0.3	1.5
27	-8.1	9.4	4.7	11.8	16.0	27.8	25.8	23.0	14.1	9.1	0.3	2.2
28	-3.7	9.1	5.0	13.2	14.6	25.2	26.1	23.9	15.3	12.3	3.8	0.9
29	-0.4	9.9	5.8	15.6	15.7	23.6	25.9	21.1	15.2	11.9	8.5	1.0
30	1.1		8.7	17.7	18.3	21.4	26.5	25.2	15.2	12.6	5.0	1.0
31	1.7		10.4		21.4		25.6	24.3		7.3		-0.3

Table 3 Phenological properties of apple varieties

Varieties	Years	Silver tip	Green tip	Half-inch green	Tight cluster	First pink	Full pink	First bloom	Full bloom	Post bloom	Harvest
Royal	2015	10.Mar	20.Mar	26.Mar	01.Apr	12. Apr	16. Apr	20.Apr	27. Apr	08.May	28.Aug
Gala	2016	05.Mar	13.Mar	18.Mar	21.Mar	25.Mar	29.Mar	04.Apr	06. Apr	13.Apr	21.Aug
Granny	2015	09.Mar	14.Mar	24.Mar	03. Apr	13. Apr	15. Apr	19. Apr	24. Apr	06.May	15.Sep
Smith	2016	05.Mar	09.Mar	15.Mar	23.Mar	26.Mar	21.Mar	04. Apr	07. Apr	14.Apr	10.Oct
Jersey	2015	05.Mar	16.Mar	26.Mar	01. Apr	10. Apr	15. Apr	20. Apr	26. Apr	06.May	19.Jul
Mac	2016	01.Mar	09.Mar	20.Mar	24.Mar	29.Mar	31.Mar	04. Apr	06. Apr	15.Apr	11.Jul
Spur	2015	05.Mar	18.Mar	26.Mar	04. Apr	13. Apr	16. Apr	21. Apr	27. Apr	08.May	15.Sep
Golden	2016	01.Mar	10.Mar	20.Mar	23.Mar	27.Mar	01. Apr	06. Apr	08. Apr	15.Apr	11.Sep
Red	2015	05.Mar	18.Mar	25.Mar	06. Apr	11. Apr	15. Apr	17. Apr	22. Apr	06.May	14.Sep
Chief	2016	01.Mar	10.Mar	23.Mar	27.Mar	30.Mar	02. Apr	06. Apr	08. Apr	16.Apr	08.Sep

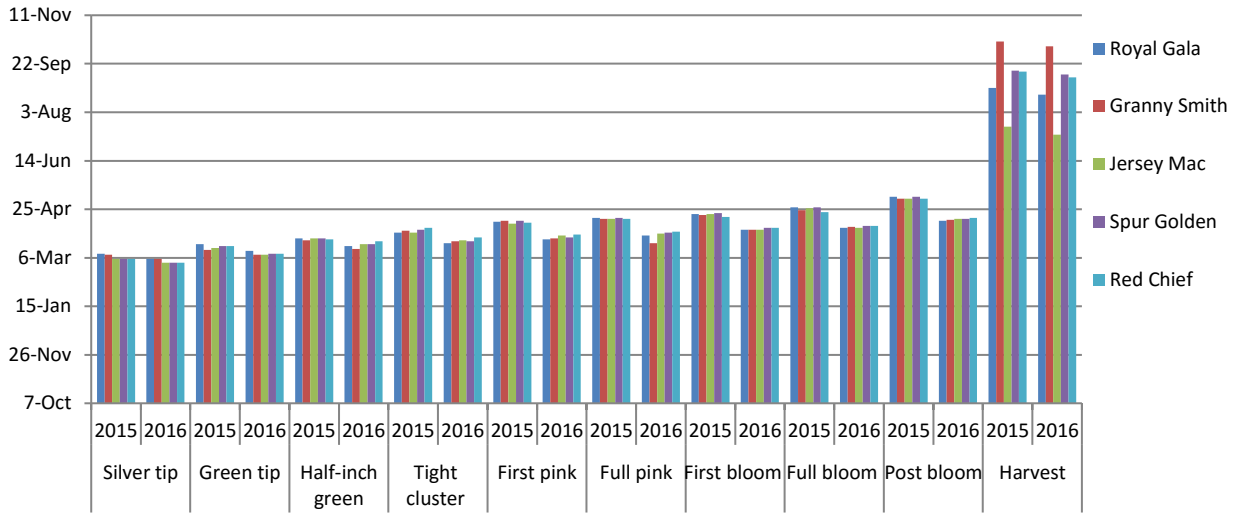

Figure1 Phenological properties of apple varieties

According to Ozbek (1977), the flowering time of fruit trees may vary according to climatic conditions in different years, but among the varieties the order of flowering and hence the fertilization stays constant. The researcher argued that there was more than 20 days difference between the earliest and latest flowering varieties.

In our work, the flowering dates for the varieties in the experiments were very close to each other. In 2015, Red Chief, and in 2016 Royal Gala and Jersey Mac were the earliest flowering; in 2015 Royal Gala, in 2016 Spur Golden and Red Chief were the latest flowering varieties (Table 3, Figure 1). It is seen that the blooming periods of the varieties (full bloom-fruit set) are close to each other.

The blooming period was between 11-15 days and 7-9 days in 2015 and 2016, respectively (Table 4, Figure 2). Very short periods of flowering of varieties can be attributed to sudden heating of the air at that time.

It is important for the fruit to obtain market qualities and to determine the appropriate harvest time in their quality protection. Harvest dates of varieties vary according to regions and years depending on climatic conditions, but ripening sequences of varieties remain constant.

When the ripening dates of the apple varieties studied were examined, the first harvest was carried out on the Jersey Mac variety on July 19th, 2015. Afterwards, the Royal gala (August 28th), Red chief (September 14th) and Spur Golden (September 15th) varieties were harvested. The latest harvest was carried out on the Granny Smith on October 15th. In 2016, the varieties were harvested in the order of Jersey Mac (July 11th), Royal Gala (August 21th), Red Chief (September 8th), Spur Golden (September 11th) and Granny Smith (October 10th) (Table 3, Figure 1).

Number of Days

In order to determine the optimal harvesting time of the varieties, besides other factors, the number of days until from full bloom to harvesting is an important criterion (Özbek, 1978). The number of days between phenological periods of apple varieties is given in Table 4, Figure 2 for the years 2015 and 2016.

It has been identified of the number of days from bud to harvest is at least 137 days in 2015 and 132 days in 2016 in the Jersey Mac variety; at most 221 days in 2015 and 219 days in 2016 in the Granny Smith variety (Table 4, Figure 2).

The number of days from full bloom to harvest for the earliest harvested Jersey Mac and the latest harvested Granny Smith was determined as 85 and 175 days in 2015; 96 and 186 in 2016, respectively (Table 4, Figure 2).

The phenological characteristics of the fruit species vary depending on the variety and ecology. Studies on different fruit species show that there are differences between varieties and ecologies in terms of phenological periods. In the study conducted in Kagızman, the full blooming dates of local apple varieties were determined to be 26-30 April, and the period from full blooming to harvest was 113-157 days (Guleryuz and Ercisli, 1995).

Table 4 Number of days between phenological stages of apple varieties

Varieties	Years	Phenological Dates				Number of Days				
		Silver tip (A)	Full bloom (B)	Post bloom (C)	Harvest (D)	A-B	B-C	C-D	B-D	A-D
Royal Gala	2015	10.Mar	27.Apr	08.May	28.Aug	49	12	113	124	172
	2016	05.Mar	06. Apr	13. Apr	21.Aug	32	7	130	137	169
Granny Smith	2015	09.Mar	24. Apr	06.May	15.Oct	47	13	163	175	221
	2016	05.Mar	07. Apr	14. Apr	10.Oct	33	7	179	186	219
Jersey Mac	2015	05.Mar	26. Apr	06.May	19.Jul	53	11	75	85	137
	2016	01.Mar	06. Apr	15. Apr	11.Jul	36	9	87	96	132
Spur Golden	2015	05.Mar	27. Apr	08.May	15.Sep	54	12	131	142	195
	2016	01.Mar	08. Apr	15. Apr	11.Sep	38	7	149	156	194
Red Chief	2015	05.Mar	22. Apr	06.May	14.Sep	49	15	132	146	194
	2016	01.Mar	08. Apr	16. Apr	08.Sep	38	8	145	153	191

Table 5 Effective heat summation of apple varieties (°C days)

Varieties	Years	Phenological Dates				Effective Heat Summation (°C days)				
		Silver tip (A)	Full bloom (B)	Post bloom (C)	Harvest (D)	A-B	B-C	C-D	B-D	A-D
Royal Gala	2015	10.Mar	27.Apr	08.May	28.Aug	35,5	67,8	1358,8	1420,5	1452,1
	2016	05.Mar	06. Apr	13. Apr	21.Aug	34,9	41,9	1444,7	1481,6	1511,5
Granny Smith	2015	09.Mar	24. Apr	06.May	15.Oct	30,4	55,9	1907,8	1955,9	1986,3
	2016	05.Mar	07. Apr	14. Apr	10.Oct	41,0	36,9	1959,4	1996,3	2031,2
Jersey Mac	2015	05.Mar	26. Apr	06.May	19.Jul	31,6	55,4	740,6	788,2	819,1
	2016	01.Mar	06. Apr	15. Apr	11.Jul	39,1	56,7	781,6	831,0	865,1
Spur Golden	2015	05.Mar	27. Apr	08.May	15.Sep	35,5	68,7	1605,6	1667,3	1698,9
	2016	01.Mar	08. Apr	15. Apr	11.Sep	50,4	45,6	1721,6	1759,9	1805,1
Red Chief	2015	05.Mar	22. Apr	06.May	14.Sep	30,4	55,9	1607,5	1655,6	1686,0
	2016	01.Mar	08. Apr	16. Apr	08.Sep	50,4	52,0	1674,2	1719,8	1765,0

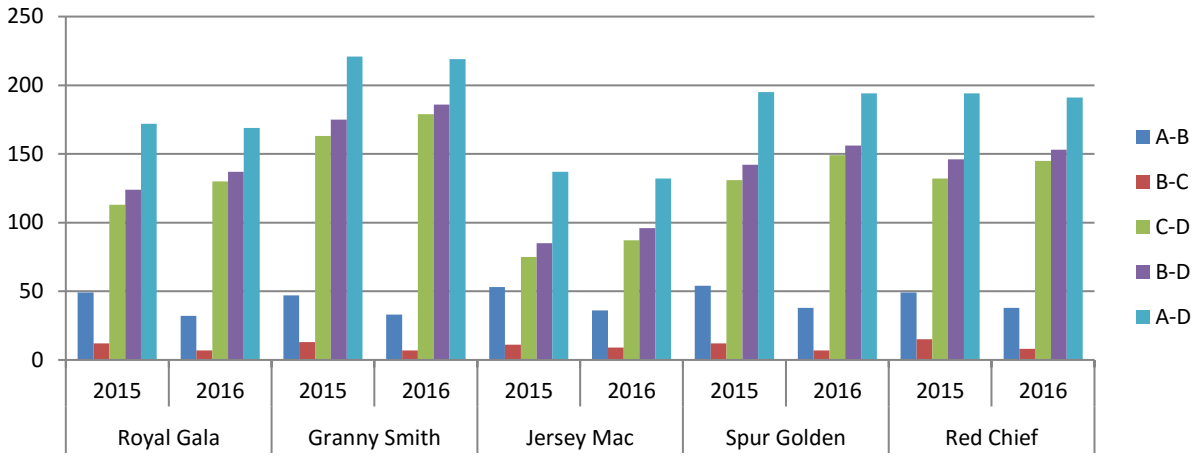

Figure 2 Number of days between phenological stages of apple varieties

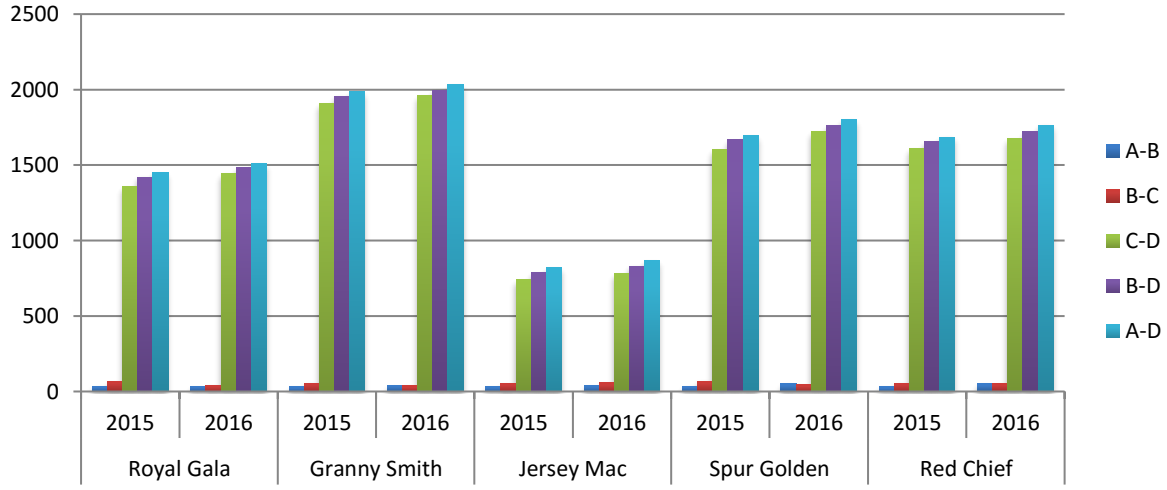

Figure 3 Effective heat summation of apple varieties (°C days)

Bostan et al. (1997) reported that the full blooming dates of local apple varieties were May 15th (Turs) and April 25th (Cebegirmez) and those that period from the full flowering to the harvest were 124 days and 177 days, respectively. In the study that apples varieties grown in the Upper Coruh valley, the period from full blooming to harvest was determined between 145 days and 154 days in 2000 year and between 145 days and 156 days in 2001 year (Karlidag and Esitken, 2006).

Effective Heat Summation

In the study, varieties with the lowest effective heat summation between bud and full bloom period (A-B) were Granny Smith and Red Chief in 2015 (30.4°C-day) and Royal Gala in 2016 (34.9°C-day). Varieties with the highest effective heat summation is the Royal Gala and Spur Golden (35.5°C-day) in 2015, the Spur Golden and Red Chief (50.4°C-day) in 2016 (Table 5, Figure 3).

In 2015, the period of from full bloom to fruit set (B-C) the lowest heat summation was determined with 55.4°C in Jersey Mac variety, and the highest effective heat summation was found at 68.7°C-day in Spur Golden.

After evaluating the fruiting to harvesting (C-D) period of fruit varieties, Jersey Mac was the variety requiring lowest effective heat while Granny Smith as the one requiring the highest total effective heat. In the years 2015 and 2015, total effective heat during C-D period for Jersey Mac variety was 740.6°C-days and 781.6°C-days, for Granny Smith variety, it was noted as 1907.8°C-days and 1959.4°C-days. Granny Smith was the variety that required the lowest total heat during the B-C period, while the same variety had the highest total heat requirement during the C-D period (Table 5, Figure 3).

Table 5 and Figure 3 show the total heat requirements of the varieties from flowering to harvesting period (B-D). Jersey Mac was the variety that had lowest effective heat requirement. The results of phenological observation indicated that total effective heat values were 788.2°C and 831.0°C-days during 2015 and 2016, respectively. During this period, the highest total effective heat (1955.9°C and 1996.3°C-days during the two years) was noted for Granny Smith variety.

For the five apple varieties, total heat requirement from the bud swelling to maturity was calculated during the years 2015 and 2016. In each of the years, Jersey Mac took the first place as an early maturing variety. For this variety, the total effective heat was 819.1°C-days in 2015 and 865.1°C-days in 2016. During this period, the variety that required the highest total effective heat to mature was the Granny Smith with 1986.3°C-days in 2015 and 2031.2°C-days in 2016 (Table 5, Figure 3).

The total effective heat required for the apples from flowering to maturity was determined by Gardner and Hooker as 926.6-2148.8°C for the regions in the USA (Dokuzoğuz, 1974).

Galletta and Himelrick (1990) reported that differences existed among the fruits regarding growth, development and maturity depending on the cultural practices and temperature; especially the temperature changes between the seasons and the number of days before full bloom and before the harvest. They suggested that total effective heat should be considered while selected the most adapted verities for a specific area.

Conclusion

Another definition of maturity period in fruit species is closely related to the total heat accumulation during the growing season (Galletta and Himelrick, 1990). In our work in the ecology of Kalecik (Ankara), the growing season were 284 and 283 days during 2015 and 2016, respectively. The effective heat total during these periods as threshold of +7°C were 2724.9°C and 2871.2°C-days. As a threshold of +10°C, these were 2070.4°C-dasy in 2015 and 2135.7°C-days in 2016. These results indicated that the Kalecik (Ankara) ecological conditions were suitable for the varieties we worked on.

In this study Effective heat summation needs of apple varieties from bud to harvest were determined as 816.1°C day-1985.3°C day in 2015 and 865.1°C day - 2031.2°C day at 2016.

As a result, it is observed that in addition to extreme temperatures, the sum of the temperatures during the growing season is also important in selection of fruit and vegetable varieties. Considering the temperature conditions of the Kalecik (Ankara) ecology and the heat accumulation requirements of the varieties, the ecology of this regions seems to be suitable for the investigated varieties. The results obtained will guide the apple growers regarding the selection of varieties in the different regions.

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