

Full Length Research Paper

Phenological observations on a bean trefoil (*Anagyris foetida* L.) population in the Kahramanmaras region, Turkey

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Bean trefoil (*Anagyris foetida* L.), Leguminosae, is a Mediterranean element and summer-deciduous shrub species. In this study, about 5.5-month phenological observations were made on a bean trefoil population in the Kahramanmaras region, southern Turkey, and the time and duration of phenological phases of the species were tried to be determined. In bean trefoil population of the region, the order of occurrence of main phenological phases was as follows: The beginning of bud burst (January 28), full leafing (March 25), full flowering (March 31), full fruit formation (May 22), full fruit ripening and full leaf colouring (June 18), full leaf fall and full fruit fall (June 25). The species shed its leaves in the second half of June, depending on the beginning of dry period in the region. In bean trefoils, the leaf duration (166-day) and phenological vegetation period (141-day) were quite short. It was determined that the species also pollinated by birds as well as insects and exhibited cauliflory. Bean trefoil could be regarded as an indicator plant for the beginning of dry period in the region.

Key words: *Anagyris foetida*, phenology, phenological observation, phenological phases.

INTRODUCTION

Bean trefoil (*Anagyris foetida* L.) is the only species of the genus *Anagyris* L., the family Leguminosae, in Turkey. It is an erect shrub with dense branches that reaches up to 2-3 m tall (Kayacik, 1982). Bean trefoil is a shrub species that is a Tertiary relict (Ortega-Olivencia et al., 2005; Valtuena et al., 2008a) and Mediterranean element (Chamberlain, 1970). This species occurs naturally in western, southern and southeastern Anatolia and between elevations of 0-1300 m in Turkey and is located in dry soils, stony slopes, frigana, maquis and degraded deciduous oak forests (Yaltirik, 1972). Bean trefoil is a tolerant plant that can grow even in the poorest soils and improve dry soils in nitrogen because of being a leguminous plant (Yaltirik, 1972). Because of unpleasant smell and toxic properties of its legumes and leaves, the species is unpalatable for animals and therefore can

survive in intensively grazed regions where other shrub species have been eradicated (Browicz, 1983). In addition, its attractive yellow flowers are important for apiculture. However, bean trefoil seeds exhibit physical dormancy resulting from hard and impermeable seed coat (Valtuena et al., 2008b; Avsar, 2009).

Phenology is a branch of science that observes the beginning and continuation of important periodical life signs of plant and animal worlds within a year (Kayacik, 1957). There are close relationships between phenological characteristics of plants and climatic conditions of site. Especially, temperature has an important role in regulating phenological events (Bednorz and Urbaniak, 2005). Important information relating to timely and successfully making of many silvicultural activities such as seed collection, taking cutting and scion, lifting and planting in nursery etc. could be obtained through phenological observations.

It is known that bean trefoil sheds all its leaves within summer months in Turkey (Yaltirik, 1972). This species also sheds its leaves in summer in Spain (Ortega-Olivencia

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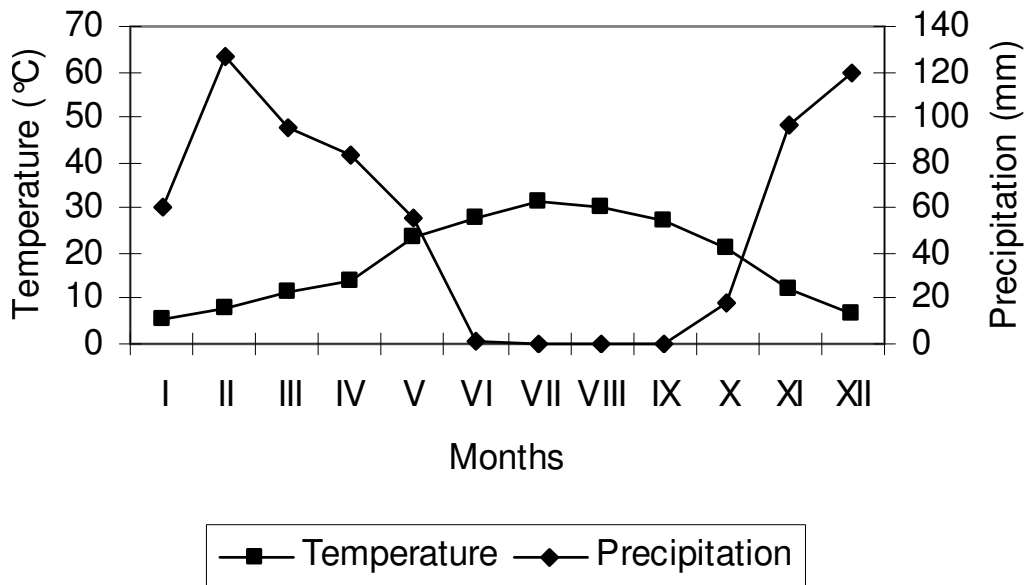


Figure 1. Water balance graph of the study area (annual mean temperature: 18.2 °C, annual total precipitation: 657.1 mm).

et al., 2005; Valtuena et al., 2008a). However, there is no detailed study in Turkey on the phenology of this species including the phases such as bud burst, leafing, flowering, fruit formation, fruit ripening, leaf colouring, leaf fall and fruit fall.

In this study, about 5.5-month phenological observations were made on a bean trefoil population in the Kahramanmaraş region, and the time and duration of phenological phases of this shrub species were tried to be determined. Thus, it was aimed at both making a contribution to the phenology of this species and obtaining some information to be useful for generative reproduction of the species.

MATERIALS AND METHODS

The study was carried out in a bean trefoil population (37°34' N, 36°50' E) in the central district of the Kahramanmaraş province, southern Turkey. The population is found at a distance of about 10 km to the province centre. The population is located at 510 m elevation, south and southwest aspects and about 30% slope. In this site, the Mediterranean climate is seen and the soil is deep. The heights of bean trefoil individuals generally vary between 1.2 and 2.0 m. In the environs, *Quercus coccifera* L. (predominantly), *Paliurus spina-christii* Mill. and *Capparis spinosa* L. are also found.

The temperature and precipitation values of the year 2007 were obtained from Kahramanmaraş Meteorological Station (37°36' N, 36°56' E, 572 m), which is the nearest meteorological station to the study area (Anonymous, 2008), and these values were interpolated by 510 m, which is the elevation of bean trefoil population. For this, mean temperatures were determined on the basis of 0.5°C decrease in temperature for every 100 m elevation increase (Cepel, 1983); annual precipitation amount was also calculated by the Schreiber formula (Erinc, 1996), then distribution of this value by months was found. According to the water balance graph drawn with the Walter method (Cepel, 1983), dry period in the study area

starts in May and continues until October, lasting about 5-month (Figure 1).

Phenological observations were performed on 20 individuals selected from bean trefoil population in the study area. The selected individuals had a normal stem and crown. Phenological observations were made between January 28 and July 13, 2007 and generally in every 7 - 10 days. A total of 23 observations were made during about 5.5-month phenological observation period in the study area and detailed notes relating to the observations were taken. In this study, 8 different phenological phases (events) such as bud burst, leafing, flowering, fruit formation, fruit ripening, leaf colouring, leaf fall and fruit fall were taken into account. Except bud burst, the other phenological phases were considered as three sub-phases such as beginning, full occurrence and ending; thus, a total of 22 different phenological phases of the species were observed.

Phenological phases were evaluated as follows: Bud burst, being visible of the green part of leaf at bud apex; leafing, about half-opening of leaves (Bednorz and Urbaniak, 2005) by normal leaf size of this species; flowering, the opening of flowers and beginning of pollination by insects; fruit formation, reaching to normal size in fruits; fruit ripening, turning from green to light brown in colour of normal-sized fruits; leaf colouring, turning from green to yellow in leaf colour; leaf fall or fruit fall, fall of leaves or fruits on the ground. The period from leaf bud burst till the fall of all leaves was also regarded as the leaf duration (Kikuzawa, 1983). Beginning, full occurrence and ending of any phenological phase in an individual were based on the occurrence of the mentioned phase at proportions of at least 10, 50 and 90%, respectively, in that individual. Occurrence of any phenological phase in the population was based on the occurrence of at least 50% of observed individuals in the mentioned phase.

RESULTS

The times of phenological phases and the pattern of the times of main phenological phases relating to bean trefoils in the region are given in Table 1 and Figure 2, respectively. The detailed results relating to each

Table 1. Times of phenological phases in bean trefoils.

No.	Phenological phases	Date	Day of the year*	Day difference with BBB
I	Beginning of bud burst (BBB)	January 28	28	0
	Beginning of leafing	March 18	77	49
II	Full leafing (FL)	March 25	84	56
	End of leafing	March 31	90	62
	Beginning of flowering	March 11	70	42
III	Full flowering (FF)	March 31	90	62
	End of flowering	April 18	108	80
	Beginning of fruit formation	May 13	133	105
IV	Full fruit formation (FFF)	May 22	142	114
	End of fruit formation	May 31	151	123
	Beginning of fruit ripening	June 8	159	131
V	Full fruit ripening (FFR)	June 18	169	141
	End of fruit ripening	June 25	176	148
	Beginning of leaf colouring	June 8	159	131
VI	Full leaf colouring (FLC)	June 18	169	141
	End of leaf colouring	June 25	176	148
	Beginning of leaf fall	June 18	169	141
VII	Full leaf fall (FLF)	June 25	176	148
	End of leaf fall	July 1	182	154
	Beginning of fruit fall	--	--	--
VIII	Full fruit fall (FFFA)	June 25	176	148
	End of fruit fall	July 1	182	154

* It indicates that that day is what day of the year from January 1.

phenological phase are also explained separately below.

Bud burst

Leaf buds are arranged distichously in bean trefoil. The buds are partly hidden in the leaf scar. It was observed that the leaf buds started to burst on January 28 in bean trefoils of the region.

Leafing

Bean trefoil is a species that has trifoliate compound leaves. The beginning of leafing, full leafing and end of leafing occurred on March 18, March 25 and March 31, respectively. Leafing phase lasted for 13-day. The leaves also reached to their normal sizes on April 25. Full leafing occurred in 56-day from the beginning of bud burst in bean trefoils.

Flowering

Bean trefoil has hermaphrodite flowers. Flower buds are quite large than leaf buds. Yellow flowers are presented in short racemes on spur shoots. In addition, it was

determined that this species can also form inflorescence and fruit on its stem, and thus cauliflory occurred in bean trefoil. Pollination is made by insects (bee etc.) and birds. The flower buds started to burst on February 18. The beginning of flowering, full flowering and end of flowering occurred on March 11, March 31 and April 18, respectively. Flowering phase and, consequently, pollination lasted for 38-day. Full flowering occurred in 41-day from the beginning of flower bud burst.

Fruit formation

The fruit of bean trefoil is a legume that contains many seeds (1-12). Formed green fruits hang down towards to the ground. There are large variations between fruit lengths. The beginning of fruit formation, full fruit formation and end of fruit formation occurred on May 13, May 22 and May 31, respectively. Fruit formation phase lasted for 18-day. There was a period of 52-day between full flowering and full fruit formation.

Fruit ripening

Fruit ripening in bean trefoil becomes clear by turning from green to light brown in fruit colour. The beginning of fruit ripening, full fruit ripening and end of fruit ripening

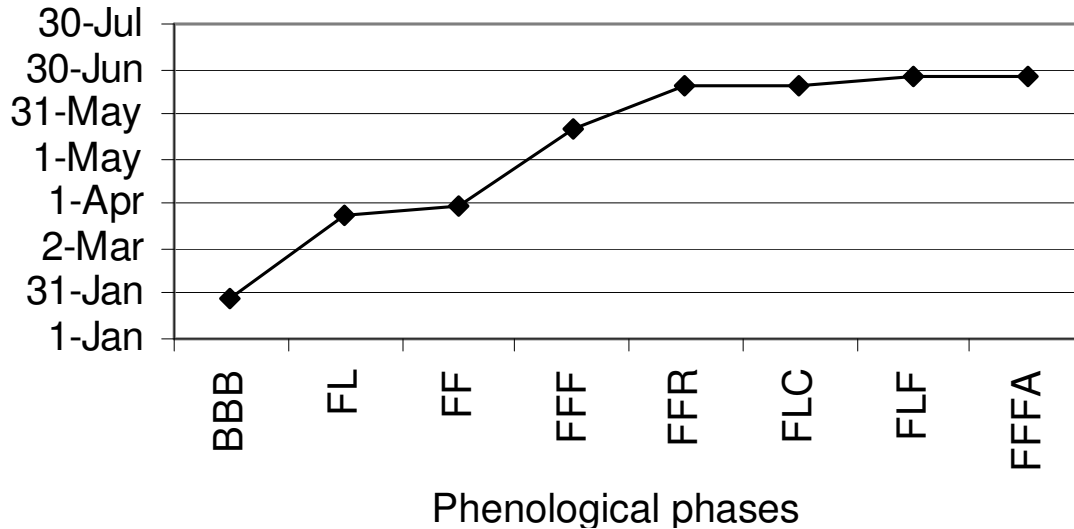


Figure 2. Pattern of the times of main phenological phases in bean trefoils.

occurred on June 8, June 18 and June 25, respectively. Fruit ripening phase lasted for 17-day. There was a period of 27-day between full fruit formation and full fruit ripening.

Leaf colouring

Autumn colouring in bean trefoil leaves occurs as turning yellow. The beginning of leaf colouring, full leaf colouring and end of leaf colouring occurred on June 8, June 18 and June 25, respectively. Leaf colouring phase lasted for 17-day. There was a period of 85-day between full leafing and full leaf colouring.

Leaf fall

The beginning of leaf fall, full leaf fall and end of leaf fall occurred on June 18, June 25 and July 1, respectively. Leaf fall phase lasted for 13-day. Only few leaves remained in some individuals on July 13. There was a period of 7-day between full leaf colouring and full leaf fall. The leaf duration in bean trefoils was 166-day, which covers the period between January 28 and July 13.

Fruit fall

Bean trefoil generally sheds its fruits under its crown; however, its fruits may also be shed to some distance from under its crown in sloping situations. Full fruit fall and the end of fruit fall occurred on June 25 and July 1, respectively. It was determined that full fruit fall phase was passed within a week, while the beginning of fruit fall phase was not yet determined. It can be said that fruit fall

phase lasted for less than two weeks. There was a period of 7-day between full fruit ripening and full fruit fall.

DISCUSSION AND CONCLUSION

The order of occurrence of main phenological phases in bean trefoil was as follows: The beginning of bud burst (January 28), full leafing (March 25), full flowering (March 31), full fruit formation (May 22), full fruit ripening and full leaf colouring (June 18), full leaf fall and full fruit fall (June 25), (Figure 2). Before leaf buds, and then flower buds burst; although leafing and flowering generally continued together, flowering ended later. Fruit ripening and leaf colouring, leaf fall and fruit fall proceeded in parallel. The durations of phenological phases were as follows: Leafing (13-day), flowering (38-day), fruit formation (18-day), fruit ripening (17-day), leaf colouring (17-day), leaf fall (13-day) and fruit fall (less than 14-day). It is seen that the longest lasting phase was flowering and the other phenological phases outside flowering occurred in relatively close durations to each other. That flowering lasted for a relatively long duration can be evaluated as a positive point for wildlife and apiculture.

Flowering of bean trefoils in the study area occurred between March 11 and April 18. In Turkey, this plant generally flowers in February-March in places with lower elevation, flowering time delays when elevation rises (Yaltirik, 1972). It was also stated that flowering of this species occurs in March-May (Chamberlain, 1970) or in April-May (Kayacik, 1982). Moreover, it was reported that the species flowers in November-February (March) in Spain (Ortega-Olivencia et al., 2005). It is seen that flowering of the species may occur in autumn, winter and spring, and shows a large variability. In this subject, it is require to consider the effect of the various climatic

conditions in different regions and elevations where the species distributes.

During phenological observations, it was determined that cauliflory occurred in bean trefoil. With the occurrence of cauliflory, flowering in this species could also become on the stem besides the crown, and thus a dense flowering could appear in flowering time. It is interesting that cauliflory, which is seen in *Cercis siliquastrum* L. in Turkey, also occurs in bean trefoil. It was stated by Ortega-Olivencia et al. (2005) and Valtuena et al. (2008a) that cauliflory is seen in this species. Moreover, in the present study, it was determined that bean trefoil also pollinates by birds besides insects. Ortega-Olivencia et al. (2005) reported that this species pollinates by birds in Spain. Durmuskahya (2006) also informed that this species pollinates by birds.

It was determined that the leaf duration was quite short in bean trefoil. Indeed, the leaf duration of this species was 166-day (January 28 - July 13) and the species was leafless in a long period of time (199-day) outside the leaf duration. This results from falling leaves of the species in summer. However, the leaf duration of the species could be longer in the sites where the soil is moister. Because, it was determined that leaf fall in summer occurred later in some situations where the soil is relatively moister in the environs of the study area. According to Yaltirik (1972), this plant is in leaf in autumn, winter and spring. This species is in leaf in the end of winter, in spring and in the beginning of summer in the study area. In this subject, it is required to consider that leafing could occur earlier in more temperate regions than the study area in winter.

The duration between leaf unfolding (flower unfolding in those that unfolds its flowers early) or bud burst and general leaf turning yellow has been termed as the phenological vegetation period (Saatcioglu, 1969). Saatcioglu (1969) stated that general leaf turning yellow is the turning yellow of more than half of all leaves. According to this basis, the phenological vegetation period in bean trefoil is 141-day (about 4-month and 3-week), which is the duration between bud burst (January 28) and general leaf turning yellow (June 18). When it was considered that this duration covers between March and November (8.5 to 9 months) in many woody plants that grow near the study area, it was seen that the phenological vegetation period is quite short in bean trefoil.

Dry period in the study area begins in May (Figure 1). The beginning of leaf colouring and beginning of leaf fall in bean trefoil occurred on June 8 and June 18, respectively. Depending on the beginning of dry period, before turning yellow and then fall started in the leaves of the species. In this respect, it is possible to say that the species was affected from drought and developed such a mechanism to adapt to drought. Ripening and fall of bean trefoil fruits occurred in June. Because the ripened fruits fall on the ground in a short period, the fruits should be

collected at once after ripening. Therefore, the making fruit collection in the second half of June would be useful. In the event of being late, because most of the fruits have fallen on the ground, collection of the fruits from the ground may be necessary. Valtuena et al. (2008a) expressed that fruits and seeds of bean trefoil ripen during summer.

As seen, because of falling leaves in summer, the leaf duration and phenological vegetation period are quite short in bean trefoil. The species adapts to drought by falling its leaves after the beginning of dry period. Thus, bean trefoil could be regarded as an indicator plant for the beginning of dry period in the region. Furthermore, the obtained results indicate that precipitation and soil moisture, besides temperature, are also important factors in the occurrence of phenological phases.

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