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## Flowering Phenology of Some Plants Grown in Zeve Campus, University of Yüzüncü Yıl (Van-Turkey)

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### Abstract

The science searching the developmental process like the budding, leafing and flowering timing and period of plant is called phenology. In other terms, phenology is broadly defined as the study of recurring plant and animal life cycle stages, especially their timing and relationships with weather and climate. Phenology (from the Greek phaino, to show or appear) is the study of the timing of these life-history events. In plants, bud-burst, leaf-expansion, abscission, flowering, fertilisation, seedset, fruiting, seed dispersal and germination all take place in due season. In the present study is aimed to investigate the flowering phenology of some plants grown in Van located in the surrounding of the world's biggest soda lake where terrestrial climate, sunny days of the year and steppe vegetation are dominant. Investigation of flowering phenology is important in terms of developing strategies against freezing especially for cultivated plants. The factors effecting flowering phenology are; temperature, photoperiod, altitude, location and fertilizing of plants. In this study, flowering time of some plants were determined in 2013, 2014 from Zeve Campus area of Yüzüncü Yıl University located in B9 square where the altitude is between 1650-1680 m. In this study flowering period of 132 plant species belong to 33 families were determined.

**Keywords:** plant, flowering time, phenology, Van.

### 1. Introduction

'Phenology is the study of the timing of recurring biological phases, the causes of their timing with regard to biotic and abiotic forces, and the interrelation among phases of the same or different species' (Lieth, 1974). Early forecasting of the phenological phases of wild and cultivated plant taxa are of great support to various sectors of human activity, particularly for all agricultural practices. Phenology science plays an important role in many processes that are relevant for agriculture, horticulture and silviculture: suitability for production and yield potential, frost damage prevention, length of growing season and frost free days, epidemiology of diseases and pests, timing of sowing, sprinkling, harvesting, insecticide and herbicide use, irrigation and many other areas. 'Predicting the onset of pollen season is of particular importance to people allergic to given pollen, who can on the base of forecast start anti-allergic treatment several days before pollination, and thereby optimizing its effectiveness' (Rodriguez-Rajo et al., 2003).

'Distinct changes in air temperatures since the end of the 1980s have led to clear response in plant phenology in many parts of the world. Since then many phenological papers report on

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trends in the timing of spring events' (Menzel, 2000; Chmielewski et al., 2004). 'Phenological phases were proposed by the European Environment Agency as climatic difference and global change indicators' (Menzel, 2003). Models of phenology are needed also for estimation of past climate conditions, improvement of primary productivity models, support of ecologists in biodiversity studies and bioclimatic zonations. 'The timing of phenological events is clearly correlated with different climatic factors including air temperature, soil temperature, precipitation, solar radiation, evapotranspiration, day length, snow cover etc.' (Wielgolaski, 2001). In mid and high latitudes, with a vegetation rest in winter and an active growing period in spring-summer time, plant phenology is mainly driven by temperature and photoperiod (Galan et al., 2001; Chmielewski et al. 2004). In many studies accumulated temperature is recognized as the main factor influencing year to year variation in phenology (Schaber, Badeck, 2003). 'It is also important to take amount of precipitation into consideration when studying pollen season, flowering, fruit production etc.' (Galan et al., 2001). 'Phenology is broadly defined as the study of recurring plant and animal life cycle stages, especially their timing and relationships with weather and climate' (Schwartz, 2003). For example; fall of leaves, phenology date of leaves and flowers, the first appearance of butterflies, the first appearance of migratory birds and the date of egg laying of some animals are some of the phenological features. Most phenological phenomena are sensitive to changes such as temperature, light, wind, humidity. In the environment where every living thing lives, a variety of reactions and adaptations that vary from individual to individual are seen in parallel with climate change. Factors affecting plants such as winter frosts, late frosts, early autumn frosts, sunburn, drought, biotic and abiotic stress factors of plant species have been clarified by revealing the phenological characteristics of plants.

'In most disciplines, the term phenology is used interchangeably with seasonality, although the two are complementary in their description of ecosystem functioning; phenology referring to biotic processes, and seasonality referring to non-biological processes' (Friedl et al., 2006). The phenological characteristics of the species present in the selection of plants according to cultural and ecological conditions are taken into consideration. Observation of this situation provides advantages for producers. One of the branches of phenology is the determination of flowering dates in plants. The planting conditions of plants are related to some ecological, geographical conditions and genetic characteristics. Some plant taxa are bloom in warmer months due to genetic features; for example many Asteraceae taxa. On the contrary, *Veronica* taxa are mostly flowered in March-June (Öztürk, 2001).

There are many ways to collect and to analyze phenological data. Though considerable efforts are under way to improve this, until present there has been only little standardization on data collection – particularly across biomes and taxa. In terrestrial fields, relationships between various visible biological phenomena and meteorological/climate changes have been studied for a long time. Among these are flowering and leaf unfolding of plants, population dynamics and changes in community structures of insects, timing of oviposition and migration of birds, and so on. In addition to these studies, genetic and ontogenetic mechanisms driving these phenomena have been investigated recently (Vitasse et al., 2009; Aikawa et al., 2010; Kobayashi et al., 2013). In addition to such genetic factors, ecological, topographic, orographic, geographical and other conditions also play an important role in the flowering of plants. For example, *Robinia pseudoacacia* can bloom in the last week of May at the altitude of 1700-1800 m in Erzurum, which is located in the northern latitude, while at the same altitude in the southern latitude Van, it can bloom in the last week of May (Öztürk, 2010).

With this study, some plants in Van Yüzüncü Yıl University, Zeve Campus have been determined to provide phenological characteristics in Van ecological conditions and contribute to the related studies.

## 2. Material and methods

The identification of many plants were done made using 'Flora of Turkey' (Davis, 1965-1988) in the floristic work (Öztürk et al., 1998) that we have done in the field of Van Yüzüncü Yıl University Zeve Campus (Figure 1). Van Yüzüncü Yıl University Zeve Campus area is seen on Map 1. Many plants have been identified in the floristic work we had done before (Öztürk vd., 1998). Identification of some plants was also done using 'Flora of Turkey' (Davis, 1965-1985).



**Fig. 1.**  Research area

During the vegetation development periods of 2013-2014, in the study area many flowering plant species blooming dates were observed and recorded. Some of the most intense blooming dates have also been identified. Plant samples were collected, pressed and deposited in the VANF Herbarium. Studied plant taxa in this study were arranged according to the alphabetical order of the families. Some of the plant photos were given at the end of the text.

### 3. Results and discussion

The timing of flowering is one of the most widely investigated aspects of the phenology of plant life-cycles, and has been studied on every scale, from the level of the community (Mural, Sukumar, 1994) to that of the individual flower (Herrera, 1995). 'In most plant communities, although at least some species will be in flower throughout the growing season, there is a tendency for peaks of flowering to occur. In wet tropical forests flower production may coincide with peaks of irradiance' (Wright, Van Schaik, 1994). In the seasonally dry tropical forests flowering is often concentrated in the transition from the late dry to the early wet season (Murali, Sukumar, 1994). A particularly marked example of the concentration of community-wide flowering is found in the ground flora of temperate deciduous woodlands, where a pronounced peak of flowering occurs in spring before the tree canopy closes (Heinrich, 1976). 'Flower production and maintenance requires the expenditure of energy to form non-photosynthetic tissue and nectar, the cost of which is considerable' (Ashman, Schoen, 1997). 'In many cases its timing may be largely determined by seasonal changes in resource availability. In some studies, climatic factors (such as some measure of cumulative heat sum) are the best predictors of flowering' (Diekmann, 1996; White, 1995). Smith-Ramírez & Armesto (1994) concluded from an investigation of a temperate rain forest in Chile that flowering (and fruiting) was largely constrained by seasonal variables. Also in this study flowering time of studied plant taxa were affected by seasonal and climatical variables.

In this study flowering period of 132 plant species belong to 33 families were determined. The plant list as follows.

**GYMNOSPERMAE**

**PINACEAE**

*Pinus sylvestris* L.: female cone formation 25.04.2014, 1.5 cm diameter; formation of male cone 10.05.2014, 1-2 cm diameter.

**CUPRESSACEAE**

*Thuja occidentalis* (cultivated): 07.05.2014.

*Thuja orientalis* (cultivated): Formation of male cone 10.03.2013; formation of female cone 10.04.2013.

*Juniperus sabina* L. (cultivated): Formation of male cone 28.04.2014; formation of female cone 28.04.2014.

**ANGIOSPERMAE**

**APIACEAE**

*Echinophora tenuifolia* L. subsp. *sibthorpiana* (Guss.) Tutin: 20. 07. 2014.

*Pimpinella aurea* DC.: 25. 04. 2014.

**ASTERACEAE**

*Achillea vermicularis* Trin.: 26.05.2014.

*Achillea biebersteinii* Afan: 15.05.2014.

*Lactuca serriola* L.: 20.07.2014.

*Chondrilla juncea* L. var. *juncea*: 24.07. 2014.

*Tussilago farfara* L.: 20.05.2013.

*Tripleurospermum transcaucasicum* (Manden.) Pobed.: 18.04.2014.

*Taraxacum androssovii* Schischkin: 01.04.2014.

*Cnicus benedictus* L. var. *benedictus*: 24.04.2014; 07.05.2014.

*Tragopogon aureus* Boiss.: 03.05.2013.

*Centaurea depressa* Bieb. : 02.05.2014, 10.05.2013. Most flowering time 22.05.2013.

*Centaurea aggregata* Fisch. et Mey. ex DC. subsp. *aggregata*: 23.06.2013; 15.07.2014.

*Centaurea solstitialis* L. subsp. *solstitialis*: 03.07.2013; 10.07.2014.

*Centaurea balsamita* Lam.: 03.07.2013.

*Centaurea iberica* Trev ex Sprengel: 15.07.2014, 29. 06. 2013.

*Centaurea virgata* Lam.: 08.07.2013.

*Carduus nutans* L. subsp. *leiophyllus*: 10.06.2014.

*Xeranthemum annuum* L.: 15.07.2014.

*Anthemis wiedemanniana* Fisch. et Mey: 05.05.2014.

*Scorzonera suberosa* K.Koch subsp. *suberosa*: 01.05.2014.

*Scorzonera mollis* Bieb. subsp. *mollis*: 22.04.2014.

*Onopordum candidum* Nab.: 01.07.2013.

*Cichorium intybus* L.: 06.07.2013 (most flowering time 07.07.2013).

*Senecio aquaticus* Hill. subsp. *erraticus*: 03.05.2013.

*Senecio vernalis* Waldst et Kit.: 16.04.2014.

**ACERACEAE**

*Acer negundo* L.: 15.05.2014.

**BETULACEAE**

*Betula pendula* Roth: 01.05.2014.

**BERBERIDACEAE**

*Berberis vulgaris* L.: 07.05.2013, 05. 05. 2014 (most flowering time 20.05.2013).

**BORAGINACEAE**

*Buglossoides arvensis* L. (Johnston): 17.04.2014.

*Asperugo procumbens* L.: 14.05.2014.

*Anchusa aucheri* L.: 18.04.2014.

*A. azurea* Mill. var. *azurea*: 16.04.2013, 15.04.2014 (most flowering time 1-25.05.2013).

*Nonea pulla* (L.) DC. subsp. *scabrisquamata* A. Baytop: 10.05.2013, 02.05.2014.

*Alkanna orientalis* L. (Boiss.) var. *orientalis*: 08.04.2014; 31.03.2013, most flowering time 10.04 - 03.05.2013.

**BRASSICACEAE**

- Alyssum desertorum* Stapf. var. *desertorum*: 20.05.2014.  
*Alyssum hirsutum* Bieb. var. *hirsutum*: 10.05.2014.  
*Crambe orientalis* L. var. *orientalis*: 13.05.2014.  
*Sisymbrium orentale* L.: 02.05.2014; 27.04.2014.  
*Cardamine microphylla* (Willd.) O.E. Schulz: 20.04.2014.  
*Brassica elongate* Ehrh.: 01.04.2014.  
*Thlaspi perfoliatum* L.: 22.04. 2013.  
*Thlaspi arvense* L.: 20.03.2013.  
*Cardaria draba* L. (Desv.) subsp. *draba*: 16.04.2013, most flowering time 10-15.05.2013.  
*Capsella bursa-pastoris* L. (Medik.): 20.04.2014.  
*Raphanus raphanistrum* L.: 15.04.2014.  
*Raphanus raphanoides*: 17.04.2013.  
*Malcolmia africana* (L.) R. BR: 20.05.2013.

**CARYOPHYLLACEAE**

- Vaccaria pyramidata* (Mill.) Rauschert: 05.06.2014.  
*Holsteum umbellatum* L. var. *umbellatum*: 01.04.2014.  
*Holsteum umbellatum* L. var. *tenerrimum* (Boiss.) Gay: 01.04.2014

**CONVOLVULACEAE**

- Convolvulus arvensis* L.: 25.05.2014.

**GROSSULARIACEAE**

- Ribes rubrum* L. (cultivated): 19.04.2014, 22.04. 2013

**CAPRIFOLIACEAE**

- Tremastelma palaestinum* (L.) Janchen: 08.07. 2013, most flowering time 13.07. 2013

**ELAEAGNACEAE**

- Elaeagnus angustifolia* L.: Most flowering time 20-30.06.2014

**EUPHORBIACEAE**

- Euphorbia terracina* L.: 21.05.2013.  
*Euphorbia orientalis* L.: 18.04.2014.

**FABACEAE**

- Glycirrhiza glabra* L. var. *glandulifera*: 25.05.2014.  
*Sophora alopecuroides* L. var. *alopecuroides*: 01.06.2013.  
*Trifolium dubium* Sibth.: 17.04.2014.  
*Trifolium pratense* L. var. *patense* Boiss. et Bal.: 14.05.2014  
*Trifolium resupinatum* L. var. *resupinatum*: 01.05.2014.  
*Astragalus chaldiranicus* Kit. Tan et Sorger: 05.05.2014, most flowering time 16-20.05.2013.  
*Coronilla varia* L. var. *varia* : 02.07.2013  
*Melilotus officinalis* (L.) Desr.: 22.05.2013.  
*Onobrychis viciifolia* Scop.: 20.05.2013.  
*Lathyrus aphaca* L. var. *affinis* (Gus.) Arc.: 15.03.2013, 13.05.2014.  
*Robinia pseudoacacia* L. (cultivated): 23.05.2013, 23.05.2014; most flowering time 1-15.07.2014.  
*Medicago sativa* L. subsp. *sativa*: 15.05.2014.

**GERANIACEAE**

- Geranium tuberosum* L. subsp. *tuberosum*: 16.04.2013, 22.03.2014.  
*Geranium dissectum* L.: 15.04.2014.  
*Erodium cicutarium* (L.) La Herit. subsp. *cicutarium*: 20.04.2014.

**IRIDACEAE**

- Gladiolus atrovioleaceus* Boiss.: 01.06.2014.  
*Iris germanica* L. (k. b.): 16.06. 2014.

**LAMIACEAE**

- Ziziphora persica* Bunge: 15.05.2014.  
*Lamium purpureum* L. var. *purpureum*: 01.04.2014.  
*Ballota nigra* L. subsp. *nigra*: 01.06.2013.

**LILIACEAE**

- Muscari neglectum* Guss.: 10.03.2013, most flowering time 10-27.04.2013.

*Gagea glacialis* K.Koch: 01.04.2014.

**PAPAVERACEAE**

*Papaver rhoeas* L.: 04.05.2013, 06.05.2014, most flowering time 15-20.05.2013.

*Glaucium corniculatum* (L.) Rud. subsp. *corniculatum*: 07.06.2014.

**PLANTAGINACEAE**

*Plantago atrata* Hoppe: 28.05.2014.

*Plantago lanceolata* L.: 07.05.2014.

*Plantago major* L. subsp. *major*: 20.05.2013.

**POACEAE**

*Poa pratensis* L.: 24.04.2013, 18.04.2014.

*Poa bulbosa* L.: 18.04.2014.

*Aegilops triuncialis* L. subsp. *triuncialis*: 01.07.2014.

*Bromus tectorum* L. subsp. *tectorum*: 10.04.2014.

*Hordeum violaceum* Boiss. et Huet: 28.06.2014.

*Elymus hispidus* Opiz (Melderis) subsp. *hispidus*: 02.07.2014.

*Eragrostis minor* Host: 26.06.2014.

*Eremopyrum distans* (K.Koch) Nevski: 01.07.2014.

*Taeniaterum caput-medusae* subsp. *crinitum*: 05.05.2014.

*Secale montanum* Guss.: 16.06.2014.

*Alopecurus myosuroides* Hudson subsp. *myosuroides*: 15.06.2014.

*Hordeum murinum* L. subsp. *murinum*: 01.06.2014.

*Phleum pratense* L.: 15.07.2014

**PRIMULACEAE**

*Androsace maxima* L.: 09.04.2014.

**RESEDACEAE**

*Reseda lutea* L. var. *lutea*: 13.05.2013, 28.04.2014.

**ROSACEAE**

*Malus floribunda* (cultivated): 30.04.2014.

*Malus domestica* (cultivated): 01.05.2014.

*Sanguisorba minor* Scop. subsp. *minor*: 02.05.2014.

*Rosa canina* L. (cultivated): 16.05.2014.

*Rosa* sp. Pink layered rose (cultivated): 01.06.2014.

*Rosa* sp. Pale pink crowned rose with a crown (cultivated): 01.08. 2014.

*Crateagus orientalis* Pallax ex Bieb. subsp. *orientalis* k.b.: 10.05.2014, most flowering time 21-28.05.2014.

*Cydonia vulgaris* (cultivated): 20.05.2014.

**SALICACEAE**

*Salix babylonica* L. (cultivated): 10.04.2014.

*Salix caprea* L. (cultivated): 15.04. 2014.

*Salix alba* L. (cultivated): erkek çiçek durumları: 10.04.2014.

*Salix viminalis* L. (cultivated): 18.04.2014.

**SCROPHULARIACEAE**

*Scrophularia carduchorum* R.Mill.: 15.05.2014.

*Veronica polita* Fries.: 15.03.2014.

*Veronica persica* Poiret: 10.04.2013.

*Veronica cymbalaria* Bodard: 01.04.2013, most flowering time 5-20.04.2013.

*Veronica triloba* (Opaz) Kerner: 28.04.2013, most flowering time 05.05.2013.

**IXIOLIRIACEAE**

*Ixiolirion tataricum* subsp. *montanum*: 01.05.2014.

**POLYGONACEAE**

*Rumex crispus* L.: 05.05.2014.

**RANUNULACEAE**

*Adonis flammea* Jacq.: 08.05.2014.

*Ceratocephala falcatus* (L.) Pers.: 05.04.2013, most flowering time 20-25.04.2013.

*Ranunculus cuneatus* Boiss.: 10.04.2013.

*Ranunculus arvensis* L.: 01.04.2014.

**RUBIACEAE**

*Callipeltis cucullaria* (L.) Steven: 15.05.2014.

*Galium tricornutum* Dandy: 28.04.2014.

**THYPHACEAE**

*Typha angustifolia* L.: 15.07.2013

**4. Conclusion**

Plant phenology models are important tools in a wide range of issues such as agricultural practices, forestry, prediction of the impact of global warming, and aerobiology. Possibilities of predicting flowering time for wild and cultivated plants were studied based on meteorological and phenological variables in some part of Turkey. This work will shed light on the work on this topic and will help to keep these efforts easier and more productive. As a result of the research, new data on the floral phenologies of the studied taxa have been obtained. It is also important to enrich the VANF herbarium by making a herbarium sample of the collected plant specimens.

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## Appendix





**Fig. 1.** Some plant taxa in the research area

1-3: Zeve campus, 4: *Tamarix smyrnensis*, 5: *Erodium cicutarium* subsp. *cutarium*, 6: *Aegilops triuncialis* subsp. *triuncialis*, 7: *Convolvulus arvensis*, 8-9: *Rosa* sp., 10: *Hordeum violaceum*, 11: *Eragrostis minor*, 12: *Althea officinalis*, 13: *Ribes rubrum*, 14: *Geranium tuberosum* subsp. *tuberosum*, 15: *Prunus* sp., 16: *Bromus tectorum* subsp. *tectorum*, 17: *Alyssum hirsutum* var. *hirsutum*, 18: *Pinus sylvestris*, 19: *Betula pendula*, 20: *Picea orientalis*, 21: *Picea glauca*, 22: *Salix babylonica*, 23: *Sisymbrium orientale*, 24: *Ranunculus cuneatus*, 25: *Acer negundo*, 26: *Berberis vulgaris*, 27: *Alopecurus myosuroides*, 28: *Phleum pratense*, 29: *Syringa vulgaris*, 30: *Cnicus benedictus* var. *benedictus*, 31: *Juniperus sabina*, 32: *Trifolium resupinatum*, 33: *Trifolium pratense* var. *pratense*, 34: *Hordeum murinum* subsp. *murinum*, 35: *Muscari neglectum*, 36: *Veronica cymbalaria*, 37: *Lotus corniculatus* subsp. *corniculatus*, 38: *Iris germanica*, 39: *Rumex crispus*, 40: *Onopordum candidum*.