

PHENOLOGICAL AND MORPHOLOGICAL CHARACTERISTICS OF *MELIA AZEDARACH* L. IN KOCAELI CITY IN TURKEY

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Abstract

Melia azedarach L. (Family: Meliaceae), is a perennial, deciduous woody plant and is native in some parts of Asia temperate, Asia tropical, Australasia and Pacific but the tree has been distributed nearly all over the world, including Northern and Southern hemisphere. Every plant tissue or parts of *Melia azedarach* have bioactive compounds. So its traditional usage or benefit make the plant greatly interesting in science for human, animal and plant health at last decades. The new scientific findings may lead to the plant a part of new generation bio-industry as drug, pesticide etc., and this will cause a demand of raw material without interruption. Due to the geographical differences, the phenological and morphological features can be different more or less. Based on this idea the present study was performed in 2013-2014 (along 24 months) plant growth season in Kocaeli city located in the East Marmara Region in the North-Western part of Turkey. Aims of the study were obtain phenological and morphological characteristics of a *Melia azedarach* tree. Determined morphological characters were on leaves, flowers, fruits and seeds additionally phenological parameters observed and presented.

Key words: *Melia azedarach*, phenology, morphology, features.

INTRODUCTION

Melia azedarach L. belongs to Meliaceae family and native in some parts of Asia-temperate, Asia-tropical, Australasia and Pacific. The plant naturalized in the other parts of Asia-temperate, Australasia and Pacific in addition with Europe, Northern America, and Southern America (USDA-ARS-GRIN, 2015). Although in most of publications the plant is called as China berry, Persian lilac, Pride of India, Pride of China, White Cedar, it also has common names. Some of the names are; cinamomo in Brasil (Piccola and Gregolim, 1980), zanzalacht in Jordan (Al-Rubae, 2009), mindi in Indonesia (Syamsuwida et al., 2012) and tespîh ağacı in Turkey.

The plant helps to improve fertility of soil in agroforestry systems (Patil et al., 2012),

adornment of living areas via usage as ornamental plant (Mishra et al., 2013). All part of the plant (roots, stem, bark, leaves, leaf juice, flowers, fruits, seeds) have traditional uses (Mishra et al., 2013). There are some scientific studies focused on importance of some chemical substances of the plant in medicine (Alché et al., 2002; Saleem et al., 2002; Leelavathi and Doss, 2014; Sen and Batra, 2012) and in plant protection against pests and diseases (Carpinella et al., 2003; Prophiro et al., 2008; Defagó et al., 2009; Cavoski et al., 2012). At the same time the plant is not only important for human and plant health, it also has living and feeding importance for avian (Arslan and Rejmánek, 2010) and primate genera (Das et al., 2014).

Because of the wide range of distribution of the plant, phenological and

morphological features expected to change in climatically and geographically different areas. The aims of the study were to obtain some information on phenological and morphological characteristics of a *Melia azedarach* tree under Kocaeli city (Turkey) environmental condition.

MATERIALS AND METHODS

The study was conducted on a tree in Arslanbey Campus of Kocaeli University under Kocaeli City ecological condition from 1st of January 2013 to 31st of December 2014 (along 24 months). Kocaeli City is in the North-Western part of Turkey in the Northern Hemisphere.

In that part of the city summers are hot and mostly dry, winters are mostly cold and rainy (Table 1).

At the experimental area, the altitude was 77.4 m, latitude was 40^o 42' N and longitude was 30^o 01' E.

In the beginning of the study the detected tree was 12 years old, 6.5 m tall and main stem diameter was 22.92 cm.

Its crown-projection area was 28.2 m². Soil analysis of the plant site was performed at a depth of 0-30 cm.

According to analysis, the soil is clay, pH 7.4, not salty, slightly calciferous, organic material at medium level, nitrogen content at a good level, slightly phosphoric, potassium is low.

Table 1. Mean of long term (1954-2014) monthly climatic data of Kocaeli City, Turkey

Climatic Data	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Average maximum air temperature(°C)	9.7	10.7	13.2	18.5	23.2	27.5	29.5	29.6	26.2	20.8	16.2	11.9
Average minimum air temperature(°C)	3.3	3.5	4.9	8.9	12.9	16.8	19.1	19.2	16.1	12.5	8.6	5.6
Average temperature(°C)	6.3	6.7	8.6	13.1	17.5	21.7	23.7	23.7	20.4	16.0	11.9	8.5
Average sunny time (hours/day)	2.3	3.0	4.6	5.3	7.2	8.6	9.3	9.6	7.1	4.5	3.4	2.3
Average rainy days	17.6	15.6	14.1	11.9	9.9	8.3	5.8	5.3	7.1	11.8	12.7	16.4
Total rainfall (kg/m ²)	93.2	73.3	73.4	52.3	45.4	52.8	37.6	43.6	52.0	89.9	81.5	108.0
Record in the highest temp.	23.7	26.0	30.8	35.0	36.6	38.7	44.1	41.6	37.8	36.2	29.1	27.4
Record in the least temp.	-9.7	-8.5	-5.7	-0.9	2.8	8.5	11.3	12.4	6.0	2.4	-0.7	-5.7

*The data were obtained from Republic of Turkey, Turkish State Meteorological Service (<http://dmi.gov.tr>)

In order to characterize the phenology;

- 1- First bud development date,
- 2-First-end leaves development dates,
- 3- First-full-end flowering dates,
- 4- Fruit maturity dates,
- 5-First-end leaf falling dates were recorded.

For this purpose; observations were carried on buds, shoots, florescences, fruit stalks from each one of cardinal (East, West, North, South) and ordinal directions (North-East, North-West, South-East, South-West). Each finding was reached from totally 40 formations and average dates were presented.

In order to characterize the morphology;

- 1-Leaflet number/leaf,
- 2- Flower number/cluster,

3-Petal number/flower,

4- Pistil number/flower,

5-Stamen number/flower,

6- Fruit number/cluster,

7- Fruit width, length, weight,

8- Endocarp width, length, weight,

9-Seed width, length, weight were calculated.

For this purpose; studies were carried on leaves, flowers, fruits from each one of cardinal (East, West, North, South) and ordinal directions (North-East, North-West, South-East, South-West) equally. Each finding was reached from totally 100 formations and average data, with the least and the highest measurements, was presented.

RESULTS AND DISCUSSIONS

Phenological Observations; (Table 2)

1-First Bud Development Date: Based on observation, first bud development initially occurred in 15th of March 2013 (Figure 1.A).

2-First-End Leaves Development Dates: First leaf observed in 25th of April 2013 (Figure 1.B) and along the summer new leaf shoots were developed (Figure 1.E) and in 26th of September 2013 development of the new leaf shoots stopped.

3- First-Full-End Flowering Dates: First flower clearly come in view in 25th of April 2013 and was synchronized with leaf development, fully flowering occurred 23rd of May 2013 at the same time old fruits from previous year were on the tree (Figure 1.C,H) and in 10th of June 2013 all flowers disappeared.

4- Fruit Maturity Dates: In 2nd of June 2013 first fruit set was come in view. In

30th of June 2013 fully grown dark green fruits clearly observed at the same time old fruits from previous year were still on the tree (Figure 1.D). In 20th of November 2013 the fruits turned yellowish-green, in 8th of January 2014 mostly pale yellow fruits and a few pale green fruits observed even in snowy days (Figure 1.G). In 5th of February 2014 all fruits was pale yellow. The over mature fruits remain the tree until 20th October 2014 together with new generation fruits (2014 spring-formed). In this wise only one term fruit remained on the tree 16 months (from May-2013 to October-2014).

5- First-End Leaf Falling Dates: First leaf fallen in 15th of October 2013 and last leaf fallen in 10th of November 2014. After the time along the winter the tree was naked, unleafy but only mature and over mature fruits come in sight clearly (Table 2; Figure 1.F).

Table 2. Phenological data from 1st of January 2013 to 31st of December 2014

Year	Date day/month	Phenological observation
2013	15 March	First bud development
	25 April	First leaf development
	25 April	First flower come in view
	23 May	Fully flowering
	2 June	First fruit set
	10 June	End of flowering
	30 June	Fully grown dark green fruits
	26 September	End of new leaf shoots development
	15 October	First leaf falling
	10 November	Last leaf dropping
	20 November	Yellowish-green fruit
2014	8 January	Pale yellow fruit mostly
	5 February	Pale yellow fruit all
	20 October	All fruit dropping

Syamsuwida et al. (2012) reported that flower initiation of *M. azedarach* began in late August, fruits grew in November-December and shedding fruits occurred in March-April in West Java, Indonesia. According to Piccola and Gregolin (1980) fully flowering of *M. azedarach* occurred from October to May, leaf fall observed two times (July-August and January-

February) in Brasil. In another report on *M. azedarach* (Anonymous, 2003), flowering occurs from March to June in Hawaii. The differences between the three studies and ours shows there is disparities between hemispheres or climate and region expectedly. In the study of Thakur et al. (2013) this was reported that *M. azedarach* flowering observed in April/May



Figure 1. *Melia azedarach* phenological steps; A. First bud development in March, B. Initial leaf and flower development in April, C. Fully flowering in May with old fruits from previous year, D. Dark green fully grown fruits in June with old fruits from previous year, E. New shoots development along summer, F. Leaves fallen tree with mature and over-mature fruit in December, G. Pale yellow fruit even under snow in January, H. A view of fully flowering tree

alongwith fruiting in June/July and seed maturation started from August and continued till October in Himachal Pradesh, India. The data was found more closer than before reports.

Morphological Data; (Table 3)

1-Leaflet Number/Leaf: *Melia azedarach* leaves are odd bipinnately compound, 17-48 cm long from main petiol basal to leaflets tip. All leaflets was between 26-64 (in average 48.54 leaflets/main petiol). Each main petiol included 5-11 side-divided petiol with the minor leaflets was

between 3-9 (in average 5.75 leaflets/side-divided petiol) (Figure 2.A). Abdel-Hameed (2014) also found leaves 20-40 cm long, bipinnated or occasionally tripinnated and leaflets as 3-11. In our study tripinnated leaves were not observed but the other data supported to our findings. This type of leaves were also described in general before; as in the twice pinnate (Singh, 2004) or bipinnate (Toker, 2004) the leaflets of the leaves are also divided into serrate margin opposite leaflets.

Table 3. Morphological data of *M. azedarach* under Kocaeli ecological condition

Plant features	Range of data	Average
Plant age (years old)	12	
Tree height (m)	6.5	
Main stem diameter (cm)	22.92	
Crown-projection area(m ²)	28.2	
Leaf lenght (cm)	17-48	36.5
Side petiol number/main petiol	5-11	6.8
Leaflets number/main petiol	26-64	48.54
Minor leaflets/side petiol	3-9	5.75
Side flower branches/main flower cluster	10-25	17.25
Flower number/main cluster	14-60	32.5
Petal number/flower	5-9	88% 5 petals, 4% 6 petals, 6% 7 petals, 2% 9 petals
Pistil number/flower	1	1
Stamen number/flower	10-11	98% 10 stamen, 2% 11 stamen
6 months old fruit		
Fruit number/cluster	1-17	7.11
Fruit width (mm)	11-53-15.84	13.14
Fruit lenght (mm)	11.15-15.08	13.27
Fruit weight (g)	1.03-2.40	1.55
Endocarp width (mm)	7.49-10.37	8.31
Endocarp lenght (mm)	8.21-12.93	10.27
Endocarp weight (g)	0.25-0.63	0.38
Seed narrow side width (mm)	0.39-2.28	1.84
Seed large side width (mm)	1.15-3.44	2.73
Seed lenght (mm)	6.14-8.26	7.49
Seed weight (g)	0.028-0.035	0.031

2- Flower Number/Cluster: The flower cluster developed from the leaf axils (Figure 2.B) and the cluster also branched into 10-25 side flower branches (in average 17.25 side branches/flower cluster). Each cluster consisted 14-60 flowers (in average 32.5 flowers/cluster). Flowers in an inflorescence bloomed simultaneously. Syamsuwida et al. (2012) also mentioned

simultaneously blooming 30-80 flowers in an inflorescence.

3-Petal Number/Flower: The flowers are in a panicle whitish-light purple petals. Flowers were found mostly 5-petaled (88%) but also 6-petaled (4%), 7-petaled (6%) and 9-petaled (2%) were come accross (Figure 2.C,D). Orwa et al. (2009) and Syamsuwida et al. (2012) also



Figure 2. *Melia azedarach* morphological samples; A. Leaves, B. Flower cluster from leaf axil, C. 7, 6 and 5 petaled flowers from left to right, D. 9 Petaled flower sample, E. 6 months old fully grown fruit cluster, F. 12 months old over- mature pale yellow fruit cluster, G. 6 months old fully grown fruits (a), endocarps (b) and seeds (c), H. 12 months old fully grown fruits (a), endocarps (b) and seeds (c).

mentioned white or white to lilac 5 petal respectively. In our study we mostly reached the same data in addition different petal numbers.

4- *Pistil Number/Flower*: Purple terminale pistil enclosed one stylus (100%). The plant produced hermaphrodite flowers with two gender organs are in the same flower.

The data was similar to Syamsuwida et al. (2012) finding.

5-*Stamen Number/Flower*: Androecium consists mostly 10 yellow stamens (98%) were united to form a tube were found at the outer close to the stigma (Figure 2.D). At 2% rate of stamens were found 11 number happened on interestingly. A tube-

like dark purple structure that appears to surround the stamens. Little (1983) also reported 10 stamens. Syamsuwida et al. (2012) reported 8 anthers.

6- Fruit Number/Cluster: Six months after the beginning of the fruit development, in November, 2013 fruits were harvested with clusters. The fruits are drupes, fleshy semi-anhydrous and nearly round. Reports of Anonymous (2003) and Orwa et al. (2009) supported our description. At this stage fruits were mostly yellowish-green, fully grown in shape. Fruit number varied between 1-17/cluster and average fruits number were 7.11/cluster (Figure 2.E). At the same time twelve months after the beginning of the fruit development, in May-2014, old fruit cluster (Figure 2.F) and fruit, endocarp and seed were shown (Figure 2.G; a,b,c)

7- Fruit Width, Length, Weight: When fruit measurements were done in November, 2013 on fully grown 6 months old newly harvested fruits (Figure 2.G;a). Width of the fruit varied between 11.53-15.84 mm and was found 13.14 mm in average. Length of the fruit varied between 11.15-15.08 mm and was found 13.27 mm in average. Weight of the fruit varied between 1.03-2.40 g and was found 1.55 g in average.

8- Endocarp Width, Length, Weight: After fruit flesh removing endocarp was measured in November, 2013 on newly harvested 6 months old fruits (Figure 2.G;b). Width of endocarp varied between 7.49-10.37 mm and was found 8.31 mm in average. Length of endocarp varied between 8.21-12.93 mm and was found 10.27 mm in average. Weight of endocarp varied between 0.25-0.63 g and was found 0.38 g in average.

9- Seed Width, Length, Weight : After fruit flesh and endocarp removing seeds were measured in November, 2013 on newly harvested 6 months old fruits (Figure 2.G;c). Width of seed from narrow side varied between 0.39-2.28 mm and was found 1.84 mm in average. Width of seed from large side varied between 1.15-3.44

mm and was found 2.73 mm in average. Length of seed varied between 6.14-8.26 mm and was found 7.49 mm in average. Weight of seed varied between 0.028-0.035 g and was found 0.031 g in average. The findings can be useful in studies on agroforestry, agriculture, ornamental and plant physiology subjects in addition with planning raw material flow in bioindustry.

CONCLUSIONS

The study on *Melia azedarach* reached the following findings in the climatic condition;

- 1- Phenological features was different from the other countries,
- 2- Observable phenological growth, bud development, begins in March,
- 3- Leaf growth occurs from April to September,
- 4- Flowering observes from May to June
- 5- Fruits occur in May,
- 6- Fruits remain on the tree for a long time (16 months),
- 7- The tree is deciduous and falls the leaves in October-November in the ecology,
- 8- To some different morphological data could be reached as being petal and stamen number.

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