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Hypericum taxa of Turkey's flora and intra-population variation of morpho-agronomic traits in H. heterophyllum Vent., an endemic species

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ABSTRACT: *Hypericum* L. belongs to the Clusiaceae (= Guttiferae) family. There are 98 species or 119 taxa of *Hypericum*, 49 of which are endemic in Turkey Flora, and the endemism ratio is 41.18%. Some of these species are used in various diseases externally/internally in the form of infusion, decoction, oleate or ointment in traditional treatment in Turkey. *H. heteropyhllum* is an endemic species that grows in arid, stony or rocky calcareous areas. In our study, the average plant height and number of branches were determined as 52.48±10.65 cm and 7.85±3.01, respectively in full flowering stage. The average length and width of the oval shaped seeds was 2.3220±0.1524 mm and 0.7933±0.0755 mm, respectively. Seeds of the plant is very small and average seed weight of 1000 seeds is 0.75975±0.0300 g. The highest fresh herb weight (587±251.91 g/plant) was obtained from plants collected at full flowering. The wide variation was observed especially in plant height and number of main branches in the measurements made on plants in the natural area.

Keywords: Flowering, herbage, *Hypericum heteropyhllum*, plant height, seed

Türkiye florası Hypericum taksonları ve endemik bir tür olan H. heterophyllum Vent.'deki morfo-agronomik özelliklerin popülasyon içi varyasyonu

ÖZET: *Hypericum* L., Clusiaceae (= Guttiferae) ailesinin bir üyesidir. Türkiye florasında 49'u endemik olmak üzere *Hypericum*' un 98 türü ve 119 taksonu bulunmaktadır. Endemizm oranı ise %41.18'dir. Bu türlerin bir kısmı Türkiye'de geleneksel tedavide infüzyon, dekoksiyon, oleat veya merhem şeklinde çeşitli hastalıklarda harici/dahili olarak kullanılmaktadır. *H. heteropyhllum* kurak, taşlı veya kayalık kalkerli alanlarda yetişen endemik bir türdür. Bu çalışmada tam çiçeklenme döneminde ortalama bitki boyu ve dal sayısı sırasıyla 52.48±10.65 cm ve 7.85±3.01 olarak belirlenmiştir. Oval şekilli tohumların ortalama uzunluğu ve genişliği ise 2.3220±0.1524 mm ve 0.7933 ± 0.0755 mm olarak belirlenmiştir. Bitkinin tohumları çok küçüktür ve 1000 tohumun ortalama tohum ağırlığı 0.75975±0.0300 gr'dır. En yüksek yaş herba ağırlığı (587±251.91 g/bitki) tam çiçeklenme döneminde toplanan bitkilerden elde edilmiştir. Doğal ortamlarında bitkiler üzerinde yapılan ölçümlerde özellikle bitki boyu ve ana dal sayısında geniş bir varyasyon gözlemlenmiştir.

Anahtar Kelimeler: Bitki boyu, Çiçeklenme, *Hypericum heteropyhllum*, tohum

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INTRODUCTION

Three (the Mediterranean, Europe and Siberia, Iran-Turan) of the seven bio-geographic regions available in the world is located in Turkey. The diversity of climate and land forms in these regions has led to having a rich flora of Turkey. Healing properties and aromatic value of hundreds of plant species that grow naturally in its flora are quite high. Flora of Turkey has 11 707 plant taxa, 3649 of which are endemic (Guner et al., 2012). *Hypericum* L. belongs to the Clusiaceae (= Guttiferae) family. There are 482 *Hypericum* species spread in different parts of the world from the equatorial belt to the Nordic countries in the north (Crockett and Rabson, 2011). Because the taxa in this genus have high therapeutic effects, they have been used for many diseases in folk medicine for centuries. *H. perforatum* L., also known as John ‟s Wort, is the most common among these species, and it is the most used for medical purposes in Europe and America. Today, this species is cultivated in different regions of the world, especially in Russia, Siberia and China (Solomon et al., 2013).

Hypericum genus is represented by approximately 119 taxa in 19 section in Turkey. 49 taxa among these are endemic. Turkey is an important gene center in terms of *Hypericum* L. species. Section *Heterophylla* N.Robson of the genus *Hypericum* contains a single species, *H. heterophyllum* (Nürk and Crockett, 2011; Guner et al., 2012). Hypericum taxa have been used in traditional medicine in Anatolia for centuries.

Hypericum taxa distributed in the Mediterranean Basin, particularly in Turkey Flora have enormous diversity, both morphologically and phytochemical (Nürk and Crockett, 2011). Genetic variation and diversity are prerequisites for the improvement of the breeding and cultivation of plants. Population variability is of great importance in the development of new varieties with desired characteristics by plant breeding methods (Tosun and Sagsoz, 1995). Therefore, it is very important to understand the genetic diversity (Verma et al., 2017). Morpho-agronomic traits are primary variables used to study genetic diversity (Liu, 1997; Bisht et al., 1998).

The aim of this study is to provide general information on *Hypericum* taxa in the Flora of Turkey, evaluate the changes in the intra-population of some morphological and agronomic properties of *H. heterophyllum*, which is an endemic species.

MATERIALS AND METHODS

Floristic data

General information about *Hypericum* taxa in the Flora of Turkey were identified by literature review (Davis, 1988; Guner et al., 2012; Ozkan and Mat, 2013).

Plant material

The aerial parts and dry capsules of *H. heterophyllum* were collected from natural area (Study Area: Inside the Yozgat Bozok University Campus Area; Altitude: 1340 m; Locality: 9º46´48,04´´ N-34º48´02,34´´ E; Sampling area: 39.880 m^2) in Yozgat/Turkey. The study area was calculated by marking the GPS (Global Positioning System) data on the map in the Google Earth program. According to the climate data of the area where plant samples were collected for many years, total precipitation was 562.5 mm, average temperature was 9.1 ºC, average highest temperature was 14.6 ºC, average lowest temperature was 4 ºC, average sunshine time was 82.0 hours and average number of rainy days was 113.5 (Anonymous, 2020). Identification of plants collected was performed in Biology Laboratory at Yozgat Bozok University/Turkey. The plant samples collected from their natural area during the full flowering stage were used for species identification. The general appearance, flower and, leaf characteristics of plant samples were examined morphologically, and the keys in the “Flora of Turkey

and the East Agean Islands" were used to determine the species (Davis, 1988).The aerial parts were collected in four different stages as before flowering (BF1, in May), beginning flowering (BF2, in June), 50% of flowering (50%F, in July), and full flowering (FF, in July) (Figure 1, Figure 2). Dry capsules were collected in October. In the laboratory, seeds were removed from dry capsules.

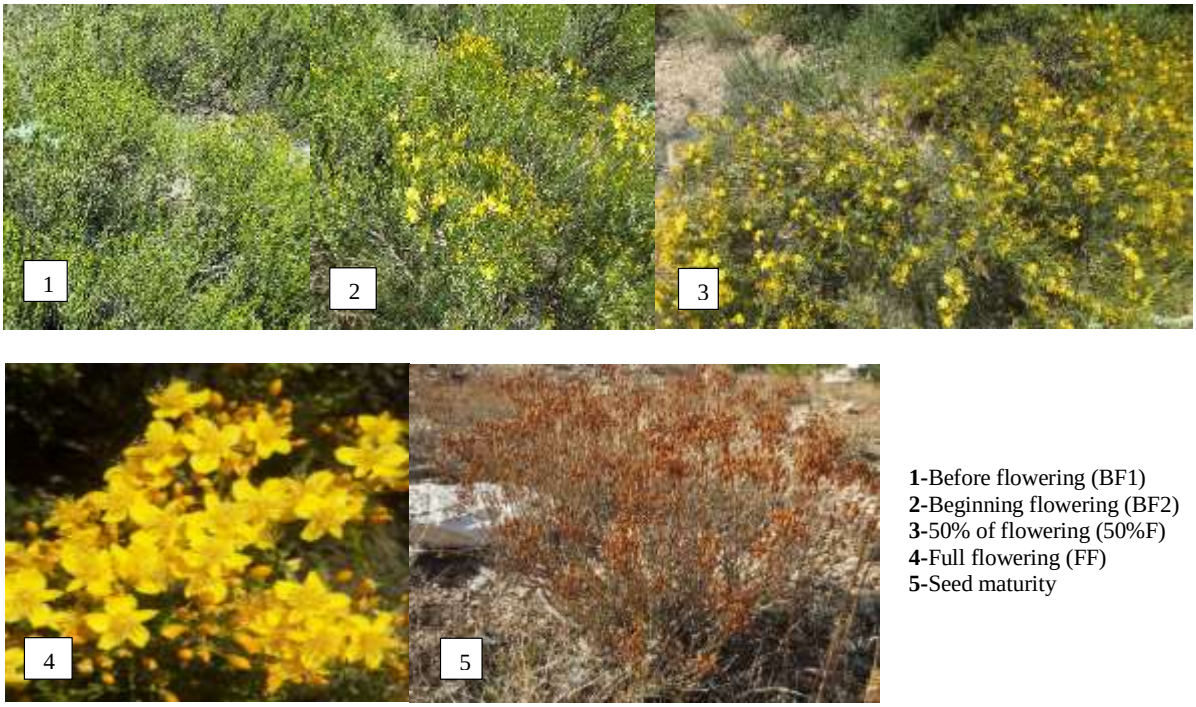

Figure 1. Images of collection times

Figure 2. The flowers (1), leaves (2) and habitat (3) of *H. heterophyllum* (Yozgat Bozok University Campus)

Determination of morphological and agronomic properties

Morphological and agronomic characteristics were determined in 60 individual plants collected from the natural area separately for each period. Plant height (cm), number of branches (number / plant), fresh herbage weight (g/plant) and drug herbage weight (g/plant) were determined. For green herbage weight, plants were weighed by cutting 5 cm above the soil level. The collected plant samples were dried at room temperature in the shade for about 2 weeks and then weighed to obtain drug herbage yield. Seed width/length, capsule width/length and leaf width/length were measured by stereo microscope (Leica S8 APO). Leaf sizes of plants in full flowering stage were measured. According to ISTA (1993) rules, weights of 8x100 seeds taken randomly from seeds collected from natural environment were weighed and 1000 seed weight (g) was calculated.

Data analysis

The numerical data were stated as means ± standard error of the mean. Analysis of variance was performed using TARIST package program, and the means were compared using LSD test ($p \leq 0.05$) (Acikgoz et al., 2004). Mean, range of variation and coefficient of variations (CV%) were computed according to Man (2010).

RESULTS AND DISCUSSION

Hypericum taxa of Turkey's flora

The genus *Hypericum* shows good development in warm, temperate subtropical and mountainous tropical regions (Robson 2001, Camas et al. 2012). There are 482 *Hypericum* species in the world. These species spread from the equatorial belt to Scandinavian countries (Crockett and Robson, 2011). In the Flora of Turkey which is an important gene center for *Hypericum* species, 119 taxa and 98 specie are available, and 49 of these taxa are also endemic. The endemism ratio of this genus is 41.18% (Table 1).

All *Hypericum* taxa naturally growing in Turkey are perennial, and in herbaceous or bush form (TUBİVES 09.07.2020; Davis, 1988, Guner et al., 2012). According to the IUCN Red List Categories, in Turkey two species are in the VU (vulnerable) category (*H. rumeliacum* Boiss. and *H. vesiculosum* Griseb.). VU is considered to be facing a high risk of extinction in the wild (IUCN, 2012). Also, two species are in the DD (data deficient) category (*H. russeggeri* (Fenzl) R.Keller and *H. thasium* Griseb.). These species have a narrow distribution area (Figure 3.).

Figure 3. The distribution areas of the species in VU and DD categories in Turkey

The most common and popular among *Hypericum* species is *H. perforatum* L. This species has been studied intensively in clinical and laboratory conditions and is used extensively in the treatment of depression. It usually spreads along roadsides, grassy rivers, rocky and stony places, forest edges, meadows, fields, areas with damp winters and dry summers. The endemic *H. heterophyllum* species shows distribution in Central Anatolia (Figure 4) (Davis, 1988).

The taxa numbered 7, 10 (endemic), 18, 19 (endemic), 33 (endemic), 46, 54, 58, 59, 65, 80, 84 (endemic), 88, and 91 in Table 1 are used in various diseases externally/internally in the form of infusion, decoction, oleate or ointment in traditional treatment in Turkey (Ozkan and Mat, 2013).

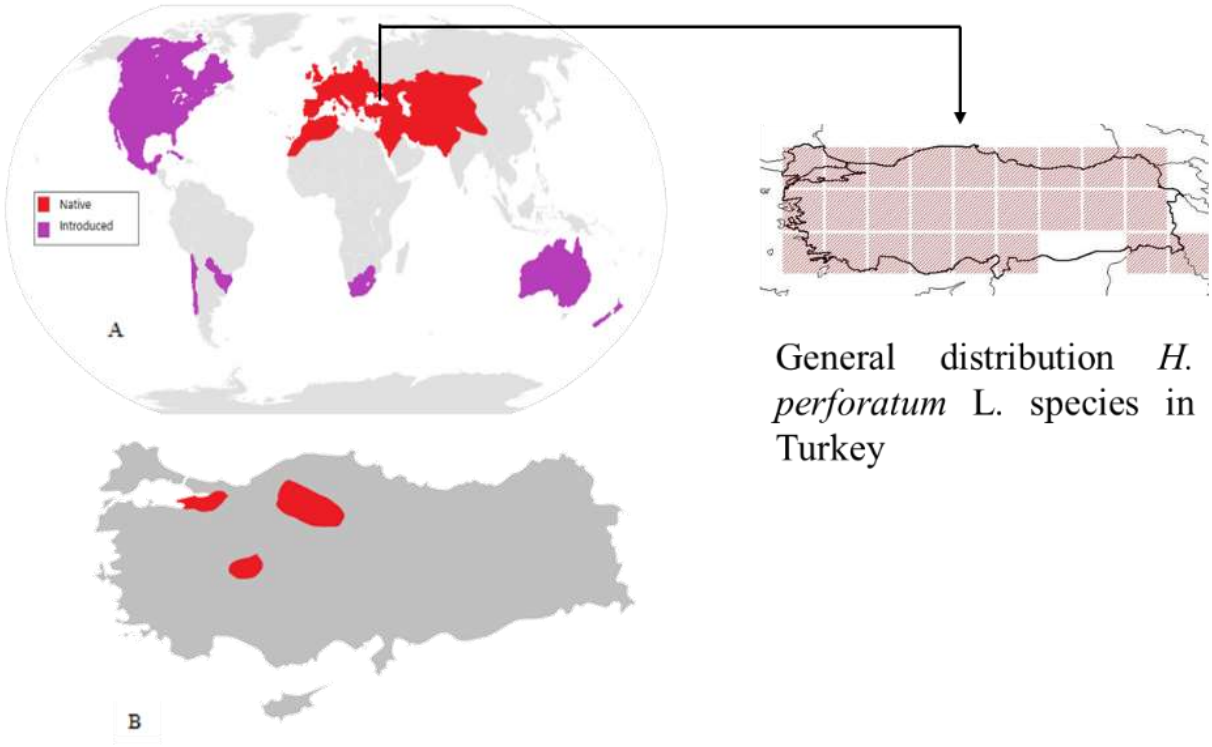

Figure 4. The distribution of *H. perforatum* (A) and *H. heterophyllum* (endemic) (B) species on the World

Investigated morphological and agronomic properties

H. heteropyhllum is an endemic species that grows in arid, stony or rocky calcareous areas especially in Anatolia. It has shrub form. The stem of the plant is a length of 20-60 cm, upright or branching from the base. It is semi-deciduous and glabrous and has not its dark glands. Leaves on main stem are 5-13 mm, narrowly elliptic-oblong to linear, acute, those on short axillary strobiloid shoots 0-5 mm, broadly ovoid, densely crowded. Sepals are 2-3-5 mm, oblong to lanceolate, acute, entire. Petals are 5-8 mm, oblanceolate. Capsule is 6-8 mm, ovoid-cylindric to cylindric. Its yellow flowers are numerous and speckless, similar to the leaves. Its habitat is dry clearings in *Pinus* thickets, etc., and 1200-1600 m altitude (Davis, 1988). Some information regarding plant morphological properties is presented in Table 2.

Table 1. *Hypericum* taxa in the Fora of Turkey

Taxon name	Taxon name
1-*H. adenotrichum* Spach*	48-*H. malatyanum* Peşmen*
2-*H. albiflorum* (Hub.-Mor.) N.Robson*	49-*H. marginatum* Woronow*
3-*H. amblysepalum* Hochst.	50-*H. microcalycinum* Boiss. & Heldr.
4-*H. androsaemum* L.	51-*H. minutum* P.H.Davis & Poulter*
5-*H. apiculatum* (N.Robson) Sennikov	52-*H. monadenum* N.Robson*
6-*H. armenum* Jaub. & Spach	53-*H. montanum* L.
subsp. *armenum* Jaub. & Spach	54-*H. montbretii* Spach
7-*H. atomarium* Boiss.	55-*H. neurocalycinum* Boiss. & Heldr.*
8-*H. aucheri* Jaub. & Spach	56-*H. nummularioides* Trautv.
9-*H. auriculatum* (N.Robson & Hub.-Mor.) N.Robson*	57-*H. olivieri* (Spach) Boiss.
10-*H. aviculariifolium* Jaub. & Spach*	58-*H. olympicum* L.
11-*H. bilgehan-bilgilii* Başköse & Savran*	f. *olympicum* L.
12-*H. bithynicum* Boiss.	59-*H. orientale* L.
13-*H. bourgaei* (Boiss.) N.Robson*	60-*H. origanifolium* Willd.
14-*H. bupleuroides* Griseb.	var. *depilatum* (Freyn & Bornm.) N.Robson*
15-*H. calycinum* L.	var. *origanifolium* Willd.
16-*H. capitatum* Choisy	61-*H. pallens* Banks & Sol.
var. *capitatum* Choisy	62-*H. pamphylicum* N.Robson & P.H.Davis*
var. luteum N.Robson*	63-*H. papillare* Boiss. & Heldr.*
17-H. cardiophyllum Boiss.	64-*H. perfoliatum* L.
18-*H. cerastioides* (Spach) N.Robson	65-*H. perforatum* L.
19-*H. confertum* Choisy	subsp. *perforatum* L.
subsp. *confertum* Choisy*	subsp. *veronense* (Schrank) H.Linb.
subsp. *stenobotrys* (Boiss.) Holmboe	66-*H. peshmenii* Yıld.*
20-*H. crenulatum* Boiss.*	67-*H. polyphyllum* Boiss. & Balansa
21-*H. cuisinii* Barbey	68-*H. pruinatum* Boiss. & Balansa
22-*H. cymbiferum* Boiss. & Balansa*	69-*H. pseudolaeve* N.Robson
23-*H. davisii* N.Robson	70-*H. pseudorepens* N.Robson*
24-*H. ekerii*	71-*H. pumilio* Bornm.*
25-*H. elegans* Stephan ex Willd.	72-*H. retusum* Aucher
26-*H. elongatum* Ledeb. ex Rchb.	73-*H. rumeliacum* Boiss.
var. *antasiaticum* (Grossh.) N.Robson	subsp. *rumeliacum* Boiss.
var. *elongatum* Ledeb. ex Rchb.	74-*H. rupestre* Jaub. & Spach*
var. *lythrifolium* (Boiss.) N.Robson*	75-*H. russeggeri* (Fenzl) R.Keller
27-*H. empetrifolium* Willd.	76-*H. salsolifolium* Hand.-Mazz.*
subsp. *empetrifolium* Willd.	77-*H. salsugineum* N.Robson & Hub.-Mor.*
28-*H. fissurale* Woronow*	78-*H. saxifragum* N.Robson & Hub.-Mor.*
29-*H. formosissimum* Takht.	79-*H. scabroides* N.Robson & Poulter*
30-*H. havvae* Güner*	80-*H. scabrum* L.
31-*H. hedgei* N.Robson*	81-*H. sechmenii* Ocak & O.Koyuncu*
32-*H. helianthemoides* (Spach) Boiss.	82-*H. sorgerae* N.Robson*
33-*H. heterophyllum* Vent.*	83-*H. spectabile* Jaub. & Spach*
34-*H. hircinum* L.	84-*H. ternatum* Poulter*
subsp. *majus* (Aiton) N.Robson	85-*H. tetrapterum* Fr.
35-*H. hirsutum* L.	var. *anagallidifolium* Boiss.
36-*H. huber-morathii* N.Robson*	var. *tetrapterum* Fr.
37-*H. ichelense* N.Robson*	86-*H. thasium* Griseb.
38-*H. imbricatum* Poulter*	87-*H. thymbrifolium* Boiss. & Noë*
39-*H. karjaginii* Rzazade	88-*H. thymifolium* Banks & Sol.
40-*H. kotschyanum* Boiss.*	89-*H. thymopsis* Boiss.*
41-*H. lanuginosum* Lam.	90-*H. trachyphyllum* Griseb.*
42-*H. laxiflorum* N.Robson*	91-*H. triquetrifolium* Turra
43-*H. leprosum* Boiss.*	92-*H. uniflorum* Boiss. & Heldr.*
44-*H. linarioides* Bosse	93-*H. uniglandulosum* Hausskn. ex Bornm.*
subsp. *linarioides* Bosse	94-*H. vacciniifolium* Hayek & Siehe*
45-*H. lycium* (N.Robson & Hub.-Mor.) N.Robson*	95-*H. vaccinioides* N.Robson*
46-*H. lydium* Boiss.	96-*H. venustum* Fenzl
47-*H. lysimachioides* Boiss.& Noë	97-*H. vesiculosum* Griseb.
var. *lysimachioides* Boiss.& Noë	98-*H. xylosteifolium* (Spach) N.Robson
var. *spathulatum* N.Robson	

Table 2. Some morphological properties of *H. heterophyllum*

Family	Guttiferae
Genus	*Hypericum*
Taxonomic section	Heterophylla (There is only one species in this taxonomic section)
Taxon	*H. heterophyllum* Vent., Descr. Pl. Nouv
Turkish name	Yara yaprağı
Chromosome numbers	2n=18
Endemic	+
Characters	
Life span	Perennial
Growth form	Shrub
Stem	10-20 cm
Leaves	5-13 mm on main stem narrowly elliptic-oblong to linear
Sepals	2-3.5 mm, oblong to lanceolate, entire
Petals	5-8 mm, oblanceolate, 5 pieces, yellow colored
Capsule	6-8 mm, ovoid-cylindric to cylindric
Habitat	woodland
The distribution in Turkey	South Marmara-West Blacksea-West Anatolia
Traditional uses	Anti-inflammatory (Ozkan and Mat, 2013)
Application	Oleat, External

In our study, the average plant height and number of branches were determined as 52.48±10.65 cm and 7.85±3.01, respectively in full flowering stage. The average length and width of the oval shaped seeds was 2.3220±0.1524 mm and 0.7933±0.0755 mm, respectively. Seeds of the plant is very small and average seed weight of 1000 seeds is 0.75975±0.0300 g. The plant has oval cylindrical capsules. *Hypericum* taxa in the Mediterranean basin follow the general trend within the genus in terms of seed characteristics. The seeds are typically very small and cylindrical or elliptical. It is also stated that the length of these seeds varies between 0.3-1.5 mm (Nürk and Crockett, 2011). The width and length of the capsules were 2.6762±0.2046 mm and 6.1890±0.5985 mm, respectively. These plants generally have a dry fruit capsule (Nürk and Crockett, 201). *H. heterophyllum* leaves differ in the lower and upper parts of the stem. The lower and upper leaves of the plant are perennating and deciduous, respectively (Robson, 1996).

In our study, the width of the narrow, elliptical leaves on the main stem was measured as 1.7283±0.1466 mm. The length of these leaves was between 7.977 mm and 11.475 mm (Table 3, Figure 5, Figure 6).

Figure 5. Leaf, flower, seed and capsule of *H. heterophyllum*

The highest variation among the studied characters was observed in BN (CV: 30.34%), followed by PH (CV:20.29%) and LL (CV:11.46%), respectively. On the other hand, the lowest variation was

recorded at 1000 SW (Cv:3.95%) (Table 3). 1000 SW is an important measure of seed quality which is effective on seed potential, seedling growth and plant performance (Afshari et al., 2011).

Figure 6. Seeds of *H. heterophyllum*

Table 3. Some plant properties of *H. heterophyllum*

Characters[1]	Minimum	Maximum	Range[2]	Mean±SD[3]	CV (%)[4]
PH	35	76	41	52.48±10.65	20.29
BN	3	16	13	7.85±3.01	30.34
SW	0.6790	0.9470	0.268	0.7933±0.0755	9.52
SL	2.1130	2.6090	0.496	2.3220±0.1524	6.56
1000 SW	0.75675	0.76275	0.006	0.75975±0.0300	3.95
CW	2.3430	3.0450	0.702	2.6762±0.2046	7.65
CL	5.374	7.440	2.066	6.1890±0.5985	9.67
LW	1.5110	1.9110	0.399	1.7283±0.1466	8.48
LL	7.977	11.475	3.498	10.543±1.208	11.46

[1] PH: Plant height (cm), BN: The number of main branches, SW: Seed width (mm), SL: Seed length (mm), 1000 SW:1000 seed weight (g), CW: Capsule width (mm), CL: Capsule length (mm), LW: Leaf width (mm), LL: Leaf length (mm) [2]Range=X_{max}-X_{min}; [3]SD: Standard Deviation, [4]CV: Coefficient of Variation

In medicinal and aromatic plants, all above-ground plant part is called as herbage. Fresh and dry herbage weight are important agricultural characters. There is no data on the plant and agricultural properties (yield and yield components etc.) of *H. heterophyllum*. In this study, fresh and dry herbage weights were determined in the plants collected from natural area (Table 4). In order to determine the change in fresh and dry herbage weights according to different development stages, plants were collected from their natural environment in three different stages (BF2, 50%F, and FF) (Figure 7). The fresh and dry herbage weight was increased from BF2 to FF stage of *H. heterophyllum*, ranged from 358±139.15-587±251.91 g/plant and 201.67±74.38-311.00±134.33 g/plant, respectively (Table 4, Figure 7). *Origanum vulgare* L. was harvested in five phonological stages (early vegetative, late vegetative, flower initiation, full bloom, and fruit set stages) in the study conducted by Chauhan et al. (2013), and the plants harvested at full bloom stages had better herbage weight. Similar findings were recorded in thyme (*Thymus vulgaris* L.) by Badi et al. (2004).

The high variation (CV: 30.05-43.19%) in herbage weights of plants was detected (Table 4). Plant height, number of branches, leaf width and leaf length are the properties that have important effects on the fresh herb weight of the plant (Taghi Khani and Kirci, 2018). Thus, high variation in PH, BN, and LL was also observed in herbage weight.

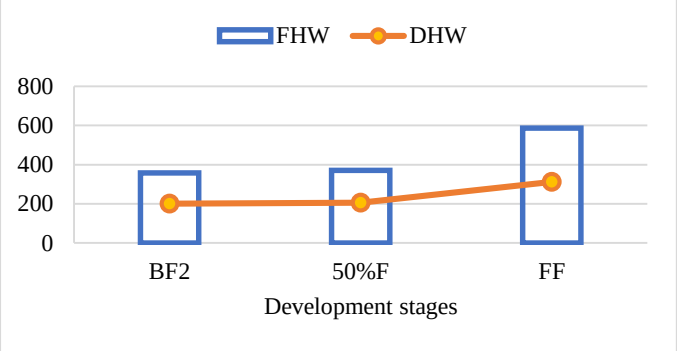

Figure 7. Variation according to developmental periods of mean FHW and DHW of *H. heterophyllum.*

Table 4. The herbage weights of *H. heterophyllum*

Development stages	Min.	Max.	Range	Mean±SD	CV (%)	
BF2	217	556	339	358±139.15	38.87	**Fresh Herbage Weight (g/plant)**
50%F	162	529	367	371±141.42	38.12	
FF	304	976	672	587±251.91	42.91	
BF2	121	299	178	201.67±74.38	36.88	**Dry Herbage Weight (g/plant)**
50%F	91	298	207	205.33±78.12	30.05	
FF	164	520	356	311.00±134.33	43.19	

CONCLUSION

Flora of Turkey is rich *Hypericum* taxa. Some of these plants are collected from natural areas and used for medicinal purposes. One of these species is *H. heterophyllum*, which is endemic. In this study, a wide variation was observed especially in plant height and number of main branches in the measurements made on plants in the natural area and the highest fresh and dry herbage weight was taken from the full bloom period. Future studies are needed for the relationship of these observed variations with genetic structure. However, these new data generated on the morpho-agronomic properties of *H. heterophyllum* can provide important information for the cultivation and breeding of the plant.

REFERENCES

Acikgoz N, Ilker E, Gokcol A, 2004. Biyolojik Araştırmaların Bilgisayarda Değerlendirilmeleri. Meta Basım Yayım, İzmir-Turkiye.

Afshari H, Eftekhari M, Faraji M, Ghaffar EA, Ghanbarimalidareh A, 2011. Studying the effect of 1000 grain weight on the sprouting of different species of Salvia L. grown in Iran. Journal of Medicinal Plants Research (16): 3991-3993.

Anonymous, 2019. Turkish Plants Data Service, http://tubives.com. (Date of access 04 February 2019)

Anonymous, 2020. Turkish State Meteorological Service, http://mgm.gov.tr/forecast-cities.aspx. (Date of access 6 March 2020)

Badi HN, Yazdani D, Ali SM, Nazari F, 2004. Effect of spacing and harvesting time on herbage yield and quality/quantity of oil in thyme, Thymus vulgaris L. Industrial Crops and Products 19: 231-236.

Bisht IS, Mahajan RK, Loknathan TR, Agrawal RC, 1998. Diversity in Indian sesame collection and stratification of germplasm accessions in different diversity groups. Genetic Resources and Crop Evolution 45: 325-335.

Camas N, Radusiene J, Stanius Z, Caliskan O, Cirak C, 2012. Secondary metabolites of Hypericum leptophyllum Hochst., an endemic Turkish species. The Scientific World Journal 2012.

Chauhan NK, Sing S, Haider SZ, Lohani H, 2013. Influence of phonological stages on yield and quality of oregano (Origanum vulgare L.) under the agroclimatic condition of Doon Valley (Uttarakhand). Indian Journal of Pharmaceutical Sciences 75: 489-493.

Crockett SL, Robson NKB, 2011. Taxonomy and Chemotaxonomy of the Genus Hypericum. Medicinal and Aromatic Plant Science and Biotechnology 5: 1-13.

Davis PH, 1988. Flora of Turkey and the East Aegean Islands. Edinburgh University Press, Edinburgh-Scotland.

Guner A, Aslan S, Ekim T, Vural M, Babac MT, 2012. Türkiye Bitkileri Listesi (Damarlı Bitkiler). Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını, İstanbul-Türkiye.

ISTA, 1993. International Rules for Seed Testing. International Seed Testing Association, Bassersdorf-Switzerland.

IUCN, 2012. IUCN Red List Categories and Criteria: Version 3.1. Gland-Switzerland and Cambridge- United Kingdom.

Liu CJ, 1997. Geographical distribution of genetic variation in Stylosanthes sacbra revealed by RAPD analysis. Euphytica 98:21-27.

Man PS, 2010. Introductory Statistics. John Willey and Sons Inc., North Carolina-United States of America.

Nürk NM, Crockett SL, 2011. Morphological and phytochemical diversity among Hypericum species of the Mediterranean basin. Medicinal and Aromatic Plant Science and Biotechnology 5:14-28.

Ozkan EE, Mat A, 2013. An overview on Hypericum species of Turkey. Journal of Pharmacognosy and Phytotherapy 5: 38-46.

Robson NKB, 1996. Studies in the genus Hypericum L. (Guttiferae). 6. Sections 20. Myriandra to Elodes. Bulletin of the British Museum (Natural History) 26(2): 75–217.

Robson NKB, 2001. Studies in the genus Hypericum L. (Guttiferae). 4(1). Sections 7. Roscyna to 9. Hypericum sensu lato (part 1). Bulletin of the British Museum (Natural History) 31(2): 37-88.

Solomon D, Adams J, Graves N, 2013. Economic evaluation of St. John's wort (Hypericum perforatum) for the treatment of mild to moderate depression. Journal of Affective Disorders 148: 228-234.

Taghi Khan H, Kirci S, 2018. Investigation of domestication, active ingredients and antioxidant activity of Origanum micranthum Vogel. Çukurova Üniversitesi Fen ve Mühendislik Bilimleri Dergisi 35: 113-122.

Tosun M, Sagsoz S, 1995. Somaklonal varyasyon ve bitki ıslahı. Atatürk Üniversitesi Ziraat Fakültesi Dergisi 26: 400-411.

Verma KS, ul HAq S, Kachhwaha S, Kothari SL, 2017. RAPD and ISSR marker assessment of genetic diversity in Citrullus colocynthis (L.) Schrad: a unique source of germplasm highly adapted to drought and high-temperature stress. Biotech 7: 288.