GLASNIK INSTITUTA ZA BOTANIKU I BOTANIČKE BAŠTE UNIVERZITETA U BEOGRADU
BULLETIN DE L'INSTITUT ET DU JARDIN BOTANIQUES DE L'UNIVERSITE DE BEOGRAD
Tom XXVI-XXVII, 1992 - 1993 (1994), Beograd

UDC 581.522.5 : 582.635.1 (497.11)
Original scientific paper

TATJANA GRABELJŠEK

SOME ECOPHYSIOLOGICAL AND MORPHO-ANATOMICAL CHARACTERISTICS OF THE SPECIES *ZELKOVA CRENATA* SPACH.

Faculty of Veterinary Medicine, University of Belgrade

Grabeljšek, T. (1992-1993): *Some ecophysiological and morpho-anatomical characteristics of the speices Zelkova crenata Spach.* – Glasnik Instituta za botaniku i botaničke bašte Univerziteta u Beogradu, Tom XXVI-XXVII, 41 - 48.

The study concerns the investigations of water regime factors, transpiration, quantity of water in leaves, water saturation deficit and osmotic pressure of a cell sap of the species *Zelkova crenata* Spach. At the same time there have been observed some of the microclimatic factors: light intensity, solar radiation intensity, air and soil temperature, air and soil relative humidity and evaporation. The study also involves the analysis of some morpho-anatomic characteristics of the leaves of this species. The investigations have been carried out in the Botanical Garden in Belgrade.

Key words: *Zelkova crenata* Spach., water relations, leaf anatomy, ecological adaptations, Tertiary relict.

Ključne reči: *Zelkova crenata* Spach., vodni režim, anatomska građa lista, ekološke adaptacije, tercijarni relikt.

INTRODUCTION

Although *Zelkova crenata* Spach. is considered to be an introduced species, the history of genus and species shows its ancient existence on the territory of Europe. During tertiary the genus *Zelkova* Spach. was spread through the whole Europe. On the basis of Walter's data (W a l t e r & S t r a k a, 1954, 1970), it could be found in upper miocene as eastern-Asia element included in Laurisilvae vegetation, together with 300 other species from *Magnoliopsida* class. During pliocene it was still present in Europe at the territory of today's Germany. It survived during the Ice Age in pleisotcene, so we can find it in intergalacial period Ris-Virm, too. Its present domicile as tertiary thermophile genus is the region of Caucasus, Northern Persia, China nad Japan. Belonging to the family of *Ulmaceae* Mirb., genus *Zelkova* Spach. is presented by 6 species in the world today.

Zelkova crenata Spach. is a woody species, 20-25 m high, which was spread through the whole Europe during tearing terciar (J o v a n o v i ć, 1967).Its today's habitat is in the warm oak forest at Caucasus and surrounding regions, and it could be found also in depression and at alluvium (J o v a n o v i ć, 1967). According to Turill's data (T u r i l l, 1929) today, in the region of Europe, taxonomically, the most closely related to it is *Zelkova abelicea* Boiss., which is distributed at Cyprus and Crete. Today, people grow this species in the great part of Europe as ornamental plant, and in all botanic gardens, so that it could be found in Belgrade Botanic garden.

Since the matter of our work is terciar species which natural habitat was in Southern Europe, we considered that the investigation of its adaptation to the present habitat conditions was necessary, if we wanted to understand the surviving mechanisms of this species, which vanished from Europe during the Ice Age.

For complete understanding of the ecology of plant species it is necessary to investigate its water regime. A water regime of a plant is influenced by both external factors of the environment and numerous internal morpho-anatomic and physiological factors.

The investigations of water regime obtains the analysis of the transpiration, quantity of water in leaves, water saturation deficit and osmotic pressure of a cell sap. The influence of a external factors such as the temperature and the humidity of the air and soil, the evaporation, the light intensity and solar radiation have been analyzed too. The morpho-anatomical investigations have been carried out on the leaves of the species *Zelkova crenata* Spach.

MATERIALS AND METHODS

The investigations of water regime and morpho-anatomical structure of the *Zelkova crenata* Spach. leaves, were carried out at the Botanical Garden in Belgrade. The tree wich was used for the experiment is about 70 year old. It grows in a dense structure that is made by the surrounding trees. Since *Zelkova crenata* Spach. is a sciophyte, these conditions are completly suitable to it.

The investigations of water regime were carried out in may, july and september 1989. Daily dynamics was controlled every two hours, from 8 to 18 h. Transpiration was determined by the method of S t o c k e r (1929, 1956), and it is presented in mg of transpirated water on g of fresh leaf weight during 1 min. period (mg/g/min). The quantity of water in leaves and water saturation deficit were obtained by the method

of Stocker (1929), Slatyer (1960) and Slavik (1974), and expressed in percentage (%). The osmotic pressure of a cell sap was obtained by the method of Walter (1931, 1970) at semimicroosmoeter made by Knauer, and is expressed in bars.

Simultaneously it has been investigated the influence of some external factors such as: solar radiation intensity (J/cm^2/min), light intensity (lux), temperature (°C) and relative humidity (%) of the air at the height of 100 cm and the soil temperature in the depth of 20 cm. The relative humidity of the soil layer in the depth of 100 cm has been analyzed once a day. These microclimatic investigations were carried out by microclimatic station according to Janković, M.M. (1971).

Water regime dynamics of *Zelkova crenata* Spach. and the dynamics of microclimatic conditions of its habitat, are presented by minimal, maximal and mean daily values. Seasonal dynamics was observed by following the average daily values in may, july and september.

The anatomical analysis of the leaves of the observed species was carried out at preparations by standard paraffin embedding procedure and double stained by safranin and light green (Blaženčić, 1979).

RESULTS AND DISCUSSION

The ability of the plant species to adapt to conditions of the habitat is reflected in its anatomical structure. Namely, the structure of leaf is the most indicative for ecological research.

Our investigations shows that the upper and lower leaf surfaces are covered with short straight hairs which are quite rare. Cell walls of the both the upper and lower epidermis, observed at the leaves surfaces are very recurved, which points to the mesomorphic leaf structure. Stomates are located only at the lower side of the leaf, and their number is approximatly 160 per 1 mm^2.

The upper and lower epidermis are single layered, with thin cuticle, while the cells are equal in size (Tab. 1, Fig. 1). Mesophyl consists of the palisade and spongy tissue which are about the same thickness. Palisade tissue is of one layer, consisting of the extended cells, almost without intercellulars, while the spongy tissue is rather loose with wide intercellulars.

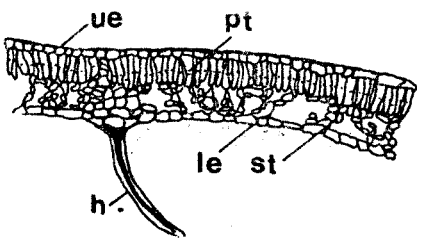

Fig. 1. – Cross section of a leave of a species *Zelkova crenata* Spach.: ue – upper epidermis, le – lower epidermis, pt – palisad tissue, st – spongy tissue, h – hair.

Tab. 1. – Anatomical features of leaves on cross section in μm

Anatomical features	min. - max. (μm)
Leaf thickness at the level of the central bundle	270 - 291
Leaf thickness	72 - 103
Upper epidermis hight	9 - 16
Upper epidermis width	13 - 31
Pilisade tissue	25 - 41
Spongy tissue	30 - 41
Lower epidermis hight	9 - 16
Lower epidermis width	9 - 28
Hair length	approx. 188

According to the literature (V u k i ć e v i ć, 1987) and on the basis of our own investigations, we have concluded that *Zelkova crenata* Spach. can be considered as a shade species (sciophyte).

The general aspect of the water regime and its dynamics shows a correlation with a present enviromental conditions and sesonal changes. The greatest amount of water in leaves (68%) during whole investigation period was found in may. In keeping that, the water saturation deficit was the lowest (16%), while the transpiration of just developed leaves was the most intensive (6,6 mg/g/min). The osmotic pressure of a cell sap was the lowest in this spring month in regard to the summer and autumn months (12 bar).

In july all the water regime parameters were changed comparing to the may values, which is connected with the changes in the environment. In that period the light intensity and solar radiation were the highest, as well as the temperature which values reached the maximum comparing to may and september (22,6°C). The air humidity was considerably lower comparing to may, and because of that the evaporation was the most intensive. The soil layer humidity goes down insignificantly comparing to the previous month. In such a microclimatic environmental conditions, the quantity of water in leaves also goes down comparing to may (62%), water saturation deficit increases (22%), transpiration goes down insignificantly (6 mg/g/min) (because of the high light and temperature intensity), wihile in keeping with that, the osmotic pressure of a cell sap increases (17 bar).

In september the quantity of water in leaves was unchangeable comparing to july (62%). The water saturation deficit reached the highest value comparing to may and july (27%), and the transpiration intensity went down (3,8 mg/g/min). This fall of transpiration can be connected with the changes that happened in the environment (such as the lowest light intensity, lower air temperature than in july, low evaporation and small quantity of water in the soil). The osmotic pressure of a cell sap were the highest in this month (18 bar), which can be explained by leaves growing old and accumulation of the metabolic products (Fig. 2-3, Tab. 2-3).

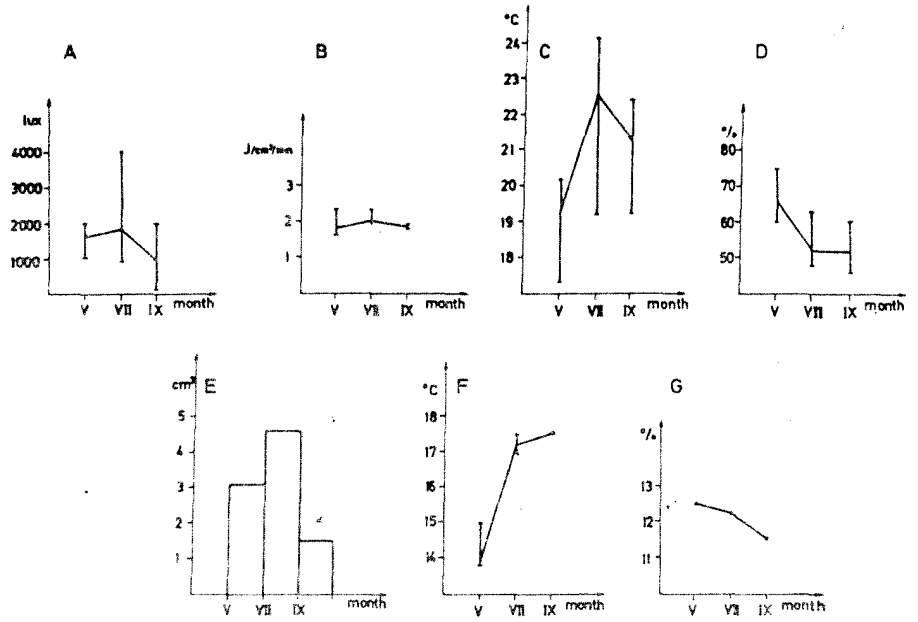

Fig. 2. – Seasonal dyanamics of microclimatic conditions of a habitat: (A) light intensity, (B) solar radiation intensity, (C) air temperture, (D) relative air humidity, (E) evaporation, (F) soil temperature, and (G) ralative soil humidity.

Tab. 2. – Dynamics of microclimatic factors during the vegetative period

Microclimatic factors	month	minimum	maximum	mean values
A Light intensity (Lux)	V	1000	2000	1680
	VII	900	4000	1836
	IX	100	2000	983
B Solar radiation intensity	V	1.68	2.37	1.88
($J/cm^2/min$)	VII	1.95	2.23	2.04
	IX	1.81	1.95	1.83
C Air temperature (^oC)	V	17.30	20.20	19.42
	VII	19.20	24.20	22.60
	IX	19.20	22.40	21.33
D Relative air humidity (%)	V	60	75	66.33
	VII	48	63	52.50
	IX	46	61	52.00
E Evaporation (cm^3)	V	-	-	3.10
	VII	-	-	4.60
	IX	-	-	1.50
F Soil temperature (^oC)	V	13.80	15.00	13.90
	VII	17.00	17.50	17.12
	IX	17.50	17.50	17.50
G Relative soil humidity (%)	V	-	-	12.55
	VII	-	-	12.20
	IX	-	-	11.50

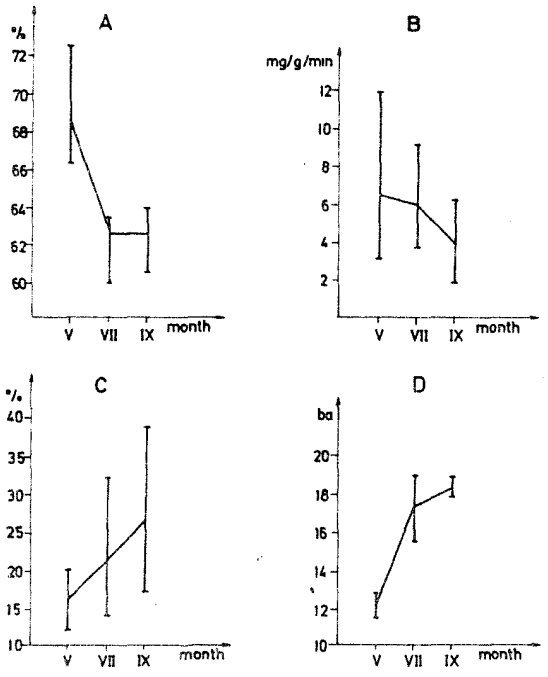

Fig. 3. – Seasonal dynamics of water regime factors: (A) quantity of water in leaves, (B) transpiration, (C) water saturation deficit, and (D) osmotic pressure of a cell sap.

Tab. 3. – Dynamics of water regime during the vegetative period

Water regime factors	month	minimum	maximum	mean values
A. Quantity of water in leaves (%)	V	66.25	72.44	68.23
	VII	59.80	63.36	62.55
	IX	60.43	63.92	62.44
B. Transpiration (mg/g/min)	V	3.16	11.91	6.58
	VII	3.72	9.02	6.04
	IX	1.99	6.32	3.75
C. Water saturation deficit (%)	V	12.31	20.56	16.35
	VII	14.32	32.38	21.80
	IX	17.74	38.95	26.75
D. Osmotic pressure of a cell sap (bar)	V	11.50	12.99	12.17
	VII	15.53	19.09	17.43
	IX	17.92	19.04	18.48

On the basis of the above reported results, it can be seen that during the vegetation period the quantity of water in leaves and the transpiration intensity goes down from spring to autumn months while water saturation deficit and osmotic pressure of a cell sap in this period shows a significant increase.

During whole vegetation period the dynamic changes of water regime of this introduced species are noticed. The investigations of water regime and the anatomic structure showed the physiological stability of the species *Zelkova crenata* Spach. at the Botanical garden in Belgrade.

CONCLUSIONS

According to morpho-anatomical adaptations and the water regime characteristics, the investigated species is sciophyte with mesomorphic structure, which survives in the areas where are no great variations on the environmental conditions.

The basic characteristics of water regime are relatively weak transpiration during the whole vegetation period as well as the moderately high osmotic pressure of a cell sap.

The species *Zelkova crenata* Spach. has a stable water regime which is in keeping with the seasonal changes in the environment.

ACKNOWLEDGEMENTS

The author thank prof. dr. Ž. Blaženčić and prof. dr. B. Stevanović for a precious help in realization of this work.

REFERENCES

Blaženčić, J. (1979): Praktikum iz anatomije biljaka sa osnovama mikroskopske tehnike. – Naučna knjiga, Beograd.

Blaženčić, Ž. (1982): Ekološka studija morfo-fizioloških adaptacija nekih kserofitnih trava (*Poaceae*) u stepskim fragmentima Fruške Gore. – Zbornik Matice srpske, *63*: 13-60.

Janković, M.M. (1963): Fitoekologija s osnovama fitocenologije i pregledom tipova vegetacije na zemlji. – Naučna knjiga, Beograd.

Janković, M.M. (1971): Metodika nastave biologije. – Zavod za izdavanje udžbenika SR Srbije, Beograd.

Jovanović, B. (1967): Dendrologija sa osnovama fitocenologije. – Naučna knjiga, Beograd.

Kojić, M., Pekić, S. (1981): Vodni režim i organska produkcija pšenice. – Posebno izdanje SANU, knj. 53, Beograd.

Matijašević-Vasić, B. (1969): Prilog poznavanju hidrature kod *Fragaria vesca* L. – Ekologija *4*(2): 141-147.

Matijašević, B. (1971): Ekofiziološke karakteristiek vodnog režima vrste *Fragaria vesca* L. u zajednici *Festuco-Quercetum petreae* M. Jank. na Fruškoj Gori. – Ekologija *6*(2): 273-282.

Matijašević, B. (1973): Neka fiziološko-ekološke karakteristike vrste *Carex silvatica* Huds. u zajednici *Festuco-Quercetum petreae* M. Jank. na Fruškoj Gori. – Ekologija *8*(1): 13-22.

Metcalfe, C.R., Chalk, L. (1950): Anatomy of the Dicotyledones. II. – Oxford University Press.

Slatyer, R.O. (1960): Absorption of water by plants. – Bot. Rev. *26*: 331-392.

Slavik, B. (1974): Methods of studying plant water relations. – Springer, Berlin.

Stocker, O. (1929): Eine Feldmethode zur Bestimmung der momentanen Transpiration und Evaporationesgrösse. I, II. – Ber. Deut. Bot. Ges. *47*: 126-136.

Stocker, O. (1956): Messmethoden der transpiration. Die Abhängigkeit der Transpiration von den Umweltfaktoren *In* Handbuch d. Pflanzenphysiologie, III. Pflanze und Wasser W. Ruhland, ed.). – Springer, Berlin.

Turill, B.W. (1929): The plant life of the Balkna peninsula. A Phytogeographical Study. – Oxford University Press.

Vukićević, E. (1987): Dekorativna dendrologija. – Naučna knjiga, Beograd.

Walter, H. (1931): Hydrature der pflanzen. – Fisher, Jena.

Walter, H., Straka, H. (1954, 1970): Arealkunde, Floristiech-historiche geobotanic. – Ulmer, Stuttgart.

Rezime

TATJANA GRABELJŠEK

NEKE EKOFIZIOLOŠKE I MORFO-ANATOMSKE KARAKTERISTIKE VRSTE *ZELKOVA CRENATA* SPACH.

Veterinarski fakultet, Univerzitet u Beogradu

Zelkova crenata Spach. je kao tercijarna vrsta naseljavala južnu Evropu, da bi tokom ledenog doba nestala sa ovih prostora. Danas se sa uspehom gaji u velikom delu Evrope kao ukrasno drvo, dok su termofilne šume Kavkaza njeno prirodno stanište. Ova vrsta ispitivana u Botaničkoj bašti u Beogradu, odlikuje se dinamičkim promenama vodnog režima, što je u skladu sa sezonskim promenama u spoljnoj sredini. Osnovne karakteristike vodnog režima su relativno slaba tanspiracija u toku čitavog vegetacijskog perioda i umereno visok osmotski pritisak. Proučavanje anatomske strukture lista ukazuje na njegovu mezomorfnu gradu.

Po morfo-anatomskim adaptacijama i po karakteru vodnog režima, ispitivana vrsta je skiofita sa mezomorfnom građom, koja se održala na mestima gde nema velikog variranja u uslovima spoljne sredine. Istraživanja ukazuju na fiziološku stabilnost vrste *Zelkova crenata* Spach. u uslovima Botaničke bašte u Beogradu.