Walnut (*Juglans regia* L.) selection in Serbia

S. Cerović, B. Gološin, J. Ninić Todorović, S. Bijelić, V. Ognjanov

Department of Pomology, Viticulture, Horticulture and Landscape Architecture, Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia

Abstract

Cerović S., Gološin B., Ninić Todorović J., Bijelić S., Ognjanov V., 2010: **Walnut (*Juglans regia* L.) selection in Serbia**. Hort. Sci. (Prague), *37*: 1–5.

The domestic population of walnut (*Juglans regia* L.) in Serbia is highly heterogeneous as a result of many centuries of propagation from seed. This paper describes variation observed in this population over the past four decades. The date of budbreak showed a 50-day range, and the date of leaf drop a 32-day range. Average nut weight ranged from 3.3 g to 29.0 g and the kernel percentage from 26.2% to 64.3%. The number of female flowers per inflorescence ranged from 1 to 32 and the number of nuts per cluster from 1 to 15. The majority of Serbian walnut seedlings had inferior traits, although a few genotypes with excellent traits were also found. Five superior selections have been released as cultivars, and additional selections await official release. To date, over 1,000 ha of orchards have been planted in Serbia using these walnut cultivars and selections.

Keywords: walnut population; selection; nut quality; resistance; nut yield

Walnut growing has a long tradition in Serbia, where the number of bearing trees is around two million. The soil and climatic conditions in most regions are suitable for walnut cultivation, and walnut trees are found in all fruit-growing regions. The major fruit-growing regions include Timok region, the region along the Drina River, Metohija region, the region along the West Morava River, the region along the South Morava River, and the Fruška Gora Mountain. Walnut trees are most abundant between 100 and 400 m elevation, although individual trees can be found at elevations of up to 1,000 m in central Serbia and up to 1,200 m in southern Serbia.

Walnut is highly appreciated in Serbia as indicated by the many names of places derived from the word "orah" (walnut). It has been propagated from seed for centuries, resulting in a heterogeneous population in which each tree is a different genotype. As a result, Serbian walnuts represent a seedling population from which superior types can be selected. Of this multitude of genotypes, types with inferior nut quality predominate. However, it is reasonable to expect a few genotypes with excellent quality, as shown in previous selection work. The walnut population in the former Yugoslavia was studied by Rahović (1959). Rudić (1962) concentrated on the region of the Fruška Gora Mountain, while Jelenković (1974) studied walnuts in the Zaječar region. These early investigations were limited to individual regions; extensive investigations started in 1973 (Korać et al. 1974). Superior types were identified based on the characteristics including high nut quality, high yielding capacity, late budbreak, early leaf drop, and high disease resistance. The most promising types have been released for commercial production, and the superior types have been used as parents in hybridization.

MATERIALS AND METHODS

Collection and evaluation. Selection from the native walnut population started at the Faculty of

Table 1. Beginning of the vegetation period of the Serbian walnut types investigated

Rating	Beginning of vegetation	Reference cultivar	% of the population
1	very early	Geisenheim 1247	8.1
2	very early to early	Eszterhazay 1	18.5
3	early	Drjanovski	27.4
4	early to medium	Šejnovo	22.7
5	medium	Geisenheim 139	12.7
6	medium to late	Marbot	6.5
7	late	Franquette	3.6
8	late to very late	Ronde de Montignac	1.4
9	very late	Super kasni	0.1

Agriculture in Novi Sad in 1962 (Korać et al. 1986). The first investigations were conducted at nearby locations, mostly in the Vojvodina Province. Each tree possessing an interesting characteristic was monitored for several years. If the particular characteristic persisted over a period of several years, scions were taken for grafting and the grafted trees were planted in collection orchards. The results were fairly modest, because of the short period of the investigation and the limited number of trees observed. Starting in 1973, we introduced an original method for identifying promising trees for initial evaluation. A contest entitled "Looking for quality walnuts" was organized annually in which growers were invited to send their best nuts and win a reward (Korać et al. 1974). Over 20,000 samples were collected in this manner. We made a long list of genotypes with nuts of superior quality, and the trees were observed for several years. Based on the results, we propagated the most interesting selections and established collection orchards in several locations. The largest collection was established in the village of Beška near Novi Sad. Observations of the most promising selections continued in these trials established in several walnut-growing regions.

The following selection criteria were used:

(1) short vegetation period – we targeted genotypes that were late in starting the vegetation period and early in ending it. Many regions in Serbia have frequent late spring frosts and early fall frosts. Genotypes with a short vegetation period thus avoid damage,

(2) high nut quality – desirable genotypes have a kernel percentage (ratio of kernel weight to nut weight) of 50% to 58%, kernels that are easy to remove from the shell, and light kernel color. Also, the shell should be well-sealed to protect the kernel, and should be smooth and of light color,

(3) high productivity – emphasis was placed on genotypes with fruitful lateral buds, that bore nuts in clusters, or that had many branches,

(4) low incidence of diseases, especially anthracnose caused by *Gnomonia leptostyla* and bacterial blight caused by *Xanthomonas juglandis*.

RESULTS AND DISCUSION

The walnut population in the former Yugoslavia is highly heterogeneous, as a result of centuries of propagation from seed. This permitted an intensive selection of native walnuts, including some 20,000 samples brought to our attention by local growers as a result of a contest. Our investigations, which became intensive in 1973, revealed a wide range in several traits, including the start of the vegetation period, end of the vegetation period, nut weight, and kernel percentage. Female inflorescences contained up to 32 flowers, and set up to 15 nuts per cluster. About 80% of the observed types had protandrous flowering.

Start of vegetation period. The walnuts selected in different regions were compared against well-

Table 2. End of the vegetation period of the Serbian walnut types investigated

Rating	End of vegetation	Reference cultivar	% of the population
3	early	Adams	55
5	medium	Hartley	28
7	late	Marbot	17

Table 3. Average nut weight of the Serbian walnut types investigated

Nut weight (g)	% of the population
Up to 6	10.1
6–8	18.5
8–10	32.2
10–12	15.2
12–14	12.8
Over 14 g	7.2

known cultivars and selections. The start of the vegetation period was early or medium-early for most of the examined types (~ 75%). The difference between the earliest and the latest was ~ 55 days (Table 1).

End of vegetation period. The range in dates of the end of the vegetative period was 32 days. Most of the examined types were medium-late in maturity (around 55%), followed by early types (around 28%), while only 17% were late (Table 2).

A positive correlation was observed between the start and end of the vegetation period. Trees that were late to start the vegetation period were typically late in ending it. However, there were several exceptions. The Serbian cultivar Šampion was rated medium for the start of the vegetation period, but the vegetation period ended quite early. The selection Super kasni was the last to start the vegetation period (it started the season on July 2, 1987), but it was medium in ending it, like most of the examined biotypes.

Nut characteristics. Types with small nuts (Table 3) and low kernel percentage (Table 4) predominated. Nut weight ranged from 3.3 g in V-1 to 29.0 g in 105/76. Selection 105/76 belonged to a type locally called "babac" and its percentage of kernel was a mere 26.2%, the lowest value observed. Only one-third of the assessed types had a kernel percentage > 40%. The highest kernel percentage of kernel (64.3%) was in selection 62/76.

Arrangement of fertile buds on annual shoots. Most of the examined types had a terminal bearing habit. Only two biotypes set more nuts on lateral than on terminal shoots. About 5% of the types had individual lateral buds that were fertile, but set on their lateral buds was considerably less than on their terminal buds. A limited number of types had a racemose type of fruit bearing. Nine selected types bore fruit in clusters, of which only four were of economic importance. Among the racemose types, the cultivar Tisa has large nuts (up to 15.5 g), while the others have small ones (< 10 g). Among the racemose types, maximum cluster size ranged from 8 for Tisa to 15 for Medveđa.

Dichogamy. Most types (~ 80%) were protandrous, a small number (~ 12%) were protogynous, and only a few (~ 8%) were homogamous.

Cultivars and selections from previous work. Five selections were officially released and recommended for commercial plantings: Šampion, Srem, Tisa, Bačka and Mire (Korać et al. 1988). Several additional promising selections continue to be studied and propagated (Cerović et al. 1999, 2003). Five cultivars and four advanced selections are described below (Table 5). All resulted from selection work at the Faculty of Agriculture in Novi Sad.

Šampion. It starts the vegetation period with Sheinovo, but ends it 15 to 20 days earlier. The tree is moderately vigorous. The nut has an attractive shape and an average weight of ~ 14 g. The kernel is attractive and of light color. Kernel percentage is around 58%. The kernel contains about 67% oil and 18.6% protein. Flowering is protandrous. The cultivar is exceptionally resistant to low temperature. In a walnut nursery established in the village of Veternik near Novi Sad, Šampion was the only one of the 36 cultivars tested that suffered no damage from winter cold in 1987, when the temperature fell to –27.6°C at the end of January. February was relatively warm, with frost-free days from February 11 to 24, and March was again very cold. On March 8, the temperature in 2 meters above the soil surface was –19.9°C. That year, while scaffold limbs of 12-year-old trees of Corne, Marbo, and Sheinovo froze, Šampion remained unharmed and it even produced an excellent yield.

Srem. It starts the vegetation period 2–3 days earlier than Sheinovo, and ends it some 10 days earlier. The tree is moderately vigorous to vigorous, and flowering is protandrous. Suggested pollenizers of Srem are Jupiter and G 139. The nut is large (> 15 g), and the shell is thin and almost smooth.

Table 4. Kernel percentage of Serbian walnut types investigated

Kernel (%)	% of the population
Below 30	14/7
30–40	29/1
35–40	22/0
40–45	15/2
45–50	9/7
50–55	6/2
Over 55	3/1

Table 5. Descriptions of five new cultivars and four advanced selections from the native population of walnut in Serbia

Cultivars and selections	Beginning of vegetation	End of vegetation	Flowering	Tree vigorous	Nut weight (g)	Kernel (%)	Kernel color
Šampion	Apr 24th	Oct 12th	protandrous	moderately	14.5	57.8	light
Srem	Apr 18th	Oct 17th	protandrous	moderately	15.7	56.5	light
Tisa	Apr 19th	Oct 23rd	homogamous	moderately	15.9	51.2	light brown
Bačka	Apr 17th	Oct 16th	protandrous	moderately	12.5	52.4	light
Mire	Apr 17th	Oct 17th	protandrous	moderately	12.5	55.5	light
Sel. Rasna	Apr 27th	Oct 19th	homogamous	poorly	14.6	52.5	light
Sel. Sava	Apr 22nd	Oct 20th	protandrous	poorly	13.5	53.3	light
Sel. Kasni rodni	May 09th	Oct 19th	protandrous	poorly	12.1	46.8	light
Sel. Kasni grozdasti	May 14th	Oct 29th	protandrous	poorly	10.4	43.2	light
Control – Šejnovo	Apr 20th	Oct 27th	protandrous	moderately	11.9	55.6	light brown

The kernel percentage is ~ 57%. The kernel is attractive and light-colored, and contains about 66% oil and 17.4% protein. Srem is highly productive.

Tisa. The vegetation period starts and ends with Sheinovo. It is a racemose type. Although the female inflorescence contains up to 20 flowers, the maximum number of nuts in a cluster is 7–8 because of their large size. Flowering is homogamous in most years. The nuts are round and quite large (~ 15 g), which is rare for a racemose form. Although the kernel does not completely fill the shell, the kernel percentage is fairly high (~ 51%) because of the thin shell. Kernel color is similar to Sheinovo, which is not sufficiently light for many markets. This is considered a shortcoming. The kernel contains about 66% oil and 19.3% protein. Tisa is a high-yielding cultivar recommended for cultivation in the grape-growing zone.

Bačka. It starts the vegetation period with Sheinovo, and ends it about 10 days earlier. The tree is moderately vigorous and very prolific, and individual lateral buds are fertile. Flowering is protandrous. The nut is medium-large (~ 12 g), has an attractive slightly conical shape, and a light-colored smooth shell. The kernel is exceptionally attractive and light-colored. Kernel percentage is ~ 52%. The oil content of the kernel is 68–70%, and the protein content is 17.9%. It is recommended for cultivation in the grape-growing zone.

Mire. It starts the vegetation period approximately three days before Sheinovo and ends it about 10 days earlier. The tree is moderately vigorous and very prolific when cultivated in regions without late spring frosts. Nut yields are about 4.5 t/ha. Flowering is protandrous. The nut is medium-large (~ 12 g), with a light-colored thin shell. The kernel is attractive and lightcolored. Kernel percentage is ~ 55%. The kernel contains ~ 66% oil. This cultivar is recommended for cultivation in warm regions. Several selections, including Rasna, Sava, Kasni rodni and Kasni grozdasti, are currently in official tests as candidate cultivars.

Rasna. It has a short vegetation period. It starts the vegetation period 2–3 days after Šampion and ends it about 7 days later. It is highly resistant to anthracnose caused by *Gnomonia leptostyla*. The tree is not vigorous but it is very prolific and precocious. Trees start to bear nuts while still in the nursery. Flowering is almost fully homogamous. The nut is large (~ 14 g) and slightly conical. Kernel percentage is ~ 52%. It is recommended for regions with a continental climate, in combination with Šampion, for which Rasna is a good pollenizer.

Sava. It starts the vegetation period before Šampion and ends it 7 days later. The tree is moderately vigorous and very prolific. Lateral buds are fertile (> 80%) and account for a large portion of the total yield. It is highly resistant to anthracnose. The nut is medium-large (~ 13 g), oval, and has a thin shell. The kernel is easily removed from the shell, giving about 90% whole kernels. Kernel percentage is ~ 53%. It is recommended for all walnut-growing regions.

Kasni rodni. It has a short vegetation period. It starts the vegetation period quite late, about 15 days after Šampion, and ends it about 10 days later. It manages to regularly avoid late spring frosts. Flowering is almost fully homogamous. It is highly resistant to anthracnose. The tree is not vigorous but it is very prolific. The lateral buds are fertile and account for a large portion of the total yield. The

nut is medium-large (~ 12 g) and slightly conical. The kernel is attractive and light-colored. The kernel percentage is somewhat low, which is the only shortcoming of this selection.

Kasni grozdasti. It starts the vegetation period several days after Milko, but also ends it later. Like all late-leafing selections, it avoids primary infection by spores of *Gnomonia leptostyla*. The tree is less vigorous but very prolific. The nut weight is ~ 10 g. The kernel is attractive and light-colored. Kernel percentage is ~ 43%.

In the course of this study of the domestic walnut population in Serbia, we found some unusual forms. One of these is the selection Bečej that belongs to the laciniata type because of its unusual leaf shape (Korać 1997).

CONCLUSION

The walnut population in the former Yugoslavia is highly heterogeneous, the result of centuries of propagation from seed. This permitted intensive selection. Our investigations, which became intensive in 1973, revealed a wide range in several traits, including the start of the vegetation period, end of the vegetation period, nut weight, and kernel percentage. Lateral bearing and racemose types were found in low frequency. About 80% of the observed types had protandrous flowering. It is evident that in the native walnut population in Serbia, inferior types predominate. However, individual trees with exceptional characteristics were found. Following extensive evaluation, five of these (Šampion, Srem, Tisa, Bačka and Mire) were officially released and recommended for planting in the former Yugoslavia. All are highly productive and have excellent nut quality, and are now grown on > 1,000 ha in Serbia. The largest walnut plantation in Serbia is 84 ha and is located in the village of Lipar some 70 km north of Novi Sad. Evaluation of four additional selections (Rasna, Sava, Kasni rodni and Kasni grozdasti) is continuing in official trials. Evaluation of the walnut population in the former Yugoslavia and selection of best types still continues. For sources of scions or trees of these cultivars and advanced selections, please contact the authors.

References

Cerović S., Gološin B., Korać M., 1999. Karakteristike selekcija oraha Poljoprivrednog fakulteta u Novom Sadu (Features a selection of nuts, Faculty of Agriculture in Novi Sad). Zbornik naučnih radova, Aranđelovac, *5*: 265–268.

Cerović S., Mitrović M., Oparnica Č., Miletić R., Ninić-todorović J., Gološin B., Bijelić S., 2003. Predlog novog jugoslovenskog sortimenta oraha i leske (The proposal of the new Yugoslav cultivars and hazelnuts). Savremena poljoprivreda, *1–2*: 33–38.

Jelenković T., 1974. Neke karakteristike odabranih ekotipova oraha u timočkoj krajini (Some characteristics of selected ecotype walnut in Timocka Krajina). Jugoslovensko voćarstvo, *27*: 49–53.

Korać M., Slović D., Rudić M., Milovankić M., 1974. Kvalitet plodova oraha u Jugoslaviji (Fruit quality walnuts in Yugoslavia). Savremena poljoprivreda, *11–12*: 22–27.

Korać M., Slović D., Rudić M., Cerović S., Gološin B., 1986. Rezultati hibridizacije i selekcije oraha na Poljoprivrednom fakultetu u Novom Sadu (Characteristics of walnut selection Shampion, Srem, Tisa, Backa and Mire). In: Proceedings of the Yugoslav Symposium on the Selection and Breeding of Fruit. Čačak: 101–107.

Korać M., Cerović S., Gološin B., 1988. Characteristics of walnut selection Shampion, Srem, Tisa, Backa and Mire. In: Proceedings of the International Conference on Walnuts. Yalova, Turkey: 47–52.

Korać M., Cerović S., Gološin B., 1997. Orah (Walnut). Prometej, Novi Sad.

Rudić M., 1962. Selekcija oraha u Vojvodini (Selection of nuts in Vojvodina). Arhiv za poljoprivredne nauke, sveska, *49*: 51–56.

Rahović D., 1959. Prilog Proučavanju Oraha iz Polimlja (Contribution to the Study of Walnut Polimlje). Naša poljoprivreda i šumarstvo, Titograd.

Received for publication April 14, 2009
Accepted after corrections August 6, 2009

Corresponding author:

Mrs. Sandra Bijelić, assistant, University of Novi Sad, Faculty of Agriculture,
Trg Dositeja Obradovica 8, 21000 Novi Sad, Serbia
phone: + 381 21 4853 275, fax: + 381 21 450 123, e-mail: sbijelic@polj.uns.rs.