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FRUIT CHARACTERISTICS IN WALNUT TREE POPULATION IN RELATION TO GROWING SEASON ONSET

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The objective of walnut selection is to obtain promissing genotypes characterised by later growing season onset, shorter period of vegetation, resistance to diseases, stable fruit productivity and high fruit quality. Aiming at obtaining genotypes with favourable properties, in five localities of Eastern Serbia, where walnut is widely grown, we studied the correlation among growing season onset on the one hand, and major pomological properites and fruit quality on the other. In the studied population, trees with early growing season onset and fruit mass up to 8.0 g (30.1%) were predominant, whereas those with late growing season onset were in minority, fruit mass ranging from 10.1 to 12 g (0.07%). Kernel ratio

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was highest in the former (20.69%), and the lowest in the latter (0.07%). Similar was observed in oil and raw proteins content in kernel which was highest in fruits of early trees (33.62%, 47,55%), while it was remarkably lower in late ones (0.72%, 0.49%). The obtained results suggest that the studied population was dominated by early trees and unfavourable or less favourable fruit properties. In spite of that, we evidenced some trees with favourable properties which can be used in breeding as donors of useful genes.

Key words: growing season onset, fruit properties, population, walnut

INTRODUCTION

The objective of walnut selection is aimed at singling out genotypes with later and shorter growing season. These genotypes should exhibit high resistance to low winter temperatures, diseases and pests. These criteria as important is walnut selection were emphasized by UNHONI and VALII (1990), SZENTIVANI (1990), GERMAIN *et al*. (1983, 1997), KORAĆ *et al*. (1998). Almost all currently cultivated walnut cultivars originated from natural populations. The results of planned hybridization of walnut in the USA, France and other countries are widely known (MITROVIĆ *et al*. 2007).

Regarding that selection of walnut is still very actual, we performed some systematic study of the walnut population in the region of Eastern Serbia. This study of selection-oriented walnut population has set up regularities between growing season onset on the one hand, and major fruit properties (fruit mass, kernel ratio, and oil content, raw protein content) on the other. Bringing these properties into correlation will facilitate and render more effective the work on selection and breeding of new walnut cultivars.

MATERIALS AND METHODS

The research was conducted in five localities of Eastern Serbia (Negotin, Zaječar, Mali Izvor, Knjaževac and Sokobanja) where walnut is commonly grown. From each of the localities by random design method we singled out 280 to 330 walnut trees of generative origin which were used in a three-year study (the total of 1464). This paper focuses on growing season onset and major fruit properties (fruit mass, kernel content, kernel ratio, and oil and raw proteins content). The assessment of all the parameters was according to UPOV (an International Association for Protection of New Plant Cultivars). The period of bud elongation and emergence of terminal leaflets is considered as growing season onset. Classification of walnut trees by growing season onset was monitored every 5 to 6 days from the beginning of the season. For better reference, growing season onset is presented in three categories: early (1), mid-season (2) and late (3).

Fruit mass was determined by measuring average samples from every tree. In terms of average fruit mass, in compliance with UPOV, fruits were classified as very small (up to 8.0 g), small (8.1–10.0 g), medium (10.1–12.0 g), large (12.1–14.0 g), very large (< 14.1 g). As regards fruit and kernel mass for each tree, we classified

samples by kernel content as: extremely small (up to 30%), very small (30.1–35.0%), small (35.1–40.0%), mid-size (40.1–45.0%), large (45.1–50.0%), very large (50.1–55.0%), extremely large (> 55.1%).

Kernel oil content was determined by NMR (nuclear magnetic resonanse) method. The classification by respective parameter was as follows: kernels with low oil content (up to 50%), medium content (50.1–60.0%), high oil content (60.1–70.0%) and very high oil content (> 70.1%). Raw proteins content was measured by micro Kjeldahl method and samples were classified as: kernel with low raw proteins content (up to 15.0%), medium (15.1–20.0%) and high raw proteins content (> 20.1%).

RESULTS

Trees with early growing season onset were predominant in the studied walnut population (67.24%), whereas mid- and late-season trees accounted for 31.18% and 1.58% respectively. Besides, very small to small fruits dominated in the population (46.76% and 32.26% respectively). In contrast, fruits with medium, high and very high fruit mass (15.01%, 4.24% and 1.72%) account for a smaller part (21.1%) of the studied trees within the population (Table 1).

Table 1. Correlation between growing season onset and fruit mass in walnut population

Growing season onset	Trees in a population (%)					
	Fruit mass (g)					
	Up to 8.0	8.1–10.0	10.1–12.0	12.1–14.0	> 14.1	Total
Early	30.10	22.13	11.21	3.02	0.79	67.24
Mid-season	15.44	9.84	3.73	1.22	0.93	31.18
Late	1.22	0.29	0.07	0.00	0.00	1.58
Total	46.76	32.26	15.01	4.24	1.72	100.00

The population is dominated by early walnuts with very small (31.10%) and small fruits (22.13%), whereas those with large and very large fruits were in minority (3.02% and 0.79%, respectively). In trees that begin to grow in mid-season, very small fruits dominate (15.44%), whereas mid-large (373%), large (1.22%) and very large fruits (9.93%) are rarely observed (Table 1). Large to very large fruits were not evidenced among late-season walnut trees. Early seasoning and extended growth period accordingly made not a major impact on fruit mass.

The results infer that the population is dominated by fruits with large (28.37%) and mid-large kernel ratio (27.4%). Those with low (15.82%) and very high kernel ratio (15.23%) were occassionally found. In contrast, fruits with very low (7.32%), extremely high (3.59%) and exceptionally low kernel ratio (2.30%) were least evidenced. As fruits with medium and high kernel ratio accounted for 55.8% of fruits, which is considered very important from the aspect of economy (Table 2).

Table 2. Correlation between growing season onset and kernel ratio in walnut population

Growing season onset	Trees in the population (%)							
	Kernel ratio (%)							
	Up to 30.0	30.1-35.0	35.1-40.0	40.1-45.0	45.1-50.0	50.1-55.0	> 55.1	Total
Early	1.44	3.73	8.55	17.60	20.69	12.14	2.66	66.81
Mid-season	0.65	3.38	6.18	9.70	7.61	3.09	0.93	31.54
Late	0.21	0.21	1.09	0.07	0.07	0.00	0.00	1.65
Total	2.30	7.32	15.82	27.37	28.37	15.23	3.59	100.00

Fruits with high kernel ratio were mostly found in early walnuts, i.e. high kernel ratio (20.69), medium (17.60%) and very high (12.14%). Mid-season walnuts are dominated by fruits with medium, low and high kernel ratio (9.70%, 6.18% and 7.61% respectively). Fruits in late seasoning walnut trees are of extremely low (0.21%), low (0.21%) and medim kernel ratio (1.09%). Only one tree with medium and another with high kernel ratio were evidenced (0.07%).

As for oil content, the population is dominated by trees with medium and high oil content (50.22% and 43.53% respectively). Trees with low and high oil content make up a small part of the population (5.03% and 1.22%, respectively) (Table 3).

Table 3. Correlation between growing season onset and kernel oil content in studied walnut population

Growing season onset	Trees in population (%)				
	Oil content (%)				
	Up to 50.0	50.1-60.0	60.1-70.0	> 70.1	Total
Early	3.38	33.62	28.95	0.64	66.59
Mid-season	1.51	15.59	13.86	0.58	31.54
Late	0.14	1.00	0.72	0.00	1.86
Total	5.03	50.22	43.53	1.22	100.00

Oil content was the highest in early walnuts (medium 33.62% and high 28.95%), and the lowest in late walnut trees (0.64%). Medium and high oil content (15.59% and 13.86%, respectively) was evidenced in fruits of mid-seasoning walnuts. Only in few individual late walnuts we observed low, medium and high kernel oil content.

As presented in Table 4, the population is dominated by trees with fruits having medium raw proteins content (71.08%), while those with low (24.02%) and high raw protens content (4.90%) were in substantial minority.

Table 4. Correlation between growing season onset and raw proteins content in walnut kernel of the studied population

Growing season onset	Trees in population (%)			
	Raw proteins (%)			
	Up to 15,0	15,1-20,0	> 20,1	Total
Early	15.32	47.55	2.94	65.18
Mid-season	8.91	22.18	1.96	33.35
Late	0.49	13.48	0.00	1.84
Total	24.02	71.08	4.90	100.00

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In conclusion, trees with medium kernel raw proteins content dominate all the above categories of walnuts. Trees with low raw proteins content are in minority. In contrast, high raw proteins content was registered in fruits of early and mid-season walnut trees.

DISCUSSION

Walnut is reproduced generatively – via seeds. Besides, due to ununiform flowering and inflorescence time cross-pollination occurs. All these issues have an effect on development of an abundant heterogeneous population with different bio-pomological properties (MILETIĆ 2004). The results above suggest no regularity, as all classified walnuts are found in different number and with different fruit properties. However, the obtained results also infer that the studied population is dominated by early trees which display higher fruit quality.

Late seasoning walnut trees have minimal share of fruits with favourable properties. The population indeed has a few such trees which can be used as gene donors in breeding, which is in accordance with the results of MILETIĆ (2009). Namely, the study of correlation between season onset and end in the same walnut population showed that only 22 (1.5%) trees had shorter growing period.

In the same vein, according to BUGARČIĆ *et al.* (1985), late leafing walnut types singled out by a selection had lower fruit mass (10.4 g) compared to early types (13.6%). Besides, late seasoning types had lower and early ones higher kernel ratio (42% and 51.8% respectively). Our results are in accordance with these data.

CEROVIĆ (1992) discovered exceptional size only in some very early, early, mid-early and mid-season walnut cultivars grown in the region of former Yugoslavia, which is in accordance with the results of our study. Similarly, some mid-late, late and very late walnut cultivars originating from Hungary and Bulgaria have low to mid-low fruit mass. Early cultivars Apolo and Bačka and mid-season cultivar Hasen have medium fruit mass. The same author reports that mid-season, mid-late, late and very late cultivars have very low, low and medium kernel ratio. Cvs Šampion and Hasen are exceptions, as their kernel ratio are very high and high respectively. Late cv. NS has high kernel ratio Very early, early and mid-early have very high kernel ratio, the exception being 'Esterhazi' with medium kernel ratio. The results above, which include a small number of walnut cultivars and selections, are in accordance with our results. In addition, our results infer that individual trees in

the studied population have favourable characters. Thus, according to KORAĆ *et al.* (1986), in a population of 6000 trees of domestic walnut (grown in the region of former Yugoslavia) studied over 30 years only in 10 trees fruits were of exceptional quality.

Regardless of the fact reported by KORAĆ (1998), MILETIĆ (2008) etc. that high oil content correlates with low raw proteins content and vice versa, our study did not suggest such regularity, and it was particularly dependent on period of growing season onset.

It goes without saying that in natural populations selection is induced by environmental factors. In this manner, a genetic pool is created, and a population adapts its performance to the environment (BOROJEVIĆ 1986). Similari, KORAĆ (1988) also emphasises the influence of environmental factors on walnut performance. According to the author, available precipitation in June affect growth and fruit size, and those in August are decisive for the kernel formation. The author also points out that kernel oil content is higher in seasons with low rainfall and vice versa. In contrast, raw proteins content in the kernel is lower when drought occurs. The results of MILETIĆ (2008 and 2009) are in accordance with the statements above.

The elimination of trees with unfavourable bio-pomological properties has resulted in improved qualitative properties of walnut trees in the population. I has also ensured that no unfavourable character be passed on to progeny via anemophylic pollination and generative propagation. The above issues are very important when describing above correlations between the studied properties in walnut population, and those between phenological properties within the population (MILETIĆ 2009).

CONCLUSION

The results of our study suggest that the studied walnut population in Eastern Serbia is dominated by trees with unfavourable and fairly favourable fruit properties. This particularly refers to a great number of early seasoning walnut trees with high fruit size and low kernel ratio, oils and raw proteins content. However, a few individual trees classified as mid- and late season trees with medium oil and raw proteins content were evidenced in the population. These walnut trees with favourable combination of charaters can be used as gene donors in the process of breeding and selection of walnut for obtaining walnut cultivars with improved properties.

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POČETAK VEGETACIJE I VAŽNIJE OSOBINE PLODOVA U POPULACIJI ORAHA

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I z v o d

Selekcija oraha u cilju izdvajanja perspektivnih genotipova sa kvalitetnim osobinama je još uvek aktuelna u svetu. Iz ovih razloga sprovedena su istraživanja na području istočne Srbije u pet lokaliteta, gde je orah masovno zastupljen. U svakom lokalitetu metodom slučajnog uzorka odabrano je od 280 do 330 stabala oraha generativnog porekla (ukupno 1464) koja su bila predmet izučavanja u trogodišnjem periodu. Ispitivana je zakonomernost, odnosno uticaj vremena početka vegetacije na važnije pomološke osobine plodova (masa plodova, sadržaj jezgre, kao i sadržaj ulja i sadržaj sirovih proteina u jezgri oraha). U ispitivanoj populaciji dominiraju stabla sa plodovima rane vegetacije sa masom do 8,0 g (30,1%), a najmanje je poznih stabala (0,07%) sa masom od 10,1 do 12,0 g. Sadržaj jezgre je takođe najveći u plodovima stabala rane vegetacije (20,69%), a najmanji kod poznih (0,07%). Sadržaj ulja je bio najveći u plodovima sakupljenih sa stabala rane vegetacije (33,62%), a najmanji kod poznih (0,72%), kao i sadržaj sirovih proteina 47,55%, odnosno 0,49%. Na osnovu dobijenih rezultata zaključeno je da su u ispitivanoj populaciji oraha dominirala stabla sa ranijim početkom vegetacije i sa nepovoljnim i manje povoljnim osobinama plodova. Uprkos tome registrovana su pojedinačna stabla sa povoljnim osobinama, koja mogu da se koriste u procesu oplemenjivanja kao donori korisnih gena u cilju stvaranja sorti oraha sa boljom kombinacijom poželjnih svojtava.

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