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Evaluation of some introduced walnut *(Juglans regia* L.*)* cultivars in Shida Kartli region of Georgia

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ABSTRACT

One of the steps to walnut improvement in the Georgia is the diversification of production by introduced varieties having high productivity and better fruit quality that comply with common market requirements. A study was made with 6-introduced cultivars viz., Fernette', 'Franquette', 'Hartley', 'Howard', 'Lara' and 'Meylanase. The results of three years of (2014-2016) study showed that some of the walnuts cultivars are characterized with important features for commercial production. The results indicated that the cultivars viz., Fernette, Howard and Lara were found to be the best. These cultivars can be suggested for production in the some regions of East Georgia (Shida Kartli), which makes it attractive for the Georgian fruit growers.

Keywords : Walnut cultivars, blooming period, phenology, size, nuts.

INTRODUCTION

Georgia is considered one of the primary centers of the origin of walnut. There are great prospects for its development. Walnut is characterized with high productivity in mountain areas of East and west Georgia on the elevation of 500-900 m from see level, as well as in high area of Ratcha-Lechkhumi and East Caucasus pre-mountain areas. Despite the significantly suitable natural and soil conditions for walnut growing in Georgia, demand on local market is more 4-8 thousand tons than the in-shell walnut production. That is why an amount of walnut is imported from other countries with high market prices. Therefore study and selection of high productive varieties and their extension in farms have great importance for filling this deficit

(Shengelia and Kvaliashvili, 2005). One of the steps to walnut improvement in the country is the diversification of walnut cultivars by introducing new ones that comply with modern requirements. In this context, there is an increasing interest in cultivars of lateral bearing habits. Germain *et al.* (1999) established that the lateral bearing cultivars have a higher productivity due to the larger number of fruit buds than the terminal and intermediate bearing cultivars. According to Dzhuvinov *et al*. (2013), the productivity of the cultivar depends not only on the type of bearing and on number of female flowers, but also on the percentage of the useful fruit set and the fruit weight (Gandev and Dzhuvinov, 2014). The yield of each cultivar depends of the kernel weight, which is about 5-7 g for most of the commercial cultivars (Gandev, *et al.*, 2009; Ramos, 1985). The aim of the work was to study some agronomical features (phenology stage development and pomological descriptions) of introduced walnut varieties and to assess the possibilities of it's growing in Shida Kartli Region of Georgia.

MATERIALS AND METHODS

Collection site: The study was carried out in the collection plot of the Scientific - Research Center of Agriculture, Georgia located in the village Jighaura of Saguramo (Mtskheta municipality, Shida Kartli) during 2014-2016. The orchard has been established in 2011 with planting distance of 7x3m. The orchard of village Jighaura is located in the eastern part of Shida Kartli, on the 630 m above sea level. The zone characterized by warm climate, moderately humid air, cold winter and hot summer is appropriate for cultivation of stone fruits. The average yearly temperature is 10.8 ^{0}C, the absolute minimum temperature is -17.8 ^{0}C. The duration of vegetation period is 245 days on an average. The late spring frosts may be caused once in 10-15 years till 20th May. The sum of active temperatures is 3870 ^{0}C. The annual precipitation is 591 mm.

Plant materials : Six walnut (*Juglans regia*) cultivars were introduced. These were Fernette, Franquette, Hartley, Howard, Lara and Meylanase. Each accession in the collection were represented

with 15 plants grafted on the rootstock common walnut (*Juglans regia* L.).

Methodology: The methods envisaged carrying out of field as well as laboratory works. The research has been carried out using the following methods:

Phenological development of cultivars was done according to the modified version of the BBCH scale (Meier, 2001).

The calendar periods of the following phenological phases have been studied: beginning of vegetation, flowering, and fruit maturity.

The beginning of vegetation, was taken time when the vegetation bud burst. Time of flowering of female and male flowers - in the beginning of flowering of male flowers a cracking of seeds of pollen begins. Flowering of male flowers ends when pollen is not evolved yet. A beginning of flowering of female flowers is marked by arising of the first female flowers; and ending - when a pistil is not recipient of pollen (surface of pistil is dried). The time of fruit maturity was recorded at 50% of nut fall.

Pomological characteristics of nut of the cultivars were studied by instructions UPOV (2006) and Bioversity Guidelines for the conduct of tests for distinctness, uniformity and stability Walnut (*Juglans Regia* L) TG/125/6.

Fruits physical measurements were made after drying in the shade. Features such as shelled fruit weight, kernel weight, kernel ratio, shell thickness, fruit length, fruit width, fruit height were determined. While weighing 0.001 g was performed with sensitive precision scales, measuring was made with 0.01 mm precision digital caliper.

The nut characteristics:

1. Nut weight - were made after drying in the shade. Features such as shelled fruit weight - mean weight of 30 fruits, grouped as: very small < 8.5 g; small –from 8.5 g to 10.5 g; medium–from 10.5 g to 12.5 g; large–from 12.5 g to 14.5 g and very large > 14.5 g.

2. Kernel/nut weight ratio (%).

3. Shell thickness - thin – to 1.2 mm; medium thick – from 1.3 to 1.7 mm; thick – over 1.8 mm.

4. Kernel percentage *(output in percentage*) very low–below 40%; low – 40-44%; medium–from 45 to 49%; high–from 50 to 55%; very high–over 55% . 3. Separate the shell from the heart – determination is made organoleptically.

The cultivars are grouped so: 1. Nutmeat is separated from nut-shell readily; 2 moderately (meat is separated by pieces with little effort); 3. Difficultly (meat is separated by pieces hardly) were determined from 30 randomly chosen nuts.

The observations/measurements were conducted during three successive years and were evaluated employing the UPOV method and the methods of studying genetic resources of Nedev *et al.* (1979) and Germain (2004).

The results were analysed statistically by the one way analysis of variance (ANOVA) and separated by least significant difference (LSD) using SAS (SAS 1990) for each trait measured (Steele and Torrie, 1980).

RESULTS AND DISCUSSION

Phenological observations

Correct choosing of cultivars of walnut needs a determination of the calendar periods of progress of phenological phases according to cultivars. The phenological observations showed that in the three experimental years, the beginning of vegetation and time of flowering are specific biological traits of common walnut (*Juglans regia* L.) and they depend on the cultivar and the climatic conditions, under which it is grown (Germain *et al*., 1999). The results of three years (2014-2016) observations on calendar periods of phenol-phases are given in the Table 2. Phenological observations made on introduced cultivars of walnut showed, that the swelling buds of the trees in Shida Kartli region of Georglia begins mainly in the second decade of April, when the average daily air temperature of 15-18°C. This phase lasts for 8 to 14 days. The difference between cultivars according to the periods of beginning of vegetation is 10-16 days, among those the earliest (23.03) vegetation began in 2015 (cv. Howard), the latest (16.04) in 2014 (cv. Meylanase). The three year observations have determined, that out of the studied 5 cultivars the following cultivars begin vegetation relatively early: Howard and Hartley (26.03; 30.03), and relatively lately Meylanase– (11.04).

The calendar periods of flowering for one and the same cultivar were very variable according to years; it is explained by the difference of climatic conditions. The most favorable climatic conditions for flowering were in 2014. During the flowering the weather was sunny and windless. The relative humidity varied within 40-60%, precipitation was low, and therefore the cultivars ended flowering very quickly, in 8-10 days on an average. The most early flowering (male flowers) began in 2016 (Lara -16-17.04) the most lately in 2014 (Fernette -12-14.05).

The results in Table 2 showed that flowering of staminate flowers of walnut cultivars begins in mid-April and continues 10-16 days. The sum of active temperatures in the flowering period was 100-138°C. Flowering of pistil late flowers proceeds in the first and second decades of May. The sum of active temperatures in this period was 178-264°C. In agreement with the 3 years average data the most early break into bloom the cultivar Howard (male flowers: 6.04 -23.04; female flowers: 20.04-10.05). The most lately cultivar was Meylanase (male flowers -05.05 -14.05; female flowers - 16.05 – 28.05). According to the flowering period the cultivars were grouped into: early flowering – cv. Howard (18.04-07.05) and cv. Hartley (16.04 - 10.05); flowering in middle period –cv. Lara (20.04-12.05), cv.Fernette (24.04-15.05) and cv. Franquette (26.04-14.05). Lately flowering – cv. Meylanase (30.04 – 21.05) cultivars.

The mass flowering of the male flowers is also different for the separate cultivars. Catkins of Howard had the earliest mass flowering. In all the other cultivars flowering of the male flowers was from 6 to 16 days after cv. Howard. The latest development of the catkins was established for Franquette and Meylanase cultivars – 12-19 days after the cv Howard.

The mass flowering of the female flowers data shows, that the long period of flowering had cv.Hartley and cv.Howard. The cultivars Meylaneze entered the mass flowering stage immediately. The latest mass flowering season of the female flowers was reported in cv Meylanese.

Duration of the phenophase of flowering greatly depends on temperature conditions in the flowering period. Flowering of early flowering cultivars continues 22-24 days. Lately flowering cultivars flower more intensively and are characterized by shorter flowering period. The flowering period of the cultivars Franquette and Meylanase is 18-20 days. The sum of days from beginning of vegetation till ending of flowering is 40-56 days. The cultivars Meylanase and Fernette are blooming later than the other cultivars – Lara, Hartley, Franquette and Howard.

The average data of observations on the phase of ripening of fruit show that the studied cultivars differ by period of ripening of nutmeat. Dates vary from 28nd September to 30th October. The sum of active temperatures from the beginning of vegetation to the mass ripening is 1960-2340 °C. The sum of days in this period is 181-200 days. The cultivar Howard and Hartley ripens most early (30.09; 05.10), and then the cultivars. The cultivar Meylanase ripens most lately - (30.10). As the observation has shown the ripening period varies depending on climatic conditions. Early ripening of fruit has been noted in 2016. In 2016 the cultivars ripened by 6-10 days earlier. The difference between the periods of ripening of individual cultivars is 7-32 days.

Cultivars began defoliation in the second half of October (12.10) and continue till the first decade of November (04.11). The results of three-year (2014-2016) observations on the course of the phenologocal phases allow to draw a conclusion that calendar periods of phenological phases depend on biological features of a cultivars and climatically conditions.

Nut weight and its dimensions

The weight and size of nut are the most important indicators of fruit quality. As the Table 3 showed that the big weight of nut was characteristic for the cultivars: Lara, Fernette and Howard. The cultivars Franquette and Hartley has relatively small nut. Nut weight ranged between 12.20 g (cv.Franquette) and 16.14 g (cv. Lara), kernel weight ranged between 5.76 g (cv. Franquette) and 7.80 g (cv. Howard), kernel percentage % 44.12 (cv.Meylanase) and 50.31 (cv. Fernette).

Nut dimensions, the important fruit quality criteria for the selections had nut width between 31.70 and 36.82 mm, nut thickness between 30.22 and 34.36 mm, nut length between 38.65 and 34.41 mm (Table 3).

Table 1 Description of the cultivars studded

#	Cultivars	Country of Origin	Biological characteristics
1	Fernette	France	The tree growth habit moderate vigor. Lateral bearing, good yieldShell good strength. Kernel Light and extra light. Used as pollinizer for Chandler. Abundant pollen producer, more precocious than Franquette.
2	Franquette	France	The tree is very large and upright.Terminal bearer (1-2 nuts per terminal.Franquette comes into production late and requires little pruning. The Franquette walnut (Scharsch strain) is a late-leafing variety with low susceptibility to spring frost damage, walnut blight and codling moth. Franquette gives a fair production of well-sealed, thin-shelled quality nuts with light kernels.
3	Lara	France	Tree is medium, moderately spreading. Average vigour, quite upright in habit and lateral bearing make it suitable for hedgerow systems Blossoms in the medium term, in late April - early May. Maturity. Good fruit quality, precocious and highly productivity. Early bud beak and fruit ripening.
4	Howard	California	Tree is small to medium and semi-upright. Moderately vigorous tree and is suitable for hedgerow plantings. Howard has reduced blight and codling moth susceptibility. The nut is large, round, smooth and well-sealed with a very high percentage of light kernels. Howard can be pollenized by Cisco or Franquette.
5	Hartley	San Francisco	The tree is medium-to-large, moderately spreading and has low susceptibility to codling moth and blight. The nut is fairly large with a pointed tip. Thin-shelled, well-sealed and easy to crack, Hartley produces a high percentage of light kernels. Hartley is usually planted with Franquette as a pollenizer.
6	Meylanese	France	The tree is moderately vigorous and semi-upright. Meylanese produces immense nuts that are oval to round, medium-textured with a good seal and a strong yet easily removed. Kernels are light and make up about 48% of the total weight.

Table 2. **Phenological stages of walnut cultivars (average 2014-2016)**

Cultivars	Beginning of vegetation	Male blooming date			Female blooming date			Time of ripening (date)	End of vegetation
		Beginning	Mass	End	beginning	Mass	End		
Fernette	08.04	24.04	02.05	06.05	02.05	08.05	15.05	14.10	04.11
Franquette	10.04	26.04	30.04	04.05	04.05	10.05	14.05	18.10	30.10
Lara	04.04	20.04	26.04	30.04	30.04	04.05	12.05	28.10	12.10
Hartley	30.03	16.04	24.04	01.05	26.04	02.05	10.05	05.10	18.10
Howard	26.03	12.04	18.04	26.04	20.04	30.04	07.05	28.09	15.10
Meylanase	11.04	30.04	07.05	11.05	10.05	16.05	21.05	30.10	22.10

Table 3. **Nut traits of walnut cultivars (average 2014-2016)**

Cultivars	Nut weight (g)	Nut Dimension (mm)			Kernel		
		Length	Width	Thickness	Weight (g)	(%)	Shell (mm)
Fernette	15.26±0.56[b]	36.82±0.34[c]	34.00±0.62[d]	32.32±0.60[a]	7.68±0.20[a]	50.31±0.87[a]	1.61±0.08[a]
Franquette	12.20±0.46[b]	34.90±0.21[d]	31.70±0.35[a]	30.41±0.36[a]	5.87±0.32[a]	48.14±0.80[a]	1.44±0.10[c]
Lara	16.14±0.44[c]	38.22±0.24[a]	36.82±0.34[a]	34.36±0.42[d]	7.65±0.07[d]	47.44±1.12[b]	1.56±0.08[c]
Hartley	13.16±0.29[a]	34.41±0.36[a]	32.90±0.27[b]	30.22±0.51[c]	6.00±0.28[c]	45.65±0.96[c]	1.22±0.14[d]
Howard	14.84±0.35[a]	38.65±0.51[a]	36.31±0.54[b]	32.63±0.45[d]	7.80±0.16[a]	52.57±0.56[b]	1.58±0.02[a]
Meylanase	14.11±0.27[a]	35.12±0.50[d]	34.56±0.44[b]	32.56±0.42[b]	6.23±0.08[a]	44.12±1.76[d]	1.40±0.07[a]

Cultivar means in the same column followed by the same letter are not significantly different according to the LSD test ($P \leq 0.05$);

The data in table describing the 6 nut cultivars - Fernette, Franquette, Hartley, Howard, Lara and Meylanase - showed that, cv Franquette, Hartley and Meylanase belong to the group of cultivars with large nuts (a mean weight from 12.5 g to 14.5 g). The cultivars Howard, Fernette, and Lara respectively belong to the group of cultivars with very large nuts (a mean weight varying from 14.84g to 16.14g). The cv Howard and cv. Fernette had a very high kernel percentage. The cv Lara Franquette and cv. Hartly had a medium kernel percentage.

The ease of extraction of the walnut kernel from the shell was determined by the quantity of effort that is necessary, and divided into a three-point scale: 1.kernel easily extracted as a whole; 2. kernel extracted in halves, with a small effort; 3.kernel extracted only with difficulty, split into small pieces. The cv Frankette and cv. Fernette nuts have thick shell and kernel medium difficult of removal of the shell. The cv Lara, Hartley and cv. Howard nuts have a thin shell with shell thickness in the range from 1.0 to 1.5 mm and kernel easily extracted as a whole.

Separate the shell from the heart: determination is made organoleptically. The cultivars are grouped: 1. Nutmeat is separated from shell readily. 2 moderately (meat is separated by pieces with little effort) 3. Difficulty (meat is separated by pieces hardly).

CONCLUSIONS

Pieral (Lara), Fernette and Howard are characterized by early beginning of fruit bearing, mainly by lateral fruit bearing type and high quality of fruit. The mentioned cultivars have good potential for significant improvement of the assortment of walnut culture in Georgia that is an important prerequisite of development of the sector of walnut producing.

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