RESEARCH ON THE AGRO-BIOLOGICAL ASSESSMENT OF SOME VARIETIES OF WALNUT TREES IN DIRECT CONNECTION WITH THE ECOLOGICAL CONDITIONS IN THE UNDER-CARPATHIAN AREA OF OLTENIA (SUMMARY)

The walnut tree is a very important plant for food, economy, the protection against the erosion of the soil etc.

The fruits of this plant are considered “luxury fruits” and are very much sought worldwide.

In Romania, the growing of walnuts is a traditional activity but the modernization of the crop in time was not made dynamically such as in other tree species.

Cultivators were satisfied with the 30 to 35 thousand tons of walnuts annually, which were very unevenly shaped because they were coming from standalone plants (natural hybrids with a wide genetic variability).

The international trading competitiveness of walnuts entails the modernization of the walnut crop from the viewpoint of varieties, of the cloning breeding, of the cropping technology and of the harvesting and preservation of fruits technology.

Purpose and objectives of the research

Purpose of the research

The research conducted in our country with regard to the walnut tree cropping were due to the policies in the past years concerning the cultivation of ungrafted walnut trees on the most inadequate lands (in sloppy areas, areas prone to erosion or weakly fertile).

In this paper, the aim is to establish some fundamental elements, with the prevalence of the variety and type of varieties of walnut trees for the modernization of the crop in order to enhance productivity and the quality of the production. Without a variety and a type, it is not possible to achieve competitiveness at the current standards of international markets.

Research objectives

In order to establish the most adequate varieties and type for the culture of the walnut tree in the ecological areas in our country, we have proposed the following research objectives:

1. Assessment of Romanian and foreign walnut varieties from the viewpoint of their growing and fruits on the basis of some agro-biological characteristics;
2. Specification of the evolution of growing and fruit-making of walnut plants to complete fruit development;
3. Assessment of ecological and technological factors in direct connection with the requirements of walnut varieties;
4. Analysis of the behaviour of walnut varieties in connection with some diseases in the conditions of the North Oltenia.
5. Identification of a valuable type of varieties of walnut for the conditions in the North Oltenia and by way of comparison with international markets.

BIOLOGICAL MATERIAL AND RESEARCH METHODS

Biological material

The research was conducted in the period 2004 – 2009 within SCDP Valcea and in the plantation on Petrisor Hill in Rm. Valcea.

The plants were aged between 11 to 15 years (plantations created in 1995 and in 1999). Plants of 1 to 4 years have also been used to determine the growing in the first years. The biological material used in this paper comprises 29 varieties of walnut, of which 12 varieties are created in Romania and 17 varieties originate in USA, France, Germany and Bulgaria (Table 18).

The varieties have been grafts on the root stock Juglans regia (walnut under generative breeding).

Each variety was represented by 5 to 10 plants. The distance of inputs is 9 x 8 m (139 plants/ha).

Research methods

Depending on the research objectives set, biometric measurements have been made as well as phenological notes and determinations as follows:

a) with regard to the habitus of plants:

- diameter of the trunk, to ½ of its height (cm);
- the area of the trunk section (cm^2);
- the diameter of the crown (cm);
- the area of the projection of the crown to the soil (m^2);
- the height of the tree (m);
- the volume of the crown (m^3);
- the average annual length of branches (cm);
- the degree of actual land use (%).
- the growing strength was determined with the formula:

Vig.c = Nr.pct.SST + Nr.pct.VOL.COR.+Nr.pct.Supr.Ocupată

[Growing strength = the area of the trunk section + crown volume + occupied area]

(∑pct.)

b) with regard to the phonological phases of growth and fruit development:

- initial shooting of vegetative stems;
- initial blossoms in female and male flowers;
- the determination of the expression of dichogamy;
- the time of fruits' maturity;
- the completion of the vegetation cycle (upon leaves falling).

c) with regard to the behaviour of walnut varieties in the fruit-making process:

- the determination of the type of fruits;
- the identification of the capacity of fruit production every year (kg/ha);
- the moment of the initial fruit-making process;
- the establishment of the level of influence of the genotype and the environment conditions;
- the determinations regarding the influences of the genotype (the variety) and of the environment (in years) and of the genotype in connection with the environment were developed by the analysis of variance, Two-Way Anova with repetitions (Sokal and Rohlf, 1995).

The interpretations were based on the estimated variance (s^2), the expected variance (δ^2) and the variation coefficient (s%).

The testing of results was made with the F test and the "t multiple" test.

By way of the expected variance (δ^2), we succeeded to quantify the production quantity obtained following the influence of G.E. and G x E.

- the economic yield of the culture of walnuts depending on the production capacity.

d) with regard to the biometric characteristics of fruits

- shape, colour and evenness of fruits;
- size and weight of fruits (mm, g);
- shell joint, thickness and hardiness of the shell;
- size, weight and amount in the core;
- colour of core outer layer;
- taste and attractiveness of the core;
- allotment of the production of walnuts by qualities;
- chemical analysis of the varieties of walnuts.

e) with regard to the behaviour of walnut varieties to some diseases and pests:

- the attack of *Balaninus nucum* (the walnut's worm);
- the attack of *Xanthomonas campestris p.v. juglandis* (bacteriosis);
- the attack of Xanthomonas *juglandis* (bean spot disease);

Within this paper, we used biostatical analysis and the following static indexes were determined:

- the analysis of the arithmetic mean ($\bar{x}$);

- the analysis of amplitudes and the variation coefficient (s%);
- the analysis of the standard deviation (s):
- the analysis of variance (s^2):
- the analysis of correlations (r):
- the analysis of regressions (byx):

RESULTS OBTAINED

Growth characteristics of the varieties of a walnut

The growth of the varieties of walnut is differentiated by the vegetable propagating material used for plantation, the variety and the environment conditions of the area.

In the first six years from the plantation, the growth of walnut plants is more intense in plants on their own roots than in grafted plants, with the diameter of the trunk from 7 to 22 mm and the height of the plants from 0.2 to 1.4 m.

16 years after the plantation, the varieties of a walnut tree have reached a surface area of the trunk section between 531 cm^2 (Germisara) and 881 cm^2 (Muscelean) in Romanian varieties and between 510 cm^2 (Pedro) and 730 cm^3 (Franquette) in foreign varieties. The largest growths in the thickness of a trunk were recorded in Argesean (829 cm^2), Geoagiu 65 (754 cm^2), Sibişel 44 (720 cm^2) and Valrex (730 cm^2).

The area of the trunk cross-section is reduced in the varieties with lateral fruit-making (579 cm^2) compared to the varieties with terminal fruit-making (679 cm^2).

The diameter of crowns and the area of projection of crowns to the soil in plants ranges between 4.9 m with 18.8 cm^2 (Orastie) and 7.3 m with 41.8 m^2 (Muscelean) in the varieties with terminal fruit-making, and between 5.3 m with 22.0 m^2 (Ferjean) and 6.2 m with 30.1 m^2 (Tehama) in varieties with lateral fruit-making.

The mean height of plants ranges between 5.6 m (Jupanesti) and 6.8 m (Valmit) in varieties with terminal fruit-making and between 5.4 m (Pedro) and 6.1 m (Fernor) in varieties with terminal fruit-making.

The volume of crowns, a very important element for growth ranged between 94.2 m^3 (Orastie) and 209 m^3 (Muscelean). Varieties with terminal fruit-making have an average volume of the crown of 151.0 m^3 comparatively higher than the varieties with lateral fruit-making of 135.8 m^3 (+15.2 m^3).

At the age of 15, the varieties of a walnut tree have occupied only a part of the area of land available from a hectare of plantation. The most reduced area of land occupied was recorded in the Orastie variety (2.613 m^2, the equivalent of 26.1%), and the largest area was recorded in the Muscelean variety (5.810 m^2, the equivalent of 58.1%). In varieties with lateral fruit-making, the degree of occupation of the area available is 30.6% (Ferjean) to 41.8 (Tehama).

When they reach the age of 15, the varieties of a walnut tree do not use actually all the area they have available in the plantation (77.8%).

Most varieties of a walnut tree occupy only 40 to 60% of the useful area and, for this reason they may be considered as having reached neither the maximum growth parameters nor the fruit-making parameters (every 15 years).

The growth strength of the varieties of a walnut (determined on the basis of the scores given for the main growth elements) enabled the classification of the 29 varieties into the following strength groups:

- with very high strength (> 30 points) : Argeşean and Geoagiu 65;
- with high strength (between 20 and 30 points) : 23 varieties among which: Valcor, Sarmis, Vina, Franquette, Hartley, etc.;
- with average strength (between 10 and 20 points): Germisara, Orăstie, Velnița and Pedro.

Phenological phases of vegetation

The initiation of the un-shooting of vegetative stems was performed in a cluster in all the varieties of a walnut tree within a period of 13 to 16 days but the un-shooting depended heavily on the conditions of years so that the initiation occurred on 6 April in one year, whereas in others on 13 April'

The massive falling of leaves occurred in the course of October between 6 October (Valmit) and 22 October (Ferjean). The leaves began to fall after 15 to 18 September.

The duration of the period of vegetation in the Romanian varieties ranged between 180 days (Sarmis) up to 196 days (Velnita), and in foreign varieties with lateral fruit-making, between 172 days (Fernette) and 183 days (Fernor, Payne).

The walnut is a monoecious plant with female and male flowers blossoming differently in time for the same variety.

The beginning of blossoms in female flowers (5 years) occurred between 15 April (Valmit and Serr) and 7 May (Fernor). The blossom period for female flowers may be extended until the second decade of May (Fernor).

The beginning of blossom in male flowers occurred between 16 April (Muscelean) and 10 May (Fernor). In the Franquette variety, the blooming of blossoms occurred on 21 May.

The blooming period of the varieties studied lasted between 6 to 12 days in female flowers (stigma receptive) and between 15 to 30 days in blossoms.

All the varieties with terminal fruit-making as well as those with lateral fruit-making have blossomed in the under-Carpathian area of Oltenia in decades II and III of April and I and II of May, and they have not been affected by rime in the five years of study.

The period of maturity of fruits was between 1 September (Franquette, Valrex and Orastie) and 30 September (Germisara, Muscelean, Velnita etc).

In the varieties of a walnut, the phenomenon of dichogamy occurs (the inconsistency between the blooming of female and male flowers) and, for this reason, the 29 studied varieties are divided as follows:

-20 varieties are protandrous (Valcor, Valrex, Franquette, Ferjean, Hartley, Vina, etc.);
-9 varieties are protogine (Idaho, Sarmis, Jupâneşti, Argeşean, Germisara, Velnița, etc.).

The climatic conditions in the area of Valcea are favorable for the development of the dichogamy phenomenon (compared to other areas in various countries).

The behavior of walnut varieties in the fruit-making process

The varieties of a walnut studied for the under-Carpathian area of Oltenia behave differently in the fruit-making process owing to the different genetic origin, to the geographical origin, to the type of fruit-making, to the environment conditions and to the cultivation technology.

The 29 varieties have been divided into two distinct groups as regards the fruit-making type:

- 19 varieties have terminal buds and originate in Romania (12), USA (4), Germany (1), France (1) and Bulgaria (1).

Among these, the Germisara variety has a low percentage and lateral buds.

- 10 varieties have lateral buds and originate in USA (6) and France (4).

The Hartley variety may also be classified into the category of mixed buds.

The production of fruits and the occurrence of buds depends on the preparation of the propagating material. In walnut trees obtained from seeds (on their own roots) the economic fruit-making is initiated in 9 to 11 years, and in those grafted, it is initiated every 4 to 5 years from the plantation. The correlation between the variables is given by the regression equation $y = 2.5 x – 4.41$ and $r = 0.54$.

The fruit-making of the varieties of walnut trees is initiated differently. In Romanian varieties as well as in foreign ones with terminal buds, the first fruits are produced in the year III, even IV. Economic productions of over 500 kg/ha are obtained with the fifth year from the plantation.

The most reduced quantities of fruits are produced in the fifth year in the varieties of Sarmis, Argeşean, Idaho, Howe, Uzlop and Orăştie (below 1.0 kg/tree).

Varieties with lateral buds are earlier in their fruit-making because all the 10 varieties yield economic outputs from the forth year following the plantation (153 to 500 kg/ha).

The varieties of the walnut tree studied have achieved yields of fruits at the age of 11 to 15 years (5 years of study), differently from one variety to the other but in a dynamic way.

The largest average productions of fruits (5 years) were recorded in the varieties of: Ferjean (2.4 t/ha), Vina (2.26 t/ha), Hartley (2.24 t/ha), Lara (1.88 t/ha), Fernor (1.94 t/ha), Valcor (1.86 t/ha), Fernette (1.84 t/ha), Jupâneşti (1.82 t/ha), etc.

The production of walnuts has constantly increased starting with the fourth year from the plantation until the 15^{th} year in varieties with lateral buds in a rate of 147 kilos/ha/year and in those with terminal buds, in a rate of 116 kilos/ha/year.

In most of the varieties studied, the largest productions of fruits occurred in the 15^{th} year from the plantation as follows: Vina (3.50 t/ha), Hartley (3.30 t/ha), Ferjean (3.0 t/ha), Fernor and Tehama (2.70 t/ha), Valcor (2.30 t/ha), Valmit, Jupâneşti and Muscelean (2.20 t/ha), etc.

Starting with the years 11 to 12 from the plantation, it was found that the varieties with lateral buds constantly exceed the production of varieties with terminal buds, this phenomenon being more enhanced in the following years. This phenomenon was possible owing to the specific genetic fruit-making nature as well as to the fact that no absolute minimum temperatures occurred except for down to -22.7 C^o and they have not affected the fruit buds.

The production of walnuts depends on the volume of crowns, which was also revealed from the regression equation y = 0.039x + 2.8 and the correlation coefficient r = 0.986xxx.

The analysis on the production of fruits in the varieties of walnut trees cultivated in the North Oltenia outlined that the genotype (the variety) accounts for 54.1% of the total production, the environment for 8.9%, the interaction between the genotype and the environment for 23.2% and other factors (error) account for 13.8%.

The genotype is the major production factor followed by the interaction between the genotype and the environment.

Biometric characteristics of fruits

The varieties of walnut trees with lateral buds have a size index of fruits ranging between 31.6 mm (Howe) and 43.8 mm (Germisara and Orastie), and those with lateral fruit-making between 34.9 mm (Tehama) and 39.9 mm (Lara). The fruits in all the varieties studied comply with the international quality requirements because they are included in the category of large and average walnut trees.

The uniformity of fruits is given by the variability coefficient (s%) determined by the size index. It ranges between 16.5% (Valcor) and 28% (Geisenheim - 139). Variability coefficients of an average value (average uniformity) were obtained in: Valcor, Sarmis, Adams 10, Valmit, Fernor, Fernette, Vina, etc.

In conditions of persistent drought (June to August), the fruits in the Jupanesti variety goes through negative changes as regards the shape (they tend to be longer, and the stylar point becomes prominent and sharp, the fruits are smaller). This is a phenomenon given by the regression equation y = 0.0067x + 9.13 and the correlation coefficient
r = 0.833.

The main commercial element in walnut fruits is their size which is given by the equatorial diameter. The extra category with very large fruits (> 32 mm) includes fruits belonging to the following varieties: Valrex (84.5%), Sibişel 44 (84.2%), Valcor (82%), Germisara (81.7%), Franquette (81.7%) etc.

The least fruits in this category belong to the varieties of: Jupâneşti (59.8%) and Howe (39.3%).

The average weight of walnuts with shell in the 29 varieties ranged between 9.9 g (Howe) and 15.5 g (Adams - 10). The international commercial standards accept walnuts with the weight of 10 to 16 g, the varieties studied being included in these limits.

The largest average weight of walnuts of over 15 g was recorded in the varieties of Adams – 10, Chase – D9, Sibisel 44, Sarmis and Germisara, and the smallest weights were recorded in Howe (9.9g) and Fernor (10.9g).

The yield in the kernel ranged between 46.2% (Geisenheim - 139) and 53.0% (Serr and Howe). The most valuable varieties are considered those with a yield in the kernel of over 50% (Valmit, Valrex, Valcor, Jupâneşti, Velnița, Howe, Ferjean, Lara and Serr).

In order to obtain a kilo of kernel, it is required to have between 1.887 kg of walnuts in a shell (Howe and Serr) and 2.165 kg (Geisenheim - 139).

The thickness of the shell ranges between 0.9 mm (Payne) and 1.7 mm (Adams - 10). All the varieties studied have a thin shell (0.9 to 1.5 mm) except for the varieties of Adam – 10 and Muscelean, which have an average thickness of the shell (1.5 to 2.0 mm). Varieties with a thick shell (2.0 to 2.5 mm) or very thin shell have not been found.

The joint of the valves in walnuts is weak in 7 varieties (Valcor, Jupâneşti, Valrex, Vina, etc), intermediate in 16 varieties (Muscelean, Orăştie, Sarmis, Hartley, Tehama, Lara, etc) and strong in 6 varieties (Franquette, Ferjean, etc).

In all the varieties, the shell breaks easily but the kernel is easily removable in only 22 varieties (Valcor, Jupâneşti, Geoagiu 65, Franquette, Hartley, Vina, etc), and in 7 varieties, the kernel is moderately removable (Argeşean, Velnița, Serr, Fernor, etc).

The colour of the walnut kernel's peel is important for the marketing of walnuts and of the kernel. It depends on the genotype, the environment conditions and the harvesting period. In optimum conditions, a number of 13 varieties had light yellow kernel, 15 varieties had a dark yellow kernel, and one variety had a brown to dark brown kernel (Idaho), complying with the commercial standards.

Behavior of walnut varieties to the attacks of some diseases

In the under-Carpathian area of Oltenia, the most important diseases with an economic effect in the varieties of a walnut are: *Xanthomonas campestris pv. juglandis* (walnut bacteriosis) and *Gnomonia leptostyla* (bean spot disease).

The walnut bacteriosis occurred on leaves, branches and fruits, in particular. The most significant damage was caused to fruits and it ranged between 3.2% (Valrex) and 14.1% (Vina).

The varieties with terminal fruit-making were attacked less by the bacteriosis (3.2% in Valrex, 6.7% in Idaho), whereas in varieties with lateral fruit-making, the attack ranged between 8.5% (Ferjean) and 14.1% (Vina).

The average production of fruits was negatively influenced by the attack of the bacteriosis, the nuts not being marketable.

Quantitatively, the production was reduced by the bacteriosis by 50 kg/ha (Valrex) up to 257 kg/ha (Pedro). The biggest production losses occurred in Vina (275 kg/ha), Pedro (257 kg/ha), Ferjean (221 kg/ha), Hartley (162 kg/ha), etc.

The attack of the bacteriosis on the leaves (0.1% to 2.0%) and on the cuttings (0.1% to 0.6%) in the first 15 years from the plantation was reduced and did not cause economic damage.

The walnut antracnosis occurs in all the varieties and is seen on leaves (2.6% - Valcor, Jupâneşti and 3.9% - Ferjean and Payne) and on leaves (4.7% -Valmit to 9.7%-Tehama).

The economic damage caused by the antracnosis is more reduced economically than the damage caused by the bacteriosis, but it sometimes may become significant by the loss of a large part of the foliar system.

The establishment of a valuable type of walnut for the northern area of Oltenia

The northern area of Oltenia with a high degree of ecological availability, historical tradition in the culture of walnut is lacking a valuable type of varieties for cultures with increased yield and commercial value at international standards.

The choice of the varieties of a walnut for the type is based on biological and agronomic criteria, and the culture technologies and the production destination on the basis of a strict score (28 to 100 points).

The highest scores were given to the varieties: Valcor (93 points), Franquette (90 points), Ferjean (89 points), Lara and Velnița (88 points), Vina, Jupâneşti and Valrex (86 points) and Sibişel 44, Valmit and Germisara (85 points).

The weather conditions of an area or micro-areas of culture are also included with the score given in order to make the choice of the most valuable varieties.

The varieties with lateral fruit-making are weakly resistant to minimum absolute temperatures of –22˚C and -25˚C and in addition, they are sensitive to the attack of the bacteriosis and antracnosis, this is why they are only recommended for areas which do not create difficulties of resistance to frost and diseases.

Under the conditions of SCDP Valcea, throughout the 15-year period, no very low temperatures have been recorded (-22.7˚C) and the behavior of the varieties with lateral fruit-making was good.

The analysis and the evaluation of the varieties of a walnut on the basis of the criteria established and of the weather conditions in the area allowed us to identify a variety comprising:

- varieties with terminal fruit-making: Valcor, Franquette, Velnița, Jupâneşti, Valmit and Germisara;

- varieties with mixed and lateral fruit-making: Hartley, Vina, Ferjean and Lara.

Recommendations

Scientific:

- to continue the research on the evaluation of several Romanian and foreign varieties in different areas and micro-areas of culture of the walnut tree.

- to identify, evaluate and select the most valuable genotypes of walnut tree existing in various areas of the country with the purpose of their introduction into the culture.

- to correlate the favorable ecological factors with higher production yields and better quality of fruits in the varieties of walnut tree in an intensive culture.

Productive:

- to promote the varieties of a walnut tree in the intensive culture in the northern area of Oltenia:

With terminal fruit-making:

-Valcor – 20%, Franquette – 10%, Jupâneşti – 20%, Valmit – 10%,

Germisara – 10%

With lateral fruit-making:

-Hartley – 3%, Vina – 4%, Ferjean – 4%, Lara – 4%

- to establish intensive walnut tree cultures with propagating material of 2 years grafted on J. regia, which ensures the economic fruit-making in 4 to 5 years from the plantation.

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