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Domain: Horticulture
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Eng. FLORIN CĂPRARU

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PhD Manager,
PhD, Prof. GICĂ GRĂDINARIU

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SUMMARY

Apple is the main fruit growing specie of temperate zone. This species found in Romania, favourable climatic conditions for cultivation, with enshrined fruit growing regions and ancient cultivation traditions, one of them being Bistrita-Nasaud Fruit Growing Region.

Even if the cultivated area has suffered significant reductions while average production is far from expressing the biological potential of grown varieties, with all efforts of scientific research and the vast majority of growers, however, the apples in this area have a specific colour and flavour, the fruits are characterized by a balance between sugar content and acidity, which gave them a good reputation both at home and abroad.

To ensure the real agro-productive potential of recommended assortment for super intensive plantations is needed eco physiologic foundation and also are important biological and technological implications that contributes to ecosystem productivity.

Researches were conducted during 2005-2008, at Bistrita Research and Development Station for Fruit Growing Production. The overall objective was the study of agro productivity of "Auriu de Bistrita", "Generos" and "Florina" apple varieties grafted onto medium and weak vigour rootstocks, the influence of planting density, trees crown system and irrigation system in a poly factorial experimental module and interactions of these factors. Also there were studied the specific and cumulative effects on varieties parameters of growth and fructification in the context of soil and climate concerned area and the assessment of the proposed model economical implications, compared with current technology used at Bistrita Research and Development Station for Fruit Production.

In this respect, there were discussed technological sequences that conduct to a more intensive cultivation protocol as increasing culture density by planting more than 1250 trees/ha, the higher use of natural light and increasing fruit quality by choosing "V" Güttingen and slender spindle crown shapes. As a novelty in fruit growing sector from Bistrita was implemented the drip irrigation system, given the fact that water is one of the main component of agro productive potential and because of the inconsistent and uneven distribution of rainfall phenomenon, especially in the vegetation periods with high consumption of water.

For a better understanding of the experimental factors interaction effects and climatic conditions implication on varieties agro productivity and to reach the general objective, there were pursued the following specific objectives:

- study of hydro physics particularities and determination of soil momentary humidity;
- study of experimental varieties growth and fructification phases and climatic factors influence on these phases initiation and development;
- studying the genotype - culture system relationship and establishment of phytometrics indicators of tree and structure of the plantation;
- study of growth and fructification main indicators by variety and used technological sequences and the existent correlations indicating the association or relational degree between these indicators, ensuring a dynamic balance of the two processes and a rational exploitation of trees productivity potential;
- agro biological argumentation of proposed fruit growing plantation structure, by integrating positive benefits and reducing disadvantages concerning the influence of technological sequences on growth and fructification parameters of the studied varieties, in the climatic and soil conditions from Bistrita region;
- plantation economical argumentation calculated based on actual technology costs, yields and prices for fruit revaluation.

Chapter I contain information on the importance of apple culture and the situation of culture development in the world and in our country. Thus, in 2007, worldwide area cultivated with apple is 4 921 117 ha, registering a significant decline of 21%, compared to 1997. Apple worldwide production of during 2004-2008 varied between 62-64 million tonnes, leading China with 36% of global production.

In Romania, after 1990, the fruit growing sector suffered from a sharp decline, especially during 1995-2007 when fruit orchards and nurseries occupied areas decreased from 277 thousand to 206 thousand hectares. Also, areas planted with apple fell from 85.6 thousand hectares to 59 thousand hectares during the same period. Average production is within the limits of 7 - 10 tones/ha with the peak achieved in 2004 of 15 tones/ha. In Bistrita-Nasaud, fruit growing had over 16 000 hectares under cultivation before 1990 of which is still producing about 2950 hectares.

Chapter II is a summary of the current state of research in the country and abroad on apple varieties agro productivity issues, with emphases on varieties general characteristics, productivity and quality and also the factors affecting these characteristics.

In Chapter III are presented the environmental conditions where the research were conducted, observing that the studied area, with the annual average temperature of 9.2^{o}C and 775 mm rainfall distributed in 142 days, is favorable for apple cultivation. The experiment was

located in the upper part of the slope with southern exposition on brown argil-iluvial soil with a humus content of 2.5%, 30% clay, medium supplied with nutrients and a 6 - 6.5 pH.

In Chapter IV are described, the biological material that was used, the organization of experience, research methods, presenting the observations, calculations, measurements and tests performed and also statistical-mathematical methods of results interpretation.

As biological materials were used "*Auriu de Bistrița"* variety grafted on M9 rootstock, "*Florina*" and "*Generos*" varieties grafted on M26 rootstock. Technological sequences included planting density with two variations: 2500 trees/ha (4 x 1 m) and 1666 trees/ha (4x1, 5 m); trees crown shape with two variations: slender spindle and V Güttingen; respectively the irrigation system alternating irrigated with un irrigated variants. Have resulted a poly factorial experience with 24 variants, each variant with three repetitions and three trees in the plot repetition so that the observations were aimed 216 trees.

To achieve its goals and to obtain objective scientific results on apple varieties agro productivity, there were made observations and measurements on growth and fructification phenology, there were studied parameters related to tree growth vigor and issues concerning fructification processes.

Biometric measurements refer to: trunk diameter, width, tree crown thickness and height, the length of multi annual and annual growth branches in the trees crown, leaf size, average distance between shoots internodes, average fruit weight, fruit size and firmness etc. These measurements helped to set certain biometric reports, determining the trunk cross section area and trees leaves surface.

Observations on the quantitative and qualitative expressions of growth and fructification processes have resulted in number of flower bud from total buds that were analyzed, the number of flowers, the number of remained fruits after the physiological fall (in June) and before harvesting, the fruit colour.

Analysis undertaken followed: biochemical analysis of fruits dry weight; total glucides content; titrated acidity and vitamin C, both in irrigated and unirrigated variants; soil momentary humidity determined by gravimetric method, and soil hydro-physics indicators.

Based on the relations between growth and fructification, between production and unit area there were calculated the following indicators:

- productivity index (kg/cm^2);
- productivity correlated with the nutrition area (kg /m^2);
- productivity correlated with crown projection area (kg /m^2);
- productivity correlated with leaf area unit (kg /m^2);
- productivity correlated with crown volume unit (kg /m^3);

- flower buds number correlated with trunk cross section unit (pcs/cm^2);
- fruits number correlated with trunk cross section unit (pcs/cm^2 S.S.T.);
- fruits number correlated with leaf area unit (pcs/m^2);
- fruits number correlated with crown volume unit (pcs/m^3).

Economic argumentation of the results was seen as a summary of costs, revenue and profitability of producing apples, based on experimental technological factors, which ultimately was compared with standard culture technology used to SCDP Bistrita.

For *statistical interpretation* of the results was used analysis of variance (DL test) and Duncan test (Savulescu N., 1967; Cepoiu N., 1968). Quantitative value that describes the relationship between different parameters of growth and fructification was established by determining the correlation coefficient "r" and the determinative factor "R2" (Saulescu NA, 1967).

In Chapter V are presented the research carried out to achieve objectives and the results that were obtained.

Concerning the objective of studying soil hydro-physics particularities, determination of hydro-physics indicators have specific values for clay texture in 0-20 cm horizon and for clay-argil texture in 20-60 cm horizon, which gives an average capacity of soil retention for water in the middle of root system active area. However, the samples for soil momentary humidity determination highlighted in two cases the limit values of fading coefficient and other cases with values below the minimum limit. These cases demonstrate the rainfall uneven distribution and even their failure at certain times of the growing season, even if the amount of rainfall exceeded the annual average in experimental years, which confirms the need to implement the irrigation system.

The start and the conduct of growth and fructification stages were mainly influenced by genotypic factor and temperature and less by the applied technology. The threshold for thermally stable climatic conditions from Bistrita installs usually within 19 – 25^{th} of March. Dates for early completion of growth and fructification stages succeed every 2-4 days between varieties, starting with “Generos” variety, followed by “Florina” and “Auriu de Bistrita”. In these circumstances also the sum of global and active temperatures from the installation of stable thermic level to blooming stage has close values between varieties, in exchange, differences arising on the sum active temperatures from flowering to harvest registering an average of 2336^oC at “Auriu de Bistrita” variety, 2486^oC at “Generos” and 2637^oC at “Florina” variety.

Trees growing particularities were aimed to trees vigor, phyto-metric characteristics, the growth of annual and multiannual branches in the trees crown, leaf surface dynamics.

Trunk dimensions expressed by cross-section area and annual growth increase confirms high vigour of “Auriu de Bistrita” variety in any experimental technological factors. The experimental average in year 8 after planting of this variety is 58.67 cm with an annual increase

of 8.3 cm, while “Generos” variety registered 40.83 cm cross-section area with an annual growth increase of 5.84 cm. With a density of 1666 trees/ha, the average of annual growth rate in diameter is higher by 3.5%.

Trees crown constructive dimensions place “Auriu de Bistrita” variety within the group of high vigour, large vigour “Florina” variety, while “Generous” variety vigour can be considered medium-low.

The ratio between the length of permanent and semi permanent ramification at the mature stage of trees is 1:3.74 at “Florina” variety, 1:2.89 at “Generos” variety and 1:2.44 at “Auriu de Bistrita” variety.

The average sum of multi-annual growths ranged from 3336-4514 cm at “Auriu de Bistrita” variety, 3523-4684 at “Florina” variety and 2855-4456 cm at “Generos” variety, higher values being irrigated with a density 1666 trees/ha, led as slender spindle.

Trees leaf area is significantly influenced by increased planting distances and water supplementation by irrigation. The results show a higher leaf area at “ Auriu de Bistrita” (8.22 m^2) and “Florina” variety (8.15 m^2), compared with the “Generos” variety (7.10 m^2).

Results on varieties fructification particularities have made reference to fruit bud differentiation, number of fruit per tree, average fruit weight and fruit production analyzed both quantitatively and in terms of its quality, using fruits biometric determination and the commercial potential.

Also, there were calculated the biennale bearing index, trees productivity reported at nutrition area and crown projection area.

“Florina” and “Generos” varieties differentiate an average number of 200 fruit buds/tree, the values are relatively constant from one year to another and distinct significant from the experimental average, while “Auriu de Bistrita” variety differentiate an average of 130 fruit buds/tree.

The variety character significantly influences also the number of harvested fruit. “Generos” and “Florina” varieties generated a large number of fruit per tree regardless the adopted technological solution, remarking constant fructification at “Florina” variety.

Average fruit weight is between 160-170 g at the “Auriu de Bistrita” and has close values with small variations in the range 140-150 g at “Florina” and “Generos” varieties. Although, variants with 1666 trees/ha density and irrigation system have provided statistically significant differences, the values obtained are higher by only 3.3% in 2500 trees/ha density, respectively 4.5% compared with non-irrigated variant.

Production levels obtained in years V-VIII after planting, have been fluctuating but suggestive in the respect of varieties productivity where, like other fructification parameters, “Auriu de Bistrita” variety, with one exception (year VI), showed a relatively low specific productivity, with an annual average of 15.9 kg/tree, representing 74% of the average production

obtained by “Generos” variety (21.5 kg/tree) or 72.3% of the production obtained by “Florina” variety (22 kg/tree). Biennale bearing index is reduced at “Florina” variety (10%), compared with the other two studied varieties, in which the average of this indicator is 30%.

In terms of quality, fruit weight of Ist and Extra quality in experimental variants is very high and close between varieties reaching 85.5% at “Auriu de Bistrita”, 74.8% at “Florina” and 78.6% at “Generos” variety. The values of fruits biometric parameters “Florina” and “Generos” varieties increased with 5.2-10.2% at 1666 trees/ha density and in irrigation conditions with 7.6-11.4%, higher values represented by “Generos” variety. Percentage of totally colored fruits is superior for V Güttingen system comparing with slender spindle, with an average of 5.6% in “Auriu de Bistrita” variety and 8.5% in “Florina” variety.

Based on quantitative indicators reflecting the relationship between fructification and growth processes, it was found that the highest values belong to “Generos” variety. This variety has been obtained average values of 0.66 kg fruits/cm^2 SST, 2.96 kg fruits/m^2 leaf area, 6.44 kg fruits/m^3 crown volume. At the opposite side it’s “Auriu de Bistrita” variety with average values of 0.36 kg fruits/cm^2 SST, 1.92 kg fruits/m^2 leaf area and 2.64 kg fruits/m^3 crown volume.

The results obtained on the basis of correlations between growth and fructification processes, show that fruit production was directly correlated, positively and distinct significantly with leaf area and crown volume; indirect and very significantly with an increased trunk cross section area. Number of fruit per tree and crown volume was directly correlated, but significantly only in “Florina” variety with a technical maximum of 166 fruits to a crown volume of 5.8 m^3.

There is a direct correlation between crown volume and production, significant in variants led as slender spindle and distinct significant at “Auriu de Bistrita” variety combinations with appropriate technical peak production of 19.2 kg/tree and a crown volume of 6.85 m^3.

Results on economic efficiency of apples production in the experimental technologic model compared with current technology used in SCDP Bistrita, showed that the production high valuation in conjunction with average productions per unit area, led to obtaining a positive financial result in a benefit of 8357 lei/ha in the variants with 1666 trees/ha, respectively 13370 lei/ha with 2500 trees/ha, higher than that achieved by comparative technology (1250 trees/ha), with 5032 lei/ha in the first density variant and 10145 lei/ha in the second variant.

The most economically efficient variety is “Florina”, followed by “Generos” and “Auriu de Bistrita” varieties and the most efficient experimental variant, based on average economic performance is the combination "Florina – 2500 trees/ha – V Güttingen – irrigation”.

In the last part of the thesis are presented the general conclusions and recommendations, which in summary, recommend the expansion of high-density plantations in the environmental

conditions of Bistrita-Nasaud Fruit Growing Region, reconsidering the culture technologies within the meaning of optimal allocation of production factors determining plantations efficiency.