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FACULTY OF HORTICULTURE

DOCTORAL SCHOOL: *PLANT AND ANIMAL RESOURCE ENGINEERING*

DOMAIN HORTICULTURE

**RESEARCHES ABOUT THE RESPONSE OF SOME APPLE VARIETIES TO  
DIFFERENT MODELS OF CROWN IN SUPERINTENSIVE PLANTATIONS**

**(Summary of Doctoral Thesis)**

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## **Summary**

The apple tree is one of the oldest, most common and important fruit plants worldwide.

Cuts for the formation of crown represent a particularly important phase, as by this operation, the trees are helped to develop new branches, to enter more quickly in fruition stage, and implicitly to obtain profitable productions from economic point of view, and of superior quality.

In its own researches, in the conditions existing at the University of Craiova SCDP Valcea, proposed the creation of different models of crown architecture in super-intensive plantations, depending on the ecological conditions of the culture area and on the assortments from our country, in order to obtain high, constant productions, of superior quality and with a high economic efficiency.

## **Objectives of own researches**

The specific objectives of the paper refer to:

- Establishing models for the formation of the crown structure according to the variety and the dynamics of the formation of structural elements;
- Behaviour of apple tree varieties depending on the type of crown, in the process of growth and fructification;
- Determining the fructification potential and fruit quality at the maximum and economically efficient level, depending on the crown type;
- Establishing the physiological parameters at the level of leafs and type of crown;
- Parameter setting for architectural models and establishing the optimal types of crown for apple tree in the sub-Carpathian area of Oltenia;
- Influence of crown type on the economic efficiency of super-intensive culture of apple tree

## **Biologic material**

The researches were carried out at the University of Craiova -SCDP Vâlcea in the period 2002-2015.

The biologic material used consisted in trees field II, under the form of lace, grafted on rootstock M<sub>9</sub>. Planting was done at a distance of 3.5/1.5m (1904 plants/ha).

The experience set up in the spring of the year 2002 is poly-factorial, type 2x8 (variety, crown forms) with four repetitions, each elementary parcel including 6 trees.

The crown forms proposed in the doctoral thesis were based on certain parameters of growth, fructification and physiological parameters found also at some architectural models promoted in the previous years. Beside the crown forms known and used at world level (Ax Vertical, Solen, Fus Fougères, Tessa and Tatura Trellis) some original forms were used too (Vâlcea 1, Cruce dublă 1, Cruce dublă 2).

Observations and biometrical measurements were carried out on the plants studied, regarding:

- a) The modality of plants growth according to the variety and form of crown;
- b) Establishing the capacity of production in Kg/tree and t/ha, for each variety, according to the type of crown;
- c) Characteristics of fruits according to the variety and form of crown;
- d) Establishing some physiological parameters at the level of leaves, at apple tree varieties, according to the form of crown;
- e) Analysis of economic efficiency of crown forms used in the super-intensive culture of apple tree.

### **Own results from research**

#### **a. Regarding the growth mode of plants according to the variety and form of crown**

The characterization of plants growth was made according to the variety and form of crown, taking into account: the trunk section area, the plants height, the crown diameter, the crown volume, the sum of annual growths etc. until the age of 14 years, depending on the type of crown.

The trunk section area (after 14 years) was on average of 89.35 cm<sup>2</sup> at 'Florina' and 78.65 cm<sup>2</sup> at 'Idared'. This growth element was influenced by the form of crown. In the case of 'Florina' variety, TSA oscillated between 78.8 cm (Tessa) and 99.1 cm (Tatura Trellis). At 'Idared' variety, TSA was comprised between 64.64 cm<sup>2</sup> (Tessa) and 90.1 cm<sup>2</sup> (Tatura Trellis)

The average height of plants was 3.2 m at 'Florina' and 3.03 m at 'Idared'. Depending on the type of crown, the height oscillated between 2.70 m (Tatura Trellis) and 3.67 m (Ax Vertical), at 'Florina' variety and 2.80 m (Tatura Trellis) and 3.40 m (Vâlcea 1), at 'Idared'.

The average diameter of crowns, at the end of the vegetation period was comprised between limits of 2.15 m (Ax vertical) and 2.65 m (Tatura Trellis), at 'Florina' and 2.18 m (Tessa) at 2.52 m (Cruce Dublă 1), at 'Idared'.

The crown volume is comprised between 11.45 m<sup>3</sup> (Tessa) and 14.14 m<sup>3</sup> (Cruce Dublă 2), at 'Idared' and between 13.11 m<sup>3</sup> (Tessa) and 16.56 m<sup>3</sup> (Cruce Dublă 1), at 'Florina'.

The plant growth vigour revealed that varieties are classified at reduced vigour, under 10 points ('Florina' – 6.0 points, 'Idared' 5.6 points).

**b. Regarding the production capacity of apple tree varieties according to the form of crown.**

Apple production was recorded in an interval of 12 years (2004-2015), i.e. between year III and XIV from planting.

At 'Florina' variety, average fruit production (12 years) was 33.7 t/ha, and at 'Idared' variety of 30.9 t/ha.

Fruit production was influenced also by the forms of crown. At 'Florina' variety, the greatest productions of fruits were obtained at Solen form of crown (37.4 t/ha), Ax Vertical (36.0t/ha) and Tatura Trellis (35.0 t/ha), and at 'Idared' variety the largest productions were obtained by crowns: Solen (34.1 t/ha), Tatura Trellis (32.3 t/ha) and Ax Vertical (31.6 t/ha).

The productivity index, after 12 years of fruitification and growth of TSA is comprised between 0.17 kg/cm<sup>2</sup> (Cruce Dublă 1) and 0.22 kg/cm<sup>2</sup> (Solen), at 'Florina' and 0.17 kg/cm<sup>2</sup> (Cruce Dublă 1) and 0.25 kg/cm<sup>2</sup> (Solen), at 'Idared'.

**c. Regarding fruits characteristics**

'Florina' and 'Idared' apple tree varieties, in super-intensive culture from Northern are of Oltenia, produced fruits of superior quality, being influenced by the form of crown and by the genotype.

'Florina' variety obtained, on average, fruits with an index of size (IS) of 71.7 mm and weight of 182 g, and 'Idared' variety, fruits with IS of 74.7 mm and average weights of 193.8 g.

The forms of crown at 'Florina' variety, produced fruits with an IS = 69.87 mm (Cruce Dublă 1) and up to 74.6 mm (Tatura Trellis ) and weight of 169 g (Cruce Dublă 1) and up to 203 g (Tatura Trellis)

At 'Idared' variety, the forms of crown produced fruits with an IS=72,7 mm (Cruce Dublă 2) and up to 76.2 mm (Tatura Trellis) and weight of 170 g (Cruce Dublă 2), and up to 208 g (Tatura Trellis)

The average size and weight of fruits classifies them as extra with an over 70 mm equatorial diameter, and the most valuable forms of crowns proved to be Tatura Trellis, Solen and Ax vertical.

**d. Regarding some physiological parameters at the level of apple leafs, according to the form of crown.**

*1) Intensity of light in the tree crowns*

The intensity of light was measured by Lux meter (PU-150). At 'Florina' variety it was 1012.8 lx, and at 'Idared' variety of 1059.8 lx, the difference between these varieties being reduced.

The forms of crown influence the intensity of light. The most powerful intensity of light is found at Solen (1187.8 lx), Vâlcea 1 (1112.4 lx), Tatura Trellis (1109.2 lx) and Tessa (1109.6 lx), and the most reduced intensities at Ax vertical (938.0 lx), Cruce Dublă 1 (951.6 lx) and Cruce Dublă 2 (971.8 lx).

*2) Intensity and rate of photosynthesis*

Intensity of photosynthesis and rate of photosynthesis recorded in the super-intensive plantation of apple tree in Northern Oltenia proved to be different among the varieties, the forms of crown and the day hour moments of recording.

The crown influences the intensity of photosynthesis, this being comprised between 509.0  $\mu\text{mol}/\text{m}^2/\text{s}$  (Fus Fougères) and 944.3  $\mu\text{mol}/\text{m}^2/\text{s}$  (Cruce Dublă 1), at 'Florina' variety and 586.0  $\mu\text{mol}/\text{m}^2/\text{s}$  (Vâlcea 1) and 933.7  $\mu\text{mol}/\text{m}^2/\text{s}$  (Tatura Trellis).

The value of photosynthesis rate proved to be different depending on the forms of crown at the two varieties ('Florina' and 'Idared'), oscillating between 9.0-8.5  $\mu\text{mol}/\text{m}^2/\text{s}$  (Ax vertical) and 11.7-14.7  $\mu\text{mol}/\text{m}^2/\text{s}$  (Tatura Trellis).

The changes proposed at the level of photosynthesis intensity and photosynthesis rate, at recording hours (10, 13 and 16) are in direct correlation to the exterior temperature of leafs, their age and the atmospheric pressure.

*3) Rate of transpiration*

The forms of crown influence the transpiration rate in reduced limits: at 'Florina' variety, between 4.2  $\mu\text{mol}/\text{m}^2/\text{s}$  (Tessa) and 7.1  $\mu\text{mol}/\text{m}^2/\text{s}$  (Cruce Dubla 1), while at 'Idared' variety between 5.2  $\mu\text{mol}/\text{m}^2/\text{s}$  (Tessa) and 6.6  $\mu\text{mol}/\text{m}^2/\text{s}$  (Vâlcea 1).

*4) Stomatal conductivity*

Stomatal conductivity of CO<sub>2</sub> proved to have very small values at the two varieties (0.4 μmol/m<sup>2</sup>/s), but also between the forms of crown (0.3-0.5 μmol/m<sup>2</sup>/s).

Stomatal conductivity remained constant at the recording hours (10, 13, 16), for all forms of crown (0.1 – 0.6 μmol/m<sup>2</sup>/s).

#### *5) Chlorophyll contents of leafs*

The forms of crown, at 'Florina', revealed a chlorophyll contents of 47.1 mg (Fus Fougères), at 52.3 mg (Solen), and at 'Idared' variety of 50.8 mg (Fus Fougères), at 53.7 mg (Tatura Trellis).

### **e. Regarding the influence of crown type on the economic efficiency of super-intensive culture of apple trees**

Apple varieties 'Florina' and 'Idared' grafted on M<sub>9</sub> at a density of 1904 trees/ha generate expenses and revenues, both depending on the variety and on the form of crown used.

The types of crown influence the expenses with cutting since the very first years. During the first 3 years from forming at 'Florina' variety oscillated between 1,350.5 lei/ha (Vâlcea 1) and 1,990 lei/ha (Cruce Dublă 2), and at 'Idared' were comprised between 1,490.0 lei/ha (Vâlcea 1) and 1,898.5 lei/ha (Cruce Dublă 1). After years 3-4 from planting, the dominant ones are fruitification cuttings.

Throughout the 12 years of fruitification cuttings, expenses reached 23,250 lei/ha (Fus Fougères) up to 24,950 lei/ha (Solen), in the case of 'Florina' variety, and in the case of 'Idared' variety they reached 22,831 lei/ha (Fus Fougères) and 24,460 lei/ha (Cruce Dublă 2).

Depending on the production of fruits, the quality and most reduced expenses the following forms of crown remarked themselves as superior behaviour: Solen, Ax Vertical and Tatura Trellis.

### **Conclusions**

Data obtained by the present study identify the most valuable types of crown adequate to varieties 'Florina' and 'Idared' in super-intensive cultures.

Out of the 8 forms of crowns, Ax vertical, Solen and Tatura Trellis are valuable and can be used in the apple culture in our country.

The forms of crown Vâlcea 1, Cruce Dublă 1 and 2, Tessa and Fus Fougères can be used in plantations of small dimensions with a real success for high productivity and easy achievement.