SUMMARY

Research on the impact of drip irrigation on the soil and on certain morpho-productive characteristics, carried out on apple and apricot varieties, under the specific conditions of southeastern Romania

Key words: drip irrigation, foliar fertilization, experimental factors, soil, type, statistical differences, productive efficiency

Research was carried out at the Belciugatele Teaching Farm, i.e. the Moara Domnească farm, during 2011-2012. What is characteristic for the Ilfov area is the thermal potential, compared to the hydric one, i.e. the water deriving from the rainfall. This proves to be the restrictive factor, with a negative outcome on the productivity of the agricultural crop. The moderate-dry climate is representative for the agricultural practices performed in this area, which accounts for the implementation of certain modern fruit-growing systems, i.e. a localised drip irrigation system and additional foliar fertilization, with the saving of energy and water as one of the outcomes.

Research was carried out following these objectives:

1. The influence of the experimental factor, i.e. the irrigation regime, on the physical and chemical properties of the soil, and the apple and apricot varieties;
2. The influence of the implementation of the drip-watering irrigation system and the foliar fertilization on the force of growth and productivity of the apple and apricot varieties;
3. The influence of the implementation of the drip-watering irrigation system and the foliar fertilization on fruit quality, with respect to the studied species;
4. The poductive efficiency of the two crops under consideration;
5. The establishment of interactive relations between the studied indicators.
6. Production-related recommendations for the implementation of the drip-watering irrigation system and the foliar fertilization on the apple and apricot varieties grown at Moara Domneasca.

The thesis is divided into 12 chapters, and comprises 28 tables and 134 graphs, with a total number of 112 bibliographical references.

Chapter I presents the concerns regarding the environment and sustainable development, with reference to natural resources: soil, water, climate, biodiversity. Another issue discussed is soil degradation and expansion, both in Romania and worldwide.

Chapter II provides a brief detail of the importance of irrigation on a qualitative and strong, lasting type of agriculture, as well as an outline of the past irrigation systems, up to its current status in Romania.

Chapter III deals with the current status of research, both in Romania and in the world, with respect to the impact of irrigation on the soil, and emphasizes its influence on the physical, chemical and biological properties of the soil.

Chapter IV includes the studies and research carried outboth in Romania and in the world, with respect to irrigation in fruit growing, and approaches such topics as the importance of irrigation in fruit growing, watering methods, water ratios, procedures and the best periods for the watering stages.

Chapter V presents the distinctive geographic characteristics of the natural habitat in which research was carried out, together with the climate and soil specifications. The specific climate conditions are further integrated into the agricultural and climate conditions, as well as the multiannual environmental indicatives (1961-2007) that are representative for the Afumați Weather Station.

Chapter VI describes the research objectives, the biological materials used, the set up of the process, the methodology used during and for research, with a focus on the observations, results, calculations, estimations and tests carried out, as well as the statistical and mathematical methods used to interpret the results. The biological resources were represented by two varieties of fruit trees, which present interest within the southeastern area of Romania: apple (*Malus domestica* Borkh) and apricot (*Prunus armeniaca* L.). Each variety included three varieties: for apple, the varieties were Romus 3, Generos and Ionathan, grafted on the M9 rootstock, in espalier as a crown-shaped living fence; for apricot, the varieties were Dacia, Comandor and Tudor, grafted on Mirobolan, in espalier as crown-shaped improved vessel. The plantations were set-up in the autumn of 2004, with the following spacing between planted trees: 3.5 x 1.5m for apple and 5 x 4 m for apricot. To reach the projected objectives, the set-up of three-factor experiences was necessary, with the following representative factors:

FACTOR A: THE SOIL

Apple: a1= Romus 3, a2 = Generos, a3 = Ionathan

Apricot: al = Dacia, a2 = Comandor, a3 = Tudor

FACTOR B: THE STANDARD FOR THE IRRIGATION TECHNIQUE

b1= *non-irrigated witness; b2*= drop 4 liters/ hour.

FACTOR C: FERTILIZATION LEVELS

c1 = unfertilized, c2 = fertilized with Cropmax 0.1%

The experiment was carried out in linear block system, with a systematic arrangement of factors A, B and C, in four repeated sessions, with five trees/repeated process. To achieve the intended and targeted goals, and to obtain objective scientific results regarding drip-watering irrigation and foliar fertilization, on specific features and characteristics, observations were drawn and calculations carried out on the strength of fruit trees, as well as productivity-related aspects.

The observations regarding the quantity factor of the fructification process were based on determinations of average production / output (kg/tree) in all variants of the experiment, both with the hydric system (b) and the variants targeting the level of fertilization (c), ultimately calculating the output according to the t/ha formula and the productivity index.

The biometric calculations concerned the following: tree height, tree trunk cross-section, crown height and size, average fruit weight, while also considering the firmness factor, of all variants falling under the hydric system (b), as well as the variants regarding the fertilization levels (c). Following the calculations, certain biometrical reports were issued, determining the surface of the tree trunk cross-section and the crown size.

The analysis t tracked the following parameters: soil analysis in the experimental variants, i.e. the hydric system (b2), the biochemical analysis of the content fruit in dry matter, the determination of titratable acidity, in both irrigated and non-irrigated conditions.

The economic demonstration of the results represented and materialized into a brief account of all expenses, income and profitability for the apple and apricot production, considering the studied experimental factors, including a control variant (b1-non-irrigated and c1-unfertilized). For a thorough understanding of the land where the experimental grids were planted, preliminary tests were carried out to determine the quality of the irrigation water, the analysis of the soil profile, and an estimation of the cropland for the area in which the research took place. Following the analysis of the irrigation water, a pH of 7.20 was noted, which led to the conclusions that (1) a longstanding use would be conducive to a firm settlement of the topsoil if irrigation was carried out through furrowing or flooding, and (2) drip irrigation would highly diminish these risks.

The resulting amount of dissolved *oxygen (O2) of* 7.4 mg/l ranged within the limits of 7-14 mg/l as normal growth conditions. The total salt content, expressed in fixed mineral

residue (mg/l) for water was 358.98 mg/l, which was suitable for the irrigation of fruit trees. Microelements (Fe, Cu, Zn, Mn, Mg) were found within acceptable guidelines, with no damaging influence on the plants.

The results of the analysis of the soil profile, i.e. the apparent density (AD - g/cm^3) and the total porosity (PT - % v/v) created a framework of the red preluvosoil that is typical for the Moara Domnească area, from a mildly compacted soil profile (the areas affected by the current agricultural projects) to a moderate type of compaction, following 30-52 cm in depth (Am and AB), and strong compaction in the Bt argic horizon (55-90 cm). As exception, the lower horizons of the profile were moderately compacted. The registered pH values varied within the interval of 5.82-6.19 (pH units). The lowest pH value (5.82) was recorded in the Apt compacted soil (16-29 cm), which indicated a mildly acid reaction of the soil. The quantity of humus content was low (1.20-2.10 %) in the topsoil (0-72 cm), corresponding to the Ap-Ab soil horizons and extremely low (0.36-0.60 %) in the lower layers of the profile (72-150 cm). The analytical data for N, P, K showed the degree of supply with important nutrients both in the soil and for plant growth purposes. The values of total nitrogen (Nt) were low (0.113-0.118 %) in the first two horizons, Ap and Apt (0-29 cm) and very low (0.055-0.088 %) in the other two analysed horizons, Am and AB (29-72 cm), which showed the very low rate of Nt supply in the soil. The values of mobile phosphorus were similar with those of Nt, as they were low (10-12%) in the first two horizons, Ap and Apt (0-29 cm), and very low (3-5%) in the other two analysed horizons, Am and AB (29-72 cm), respectively, which showed the very low rate of P supply in the soil. The values of mobile potassium were low (78-94 mg/kg), indicating the very low rate of K supply in the soil. The land used for tree cultivation was evaluated and received the grade of 63, which means quality class II. In apple, the evaluation grade was 58, i.e. the upper limit for quality class III (ranging between 41-60 points); in apricot, the evaluation grade was 64, i.e. the lower limit for quality class II (ranging between 61-80 points).

Chapter VII presents the results of the effect of drip irrigation on the physical and chemical properties of the soil. The analysis of the effect of drip irrigation on the physical properties of the soil showed that compaction increases with depth in both experimental variants. The increase in bulk density (BD) in 20-40 cm depth is closely related to the increase in the clay content in the soil profile. Total porosity (TP) decreased with the depth as a result of soil compaction in the lower layers. The analysis of the soil compaction level (CL) showed no compaction in topsoil. Concerning the effect of drip irrigation on the chemical characteristics of the soil, in both studied species, the content in soluble salts (mg/100g soil) ranged bewteen 32

and 36 mg/100g soil and was uniformly spread in all the tested variants, corresponding to the non-saline soil type.

The nitrogen amount available ($N\text{-}NH_{4+}$ $N\text{-}NO_3$) was very low in all studied variants, which is under the highest limit of 40 ppm in both studied species. Comparing the N content in all variants, it was slightly higher in the b2 variant (irrigated). The low values of the nitrogen content in applee and apricot reault in recommendations related the application of N-based fertilizers. In apricot, the values of accessible (mobile) phosphorus indicated low and very low rates. In apple the values were average and low.

In both studied species, the evaluation of the accessible (mobile) K^+ rate in the soil was based on the values resulted from the layer between 0-40 cm. The values ranged between the limits of 25-40 ppm, which means a low rate.

Chapters VIII and IX present the results of the experimental factors influence on the studied features and characteristics in apple in chapter VIII and in apricot in chapter IX, respectively. The studied experimental factors recorded statistically different data, compared with the studied indicators.

Tree height in apple, in the irrigated variant (b2), recorded a significant difference between the Generos and Ionathan varieties, compared with Romus 3. In apricot ree, the height increase was directly proportional with the application of the experimental factors in the non-irrigated+fertilized variant (b1c2), irrigated+unfertilized variant (b2c1) and irrigated+fertilized variant (b2c2).

Crown volume in apricot increased directly proportional with the application of the experimental factors. The Dacia variety increased volume by 0.94 m^3, Tudor by 1.65 m^3, and Comandor by 1.81 m^3, in the b1c1Mt control variant (non-irrigated+unfertilized) and the b2c2 variant (irrigated+unfertilized). The crown shape index in apricot is specific to each variety and does not undergo significant changes resulting from the application of the experimental factors. The Dacia variety recorded an index corresponding to a spherical shape, ranging between 1.057 and 1.091; the Comandor variety recorded an index corresponding to a slightly elongated shape, ranging between 1.189 and 1,218; the Tudor variety recorded an index corresponding to a pyramidal shape, ranging between 1.453 and 1.509.

Trunk section area (SST). In apple, growth vigour recorded slight increase. The largest area of trunk section was recorded in the Generos variety, at a significant difference from both Ionathan and Romus 3. In apricot, there were significant differences between the Tudor variety and the other two varieties; the former had the largest trunk area while the latter recorded sligh increases although without statistical differences.

*Fruit production (t/ha)***.** The most productive variety was Generos, recording an additional amount of 8,1 t/ha. The Romus 3 variety doubled production. Significant differences occurred between the control variant (b1c1Mt) and the irrigated+ fertilized variant (b2c2). In apricot, the differences in fruit production (t/ha) between the experimental variants b1c1 Mt (non-irrigated+ unfertilized) and b2c2 (irrigated+ fertilized) ranged between 3.89 t/ha in the Comandor variety, 3.9 t/ha in the Tudorvariety and 4.75 t/ha in the Dacia variety.

Productivity index. The highest productivity index was recorded by the Romus 3 variety in the irrigated+ fertilized variant (b2c2) by 0.66, followed by the Ionathan variety by 0.546 and the Generos variety by 0.502. In apricot, differences were recorded in the b2c2 variant (irrigated+ fertilized), so that the highest productivity index was recorded in the Dacia variety by 0.192, followed by Comandor by 0.109 and Tudor by 0.070.

Fruit weight (g) was specific and increased gradually together with the application of the experimental factors, recording stastically accurate differences in both studied species.

Titratable acidity. In apple, the Generos and Ionathan recorded significant differences, compared with the Romus 3 variant, with very similar differences in all the studied variants, except in the b1c1 control variant (non-irrigated+ unfertilized) where acidity was very similar, with no statistical differences accurate. In apricot, the Dacia and Comandor variants recorded a similar acidity content in all the studied variants, significantly different from the Tudor variety, ensuring positive significant differences.

Dry matter. In apple, the Generos variety recorded the highest content in dry matter in the non-irrigated variant (b1), by 11.5% in the unfertilized variant (c1) and by 12.6% in the fertilized variant (c2). Compared to the Generos variety, once the irrigation regime was changed (b2), the Ionathan variety accumulated a higher content in dry matter. In apricot, the differences between the extremes of the tested variants (b1c1-b2c2) were very similar between the three studied varieties, as follows: 2.35% in Dacia, 2.45% in Comandor and 2.67% in Tudor; all data were statistically accurate.

Firmness was influenced by the gradual application of the experimental factors and recorded significant statistical differences. In apple, the best results were recorded in the Generos variety, ranging between the limit variants (b1c1 non-irrigated+ unfertilized control and b2c2 irrigated+ fertilized) 4,4 kgf/cm^2 and 4,7 kgf/cm^2; the Romus 3 variety also recorded good results, between 2.9 kgf/cm^2 and 4.5 kgf/cm^2. In apricot, the differences ranged between 0.14 kgf/cm^2 in Dacia, 0.49 in Comandor and 0.64 kgf/cm^2 in Tudor. In the latter variety the foliar fertilizer Cropmax 0.1% recorded a major influence on fruit firmness, with fruit pulp ranging from soft (1.34 kgf/cm^2) to medium (1.98 kgf/cm^2).

Chapter X presents the economic analysis of the studied crops, based on the technological data recorded for each tested variant. The following economic elements were calculated: expenses (RON/ha), income (RON/ha), profi (RON/ha) and profitability rate (%). In apple, the significant profitability rate resulted only from the irrigated variant (b2c1) by 20% and the irrigated+ fertilized variant (b2c2) by 75% in the Romus 3 variety. In apricot, in all the studied variants, the Dacia variety recorded a significant profitability rate, compared with the other two varieties, and ranged between 60.66% in the non-irrigated+ fertilized variant (b1c2) and 80.25% in the irrigated+ fertilized variant (b2c2); in the control variant the profitability percentage was very high, i.e. 62.4%.

Chapter XI is based on the correlations between the studied indicators. In apple, the results show that fruit production recorded a direct, positive and distinctly significant correlation with the specific elements of vigour, tree height and tree trunk cross-section area. In apricot, fruit production recorded a direct, positive and distinctly significant correlation with the cross- section area while with the other elements (vigour, tree height, crown volume, crown shape index) the correlation was reversed.

The last part of the thesis presents the general conclusions and recommendations regarding the drip irrigation use in relation to foliar fertilization by 0.1% Cropmax as it is necessary to create a nutrient medium that is favourable for top quality productions and indicators. Maintaining and enhancing the fertility of irrigated soils is possible if, together with rational watering application, a fertilizer program is carried out by administering organic and mineral fertilizers both at ground and foliar levels.