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THE INFLUENCE OF CLIMATIC AND SOIL CONDITIONS ON THE GROWTH AND DEVELOPMENT OF THE PLUM TREES AND ON THE YIELD LEVELS ON A TYPICAL LUVOSOL AT CARANSEBES - CARAS SEVERIN COUNTY

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Abstract: *Soil is an essential component in orchard ecosystems. For a fruit tree performance the soil is and will remain in the future, the unique place for growth and development of root system, while providing mineral elements with an essential role in nutrition of fruit trees. The paper presents an integrated and operational set of measurable criteria and indicators as a basis for a harmonized comprehensive information system used for achieving an intelligent infrastructure to create an ecologic quantified and integrated model of the climate, land and infrastructure resources, specific to fruit-trees lands and orchards. The objectives were to emphasize the monitorisation of the climatic conditions, soil fertility and biometrical measurements in some of the studied areas, in order to supplement the database. It is unanimously admitted that from all the relevant scientific indicators for fruit-tree cultivation, the thermic conditions in the air have a basic role. In this context, to highlight the climate of the area it was used a method based on the frequency of repetitiveness of thresholds and optimal climatic intervals in the last ten years. The paper, also, presents a relatively complex soil characterization, of the orchard from Research and Development Station for Fruit Tree Growing Caransebeş. For a thorough understanding of soil conditions in Caransebes orchard has been studied the typical luvosol characteristic of the territory. That soil texture is loamy-silty loam. Soil reaction is moderately acid to surface and slightly acid on the soil profile. Total cation exchange capacity is low, increasing from surface to the Bt horizon. The degree of base saturation is oligomesobasic - mesobasic. Analytical data have revealed, generally, low and very low content of organic matter and macro-elements (N, P, K) and micro-elements (Fe, Cu, Mn, Zn) supply condition is good. The influence of soil conditions on trees trunk thickness is synthesized in indicators for roots and trunk biometry. For production structure of plum fruits in Caransebes orchard, were studied three cultivars: Stanley, Vânăt de Italia and Vânăt Românesc. The main mass of roots of plum trees, although is located at 20-60 cm depth, can explore the soil profile (≥ 100 cm) and have no significant restrictions in this regard.*

Key words: *plum orchard, expert system, climatic and soil conditions*

INTRODUCTION

It is unanimously admitted, nowadays, that a category of assortments can achieve its biological potential (even in the case of an avant-garde technology is applied) only if the area ecological offer it is optimally to satisfies the biological needs of fruit trees. So, i tis very important the connection existing between the production capacity and level of soil supply with mineral elements.

The specific objective of the paper is the management of the natural (climate, soil, relief, etc.) and artificial (orchards, infrastructure) resources, as well as the quantification and the characterization of the indicators of these resources, in an expert system. The final purpose is to create a regional evaluators network for the prognosis of the efficacious use of the fruit-tree lands and for an adequate management and robust to failures, on the basis of an operational handbook. Researches have been necessary to show the criteria and indicators necessary for an expert system in fruit-tree lands and orchard at Research and Development Station for Fruit Tree Growing Caransebeș.

MATERIAL AND METHODS

The researchers were carried out on typical luvosol from a Caransebes orchard, at three cultivars of pum: Stanley, Vânăt de Italia and Vânăt românesc.

Relatively high degree of complexity of the land in this orchard, required to open a soil profile up to a depth of 100 cm. From each pedogenetic horizon of this profile were collected soil samples (according Methodology ICPA), in small metal cylinders for the physical analysis and in disturbed state (in plastic bags), for the chemical analysis.

The physical properties as non-gleyed, non-pseudogleyed soil volume (%), particle size distribution (%), bulk density (g/cm^3), aeration porosity (volume-%), permeability (mm/hour) and resistance to penetration ((kg/cm^2) were analyzed. Soil fertility was characterized by humus content (%), C/N ratio, content of total nitrogen (%), available P and K (mg/kg) and microelements (mg/kg). The chemical parameter as pH_{H2O}, total cation exchange capacity (me/100g soil), base saturation degree (%), exchangeable aluminum (mg/kg), total and active carbonates (%) and exchangeable cations (%) were also determined according to the ICPA methodology (1987).

RESULTS AND DISCUSSIONS

There were defined criteria and scientific sustainable and relevant indicators quantifying the meteorological elements that condition fruit-trees phenological phases, using an original method. The method is based on the frequency of repetitiveness of thresholds and optimal climatic intervals in the last ten years.

The results showed that from all the relevant scientific indicators for fruit-tree cultivation, the thermic conditions in the air have a basic role. These thermic conditions refer to the optimal average air temperature of months and of monthly intervals required for phenological phases, for each fruit-tree category at species/variety/rootstock level. The relevant *scientific indicators* for fruit-tree ecosystem are:

Temperature

The climatic data presented in this paper (table 1) were provided by the Meteorological Station Caransebes.

The *minimum absolute temperature* with different values when decrease suddenly or slowly at species level; the *thermic amplitude* in: November-February for plum tree, cherry tree, apricot tree and peach trees; December-February for apple, pear and sweet cherry trees.

Rainfalls

Rainfalls are also quantified in - the period of V-VII months for apple tree, pear tree, plum tree, sweet cherry tree, cherry tree and peach trees, and apricot trees.

According to this method, the frequency of repetitiveness of thresholds and optimal climatic intervals in the last 10 years is expressed by frequency (%) in five classes: null (frequency of 0-5%), very low, low, moderate and optimum (with frequency of 90-100%).

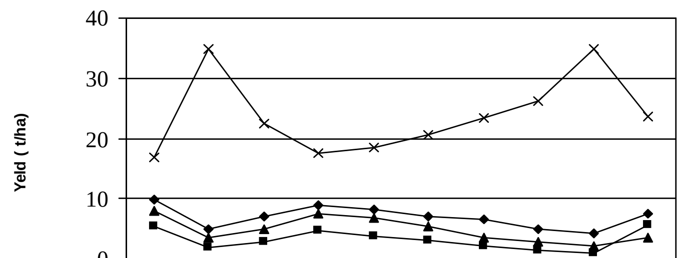
The paper prognosis the frequency of repetitiveness of thresholds and optimum climatic intervals and considers some studied fruit-tree species grouped considering the terrain type. In this view, grouping the lands of fruit-tree patrimony in *no restrictions* lands, lands with restrictions and lands excluded from climatic point of view, will be achieved for the further integration in the ecological quantified module.

In order to achieve the tasks of the objective and to develop the climatic model quantified in addition points, as well as to test and to validate in the field the thresholds and climatic intervals values, the climate data and the yield (between 1996 and 2005) were statistically process. The obtained yields for plum trees in Caransebs orchard, at the 3 species of plum were studied in relation to the thermic amplitude (°C, XI–II months). For the studied years the plum yield fluctuated, according to the climate and thermic amplitude (figure 1, 2*)*.

Table 1

The evolution of temperatures and rainfall in the period 1996-2005 in Caransebes, Caras-Severin County

Year	The average air temperature (ºC)			The *minimum absolute annual temperature* (ºC)		*Thermic amplitude* XI-II > 20ºC	Rainfall V-VII 200-250 mm
	Annual 7-10	V-X ≥ 16-18	V ≥ 18-19	Decreases suddenly < -22 ºC	Decreases slow < -32 ºC		
1996	10,7	17,4	20,4	0	-12,6	16,8	283,5
1997	9,7	15,8	19,3	0	-11,6	34,8	289,4
1998	10,3	17,2	19,9	0	-17,0	22,5	283,6
1999	10,8	17,5	19,5	0	-15,2	17,5	258,8
2000	12,0	18,6	20,7	0	-22,0	18,4	259,4
2001	10,6	17,4	17,4	0	-10,6	20,6	381,0
2002	11,6	17,9	20,4	0	-19,4	23,3	254,3
2003	11,0	18,0	21,6	0	-15,5	26,2	216,5
2004	10,8	17,9	19,0	0	-19,4	34,8	255,3
2005	9,9	16,8	18,0	0	-21,0	23,6	356,1



Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Stanley	9,8	5	7	9	8,1	7,1	6,5	4,8	4,2	7,5
Vânat de Italia	5,3	1,8	2,8	4,7	3,8	3	2	1,5	1	5,5
Vanat românesc	8,0	3,5	4,8	7,6	6,8	5,3	3,5	2,8	2,2	3,5
Thermic amplitude	16,8	34,8	22,5	17,5	18,4	20,6	23,3	26,2	34,8	23,6

Figure 1 - The variation of the yield levels (t/ha) in relation to the thermic amplitude (^{o}C, XI –II months) for plum: Stanley, Vânăt de Italia and Vânăt românesc at S. C. D. P. Caransebes

The yield from plum in the area Caransebes, at three plum species, in the studied years were variable, for this being responsible the climate elements - thermal amplitude. Production decreases as the thermic amplitude value is greater than 20 ºC, which is illustrated in figures 1-2.

Soil fertility

Soil is an essential component of the fruit-tree ecosystems. The paper has in view to quantify relief, drainage and soil conditions (active edaphic volume, pH, salinization, alkalization, mobile Al content of acid soils and $CaCO_3$ in relation with depth of Cca, Cpr, Rz horizons, and active $CaCO_2$ in carbonates horizon) and industrial pollution (VOICULESCU, 2006).

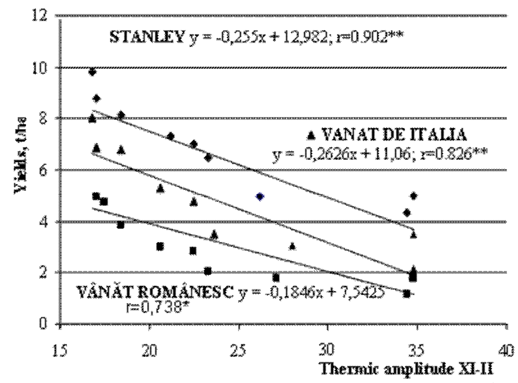


Figure 2 - The relation between the yields and thermic amplitude (^oC, XI-II months) for plum: Stanley, Vânăt de Italia and Vânăt românesc at S. C. D. P. Caransebes, for 1996-2005

Baseline values for relief, drainage and soil condition depending on their role in the fruit-tree ecosystem are granted with addition points. Depending on their baseline values, the fruit-tree lands are also grouped from the soil characteristic point of view in no restriction lands, lands with some restrictions and lands that cannot be used for fruit-tree cultivation.

To accomplish this objective, one important activity was to sample the soil for physical and chemical analysis in order to characterize soil fertility.

The granulometric data (table 2), emphasize that the Typical Luvosol from Caransebes orchard has a loamy-silty loam texture.

Table 2

Phisycal properties of Typical Luvosol from Caransebes

Horizon	Depth horizon cm	Non-gleied non-pseudogleyed soil volune %	Granulometric fractions (%) Coarse sand 2,0-0,2 mm	Fine sand 0,2-0,02 mm	Loam 0,02-0,002 mm	Clay < 0,002 mm	Bulk density g/cm^3	Porosity aeration % vol.	Permeability mm/hour	Resistance to penetration kgf/cm^2
Ap	30	100	4,2	38,9	32,2	24,7	1,43	16	9,85	38
EB	28	100	4,1	37,1	33,3	26,5	1,47	14	2,71	48
Bt_1	24	100	4,6	32,7	33,2	29,5	1,43	15	3,94	38
Bt_2	18	80	4,5	38,5	27,1	29,9	1,44	14	5,17	60
0-100	*100*	80	*4,6*	*38,9*	*33,3*	*29,9*	1,47	14	2,71	60

Loam (from 0.002 to 0.02 mm) have values between 32.2 to 33.2%, with a minimum (27.1%) in the horizon Bt_2. Fine sand (0.02 – 0.2 mm) has higher values than those of loam, ranging from 32.7 to 38.9% (table 2). In the profile, mineral particles are present at the size of coarse sand (0.2 to 2.0 mm) but they do not exceed 4.6%.

Bulk density is medium throughout the profile, the values recorded are 1.43 g/cm^3 in the surface horizon (Ap), then increases in the transitional horizon (EB) where reaches a maximum (1.47 g/cm^3), then gradually decreases 1.43 to 1.44 g/cm^3 in the argillic horizon (Bt). This reveals a moderate degree of soil compaction (figure 3).

Porosity aeration is medium (16%v/, figure 4) in soil surface and then decrease slightly towards the base of the profile and it is relatively close to 14-15%/v. Hydraulic conductivity or soil permeability is medium; the highest value (9.85 mm / hour, figure 5) was recorded in the surface horizon.

Typical Luvosol texture makes nearly, medium, all its physical characteristics and so the degree of compaction is reduced. The penetration resistance values are medium (38-48

kgf/cm^2) on the soil profile, but only in the base horizon reach to a high value (60 kgf/cm^2, figure 6). This value is not important for the development of root systems of trees, but reflects conditions that favor the emergence of a weak pseudogleisation process.

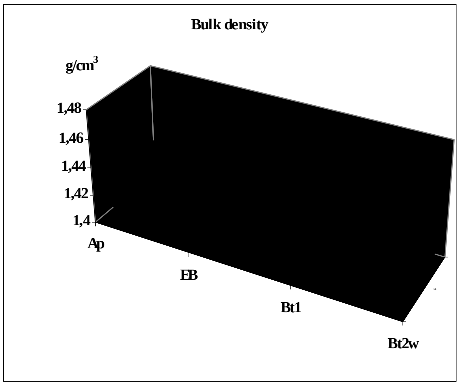


Figure 3 – The bulk density of Typical Luvosol from Caransebes

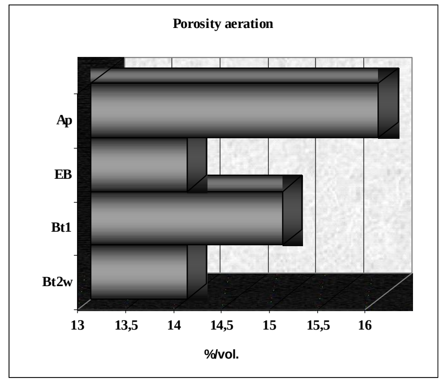


Figure 4 – The porosity aeration of Typical Luvosol from Caransebes

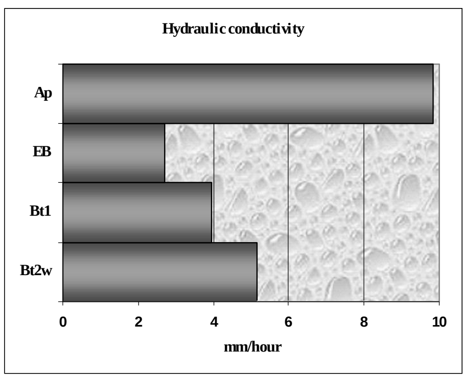


Figure 5 – The hydraulic conductivity of Typical Luvosol from Caransebes

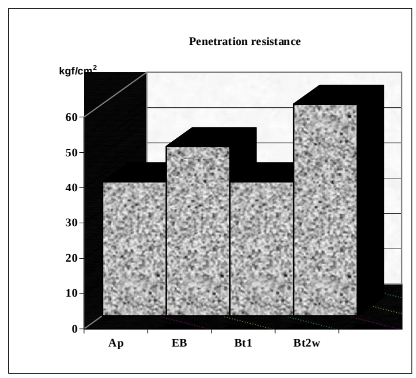


Figure 6 – The penetration resistance of Typical Luvosol from Caransebes

Soil reaction (table 2) is moderately acid on the surface horizon to slightly and acid on the profile (pH lies in the range from 4.90 to 5.20).

Total cation exchange capacity of soil is determined, for the most part, by clay and organic matter. For the studied soil this is low (table 3) increasing from surface to the Bt horizon. The degree of base saturation for the Typical Luvosol from Caransebes is oligomesobasic - mesobasic.

Soil fertility (table 4) is also emphasizing by the data of physico-chemical analysis as organic matter and N, P, K.

The organic matter content is low and very low, with a maximum (1.52%) in the surface horizon due to a weak accumulation and gradually on the soil profile decreases (up to 0.67% in the horizon Bt_2). However, the organic matter is accumulated on a great depth ($\geq$ 80 cm) in the soil profile.

Carbon/nitrogen ratio is a biochemical parameter that reflects both the intensity of biological activity and the environment for conducting biochemical reactions in soil. This ratio has characteristic values depending on the nature of humus and climatic conditions. C/N ratio in the Typical Luvosol from Caransebes not differs much from one horizon to another, ranging from 7 to 9. This values show a moderately active biological soil, relatively poor in Ca and Mg.

Table 3

The cation exchange capacity of Typical Luvosol from Caransebes

Horizon	Depth horizon cm	pH H_2O	Total cation exchange capacity me/100 g sol	Base saturation degree %	Exchangeable Al ppm	Carbonates Total	Carbonates Active	Exchangeable cations H^+ %	Na^+	K^+	Mg^{++}	Ca^{++}
Ap	30	4,90	13,07	51	109	0	0	49,5	0,8	2,1	13,2	34,4
EB	28	5,20	12,50	61	87	0	0	38,7	0,8	1,4	17,1	42,0
Bt_1	24	5,10	14,54	61	87	0	0	39,5	0,9	1,2	20,6	37,8
Bt_2	18	5,20	14,19	73	55	0	0	27,5	1,2	1,2	26,1	44,0
0-100	*100*	*4,90*	*13,10*	*51*	*109*	*0*	*0*	*41,1*	*0,9*	*1,5*	*17,2*	*39,4*

Table 4

Fertility of Typical Luvosol from Caransebes

Horizon	Depth horizon cm	Organic matter %	C/N	Total nitrogen %	Available P mg/kg	Available K	Microelements Fe	Cu	Mn	Zn
Ap	30	1,52	8	0,123	3	133	6	4	75	1
EB	28	1,02	9	0,076	2	76	3	3	39	1
Bt_1	24	0,80	7	0,076	1	64	2	4	49	1
Bt_2	18	0,67	7	0,070	2	70	1	5	53	1
0-100	*100*	*1,07*	*8*	*0,085*	*2*	*85*	*3*	*3*	*131*	*1*

The values of nitrogen and phosphorus contents highlight the nutritional conditions of trees in Caransebes orchard. In the Typical Luvosol these values decrease from the surface horizon on the soil profile.

Total nitrogen content is low (0.123%) in the surface horizon and very low in the rest of the profile (0.076%), while available phosphorus content is extremely low (1-3 mg/kg) throughout the soil profile. Available potassium ranges from a medium content (133 mg/kg) to a low one (64-76 mg/kg).

Micronutrients supply status, generally, is proper for the nutrition of fruit trees (table 4). Copper values are similar on the soil profile, from 3 to 5 mg/kg, while manganese has a smooth decrease in the profile, its values ranging between 39 and 75 mg/kg. Zinc content is uniform on the soil profile, but the values are low (1 mg/kg in all horizons).

Biometrical measurements

Biometrical measurements concern with the measurements of roots and trunks.

The influence of soil conditions on trees trunk thickness is synthesized in indicators for root and trunk biometry. These indicators react at the presence in soil of limiting factors inducing modifications opposite of normal distribution of the trees root system (LAZĂR, 2006).

The indicators for roots biometry are:

1. The roots frequency (F.R.) representing the number of the roots (or their sum) calculated according to the depth (from 10 to 10 cm) of soil profile, until 100 cm depth. In the field, the roots from each group of diameter were counted, according to the depths, and recorder in the field register card;

2. The surface of root section (S.S.R.);

3. The main root masse (M.P.R.), define as depth range in which more than 75% of S.S.R. is located;

4. The indices of roots distribution (I.D.R.).

The indicators for trunk biometry are:

1. The trunk of real age (T.V.R.) - use for the plantation characterization and for the expeditive estimation of fruit-tree yield;

2. The trunk of conventional age (T.V.C.) for the correlations with soil properties.

An important aspect is that for this soil, the main mass of roots of the plum trees is camped at 20-60 cm in the soil profile (figure 7). This fact is emphasized by the analytical values obtained for the main soil physical indicators, relevant for the fruit tree nutrition conditions (bulk density, porosity aeration, permeability and soil resistance to penetration) and showed that the EB horizon offers the optimal conditions root system development.

Bulk density *g/cm³*	Porosity aeration *%/vol.*	Hydraulic conductivity *mm/hour*	Penetration resistance *kgf/cm²*	Horizon
1.43	16	9.85	38	Ap 30 cm
1.47	14	2.71	48	EB 58 cm
1.43	15	3.94	38	Bt_1 82 cm
1.44	14	5.17	60	Bt_2 100 cm

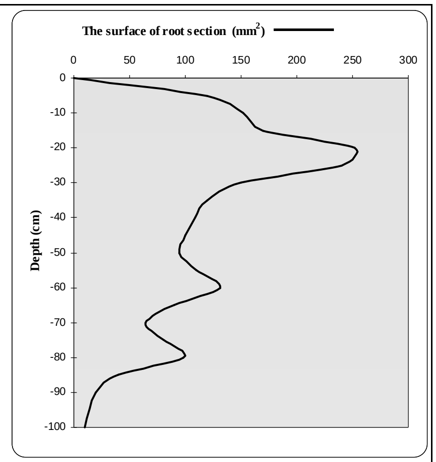


Figure 7 - The change of root distribution under the influence of soil conditions, at the plum variety Stanley, on the Tipical Luvisol at Caransebes

CONCLUSIONS

1. The obtained yields for plums in Caransebes orchard, at the three species of plum were studied in relation to the thermic amplitude (°C, XI–II months). For the studied years the plum yield fluctuated, according to the climate and thermic amplitude;

2. The granulometric data (table 2), emphasize that the Typical Luvosol from Caransebes orchard has a loamy-silty loam texture;

3. The organic matter content is low and very low, with a maximum (1.52%) in the surface horizon due to a weak accumulation and gradually on the soil profile decreases (up to 0.67% in the horizon Bt_2);

4. Total nitrogen content is low (0.123%) in the surface horizon and very low in the rest of the profile (0.076%), while available phosphorus content is extremely low (1-3 mg/kg) throughout the soil profile. Available potassium ranges from a medium content (133 mg/kg) to a low one (64-76 mg/kg).

5. Micronutrients supply status, generally, is proper for the nutrition of fruit trees;

6. The influence of soil conditions on trees trunk thickness is synthesized in indicators for root and trunk biometry. These indicators react at the presence in soil of limiting factors inducing modifications opposite of normal distribution of the fruit trees root system;

7. For this soil, the main mass of roots of the plum trees is camped at 20-60 cm in the soil profile.

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