MULTIDISCIPLINARY RESEARCH ON PILOT AGROECOSYSTEMS UNDER CONDITIONS OF CLIMATE CHANGE

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Abstract

In correlation with the research activity promoted by the EU Framework Programme 7 concerning "Promoting sustainable agriculture, increasing food safety and security", an inter-institutional partnership has been initiated between the Agronomic University of Bucharest and three research institutes specialized in fruit-tree growing, biology and natural history, and environmental study and management.

The results of the interdisciplinary and multidisciplinary research performed in the areas of the Vlăsia Plain (southern Romania) and the Dobrudja Plate (nearby the Black Sea Coast) consist in leading an agroecosystem aimed at preserving the environment, natural habitats, wildlife and grown flora and fauna, biocenoses (agricultural crops, pathogens, bioantagonists, useful and harmful entomofauna, soil macro and microorganisms, spontaneous flora, water), biotypes (the changing climatic, edaphic and orographic components), as well as the agrophytotechnical and socio-economic subsystems that affect the lower intensity of the anthropogenic factors and global warming.

INTRODUCTION

This paper is aimed at proposing a synthesis of the interdisciplinary and interinstitutional research results performed between 2007 and 2010, under the project titled „Agroecosystems influenced by anthropogenic risk factors and their piloting sequences", financed by the Ministry of Education and Research.

MATERIAL AND METHODS

Starting from the basic ecological principle of alternative agriculture, i.e. the interrelation between 'living', 'eating', and 'making food for other living

organisms', interdisciplinary research was developed in order to find solutions for ecosystem leading.

The methods used in activities in the paper refer to:

Studies, determinations and analyses on the variation of the environmental factors up- and downstream the agroecosystems Moara Domnească, Vlăsiei Plain and Valul lui Traian, Dobrudja [2]; Methodological study on the evaluation of species biodiversity and substantiation in the agroecosystems in two regions [3]; Analyses and determinations on nutrients concentrations (N, P, S), oxygen level (dissolved oxygen concentration, oxygen saturation, chemical and biochemical oxygen consumption, primary production), phytoplankton (biomass, chlorophyll "a"), and microorganism, macroinvertebrate and fish populations in the water sources existing agroecosystems [1.5]; Evaluation of microflora and microfauna biodiversity under the impact of intensive chemical fertilisation by the time of the study [6]; Biological study of the useful and damaging entomofauna, pathogenic and antagonistic agents under the impact of the risk anthropogenic factors [4]; Study on the behaviour of the newly patented varieties belonging to agricultural, fruit-tree and vegetable species resistant to diseases and changing climate factors [2].

RESULTS AND DISCUSSIONS

Study on climate change within the Moara Domnească agroecosystem by typical meteorological year-TMY and cluster analysis

The objectives were: to build a typical meteorological year-TMY for the ecosystem existent at the Moara Domnească experimental field.

Our research used a statistical weather method introduced by J.M. Finkelstein, R.E. Schäfer (1971). For discrete distributions, the Finkelstein-Schäfer statistics gives better results than the statistics used in accordance with the Kolmogorov-Smirnov tests. This type of statistics was used in the USA Sandia Laboratories to determine the typical meteorological year (TMY), i.e. the mathematical model using the American standard and ISO 15927-4/2005.

The sample contains observations for 23 years, with complete for the ecosystem the periods 1977-1983 and 1991-2006 at Moara Domnească. He was eliminated on the date of February 29th in the leap years was eliminated, therefore the total number of observation days was 9,395. Comparisons were made with the meteorological year 2007 as standard.

The typical months for the period under analysis are shown in Table 1.

Table 1

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1982	1994	1992	1979	2005	1982	1992	1977	1995	1999	2005	1978

The overall mean temperature was 11.31 ± 9.1^0C for typical normal TMY, and 11.33 ± 10.51^0C for 2007; the variability coefficient for that year was high, i.e. 93%.

Four types of typical days were defined – two for the hot season and two for the cold season, as follows 1) summer days with maximum temperature $\geq 25^0$C, 2) hot days, maximum temperature was $\geq 30^0$C, 3) days of frost with minimum temperature $\leq 0^0$C and 4) frosty days - minimum temperature was $\leq -10^0$C.

A very significant difference was determined in the frequency of the characteristic days (Test Z) in TMY to 2007 (205 days characteristic in TMY, and 254 in 2007).

In the end, we used a nonlinear model of cluster analysis to compare the months of 2007 in order to highlight the idea of climate change occurring in the examined ecosystem. The climatic characteristics used were: mean temperature, relative humidity, rainfall, solar radiation and temperature amplitude. Through a non-linear projection model we show three clusters (Figure 1) (possible three seasons). In 2007, a cold season - months of November, December, January and February; a hot season - April, May, June, July, August; and finally, a transient season - March, September and October. The cold season in 2008 includes the same months: a warm season (March, April, May and September) and a very hot season (June, July and August).
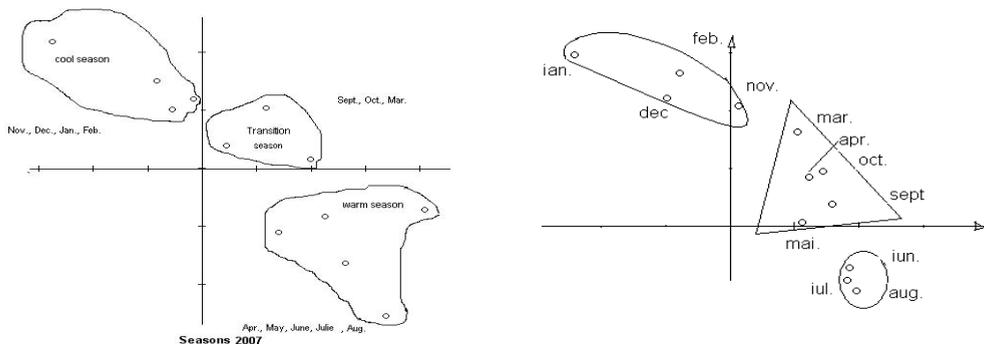

Fig. 1. Cluster diagrams (years 2007 and 2008)

Characterisation of biotic and enzymatic red preluvosoil grown with fruit tree species in the agroecosystem provided by Moara Domnească

Changes in the biotic (breathing and celuloliza) and enzyme (catalase, urease, phosphatase and sucrase) characteristics have been highlighted, according to the methodology developed by Ştefanic (1999). Also, changes have been recorded in the red preluvosoil cultivated with fruit-tree species within the Moara Domnească agroecosystem (depths of 0-0-20 cm and 40 cm during the full growing season and its termination). Statistically, in the vegetation period, the vital activity of the soil records no differences in the planting of apricot and peach (year II – hollow and fruiting) and cherry and sour cherry.

The most intense biological activity was recorded in the hair planting apple and pear plantations, whereas the lowest in apricot and peach - Year II (ground level).

The slow phase of metabolism in the first 20 cm, the soil vital activity expressed by IPAV% ranges between 29.39 and 37.09, and the 20-40 cm layer between 23.12 to 33.23. The highest enzyme activity of the soil, expressed by IPAE%, was recorded for apricot and peach in year 2 (hollow) in the first 20 cm. In 20-40 cm depth, the most intense enzyme activity occurred in the plum and apple grown variants. Analyzing the biological soil activity at the end of the fruit-tree vegetation cycle, and considering the average of the two depths of soil sampling, there may be variations in 4 separate groups (descending order): Group 1 - apple, Group 2 - apricot and peach - second year (hollow), Group 3 – walnut, and Group 4 - apricot and peach - second year (level ground), apricot and peach, plum, cherry and cherry.

The results are mainly due to the different technology applied to the species of fruit trees.

Investigations of specific composition, taxa and systematic group number, biomass density, bio-volume, abundance, sensitive taxa, ecological status and diversity index in the aquatic ecosystem of Lake Moara Domnească

According to the Water Framework Directive 60/2000 EC, the definition of the ecological status of water bodies involves the full knowledge of the characteristic biocenoses and species. The group of primary producers in an aquatic ecosystem is represented mainly by all green plants (i.e., phytoplankton and macrophytes).

Phytoplankton biomass showed high values, ranging from 11.9 to 17.6 mg/l, which suggest hypertrophy in Lake Moara Domnească 75 algal taxa were inventoried, belonging to the groups: *Cyanobacteria, Bacillariophyta, Pyrrophyta, Euglenophyta* and *Chlorophyta*.

The analysis of the qualitative composition of the phytobenthotic association indicates a numerical abundance of the algae diatom group: 32.86% of the association, followed by other groups: chlorforphiceae - 31.42%, cyanobacteria - 22.86 %, euglenopyceae - 10%, pyrrophyceae - 2.86%.

Based on the phytonethone analysis, we can state that the environmental status of Lake Moara Domnească is low to moderate.

Bacteriologically, Lake Moara Domnească was identified as an aquatic ecosystem with relatively clean water, corresponding to a moderate level of bacterial pollution. The bacteriological quality indicators were within the limits prescribed by the Order 161/2006, referring to GD 567/2006, the quality class II (> 5000 bacteria/100 ml water, for total coliform bacteria).

Lake Moara Domnească is directly affected by anthropogenic impact upstream. It is a lake with high trophic potential considering the nutrient concentrations in water. An excesses of quality standards is observed for both Pb and for Ni. The three drin-class compounds under analysis (aldrin, endrin, dieldrin) are not present in any of the sections. Moreover, heptachlor is not present.

Study of useful and harmful entomofauna biology, of agrowcosystem pathogens and antagonists under the impact of anthropogenic risk factors

The biological study of the pathogens and pests present in the period 2007-2009 was developed under the Moara Domnească fruit-tree agroecosystem, as well as in the peach and apricot plantations, as dominant species in the Valu lui Traian basin.

In the Moara Domnească fruit-tree agroecosystem, pathogenes and sarophites were identified macroscopically and microscopically, in association with peach shoots, while separate species of the useful microflora were dissociated. Micoflora was highlighted by the agar plate method (average PDA - Potato dextrose agar, Sigma Biochemicals, 39 g/l).

The micoflora associated the peach shoots belonged to the species: *Alternaria alternata, Aureobasidium pullulans, Cladosporium carpophilum, Botrytis cinerea, Mucor racemosus, Penicillium* spp., *Rhizopus stolonifer*. Also, species with antagonist resources were identified: *Epicoccum purpurascens*, *Trichothecium roseum*, *Cheatomium globosum* and *Trichoderma viride*.

There have also been isolated filamentous yeast species belonging to the genera *Aureobasidium*, *Rhodotorula* and *Cryptococcus*. *Aureobasidium pullulans* was the most common of the yeasts, followed by *Cryptococcus*. Some of *Cryptococcus* and *Rhodotorula* yeasts have a recognised antagonist activity, particularly those of the genus *Rhodotorula* and *Aureobasidium* - used to control the *Botrytis cinerea* and *Penicillium expansum* fungi in the pear-tree species.

The interrelations between the species vary in vitro. Thus, the *Alternaria alternata* species can occupy the substrate faster (which explains its high prevalence-Figure 2).

The study of pathogens-antagonists interrelations show a strong antagonistic action of the *Trichoderma viride* species against the various species of pathogenic isolates tested, restricting their development space almost completely after 7 days (Figure 3).

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The *Epicoccum* species and *Trichothecium* isolates showed antagonistic action, compared with the species mean test.

The useful fauna was represented by the species of Coccinellidae (*Coccinella septempunctata, Adalia bipunctata*) and Chrisopidae (*Chrysoperla* meat) in the plantation grown with the following apple varieties: Florina, Generous, Idared, Goldspur, Starkrimson, Sirprise, Jonathan, Granny Smith, Mutzu, Liberty, Elstar, Royal Galla, Delbard, Prima.

In the Valu lui Traian agroecosystem, the contribution of the useful fauna was evident in the peach and apricot plantations.
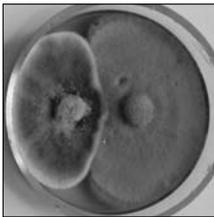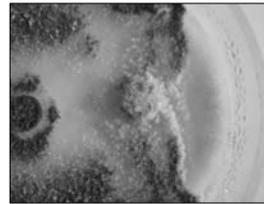

Fig. 2. *Epicoccum / Alternaria*

Fig. 3. *Trichoderma / Botrytis*

In the case of the *Anarsia lineatella*, which frequently attacks the larval stage of the peach and apricot buds and shoots, there were identified 6 species of primary parasitoids that limits its populations, such as: the Fam. Braconidae: *Apanteles anarsiae* Faure et Alaba and *Apanteles longicauda* Wesn; Enczrtidae family: *Paralitomastix varicornis* Nees.

For *Laspeyresia molesta,* which attacks the larva stage of the peach, apricot, plum, quince, almond shoots and fruit - and, less frequently, the apple, cherry plum, quince, almond shoots - there have been identified eight species of primary parazitods belonging to the Ichneumonidae family: *Itoplectis alternans* Grav, *Coccygomimus turionella* L., *Lissonota paralella* Grav.; the Braconidae family: *Apanteles anarsiae* Faure et Alaba, *Macrocentrus linearis* HEES; the Pteromalidae family: *Dibrachyus cavus* Walk; and the Trichogrammatidae family: *Trichogramma cacoeciae* March.

The primary parasitoid complex was able to reduce the *Laspeyres* populations by 40-65%.

However, its action was limited by the intervention of some secondary parasitoids, as indicated in the food chain under study.

To limit the *Anarsia lineatella* and *Laspeyres molesta* moth attack in expanding the study of the useful wilfdlife, there were tested bioproducts posed by biological extracts from wormwood, celandine, garlic and ladybug. All the four biopreparates provided a very effective protection of the peach shoot and fruit against the moth larvaeattack. Their control efficiency was over 90%.

Fauna diversity in the Moara Domnească agroecosystems

The fauna identified is composed of 147 species, of which 126 are invertebrates: 7 species of arachnids belonging to 5 families and 119 species of insects belonging to 9 orders and 56 families. The vertebrate fauna includes 21 species, of which: 13 species of fish (belonging to 2 families), 3 amphibians, one reptile species and 4 species of mammals. Fish are the dominant species: *Scardinius erythrophthalmus, Rutilus rutilus, Carassius auratus, Lepomis gibbosus.*

Biodiversity in the agricultural ecosystems of Moara Domnească is very low, representing approximately 9.36% of the biodiversity of natural habitats (the Cernica-Pustnicul forest complex). Many of the collected species have high adaptation capacity and are pests generally specific to crop plants (Ord. Othoptera, Heteroptera, Coleoptera).

Impact of meteorological factors on fruit-tree phenology and production

The last nine years out of the 19, located in the decade 2000-2009, were crucial for drawing conclusions about the damage caused by rising temperatures in winter and their sudden drop binding during flowering or fruiting periods.

The low temperatures in the spring of 2008 were strongly felt on the apricot varieties with very early and early ripening and, to a lesser extent, the late ripening varieties such as Commander, Favorite, Augustine, Histria. In 2009 the lowest temperatures were within the normal until 23.04, when the absolute temperature was recorded in the early morning -1.4 ºC, associated with white frost, and followed the very next day by positive temperature of 0.8 ºC, which surprised the apricot and nectarine species in phase fruit 1 cm followed by early-fruit fall, and nut species in full bloom, causing the total damage in the apricot, peach, and nectarine production.

In the years 2000-2009, the higher temperatures after fruit formation resulted in changes in the biochemical and physiological processes of fruit growth and development, accelerating fruit ripening fruits in all species.

CONCLUSIONS

1. The paper highlights three clusters as a result of climate change, representing three possible seasons: a cold season in November, December, January and February, a hot season in April, May, June, July, August and a transitional season in March, September and October.

2. The changes in the biotic (breathing and celulolysis) and enzyme characteristics (catalase, urease, phosphatase and sucrase) of the Moara Domnească preluvosoil grown with fruit-tree species are due to the applied technology rather than the specific biology of the species and varieties.

3. Lake Moara Domnească has a low-to-moderate ecological status due to the presence of phytobenthone; water is relatively bacteriologically clean,

affected by the anthropogenic impact directly upstream hypertrophy. It is a lake with high trophic resources, considering the nutrient concentrations in water. It exceeded the quality standards for both Pb and Ni, and had neither heptachlor nor drin compounds (aldrin, endrin, dieldrin).

4. In the Moara Domnească fruit-tree agroecosystem, the macroscopic and microscopic analyses identified pathogenic and saprophyte species associated with peach shoots; also, species of useful entomofauna (*Coccinella septempunctata*, *Adalia bipunctata*) and chrisopidae (*Chrysoperla* meat) were identified and isolated.

5. At Valu lui Traian, the primary parasitoid complex managed to reduce Laspeyres the populations by 40-65%. The bioproducts represented by organic extracts of wormwood, celandine, garlic and ladybugs provided very efficient (over 90%) protection of the peach shoots and fruit against the moth larvae attack.

6. Biodiversity in the Moara Domnească agricultural ecosystems is very low, i.e. approximately 9.36% of the natural habitats biodiversity (the Cernica-Pustnicul forest complex).

7. Any degree of negative temperature (very short hours, not days), which was recorded in the springs of 2008 and 2009, and the intrusion of arctic temperatures affected the floral organs of the fruit-tree species, the apricot being the most sensitive of all.

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