PhD THESIS

DIFFERENTIATION OF AGRICULTURAL TECHNIQUES APPLIED IN ECOLOGICAL AGRICULTURE FOR ADAPTATION TO CLIMATE CHANGES

(SUMMARY OF THE PhD THESIS)

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INTRODUCTION

Climate changes, in particular global warming which is altering the growth area of some area-specific plants, also altered the water cycle across the globe. The result is dramatic, leading to weather anomalies such as powerful storms accompanied by excessive rainfall in short amounts of time, droughts and scorching heatwaves, large temperature variation between day and night, increased UV radiation and acid rains, all these being the most significant phenomena caused by humans, to which agriculture is also a contributing factor [GOLDEWIJK and RAMANKUTTY, 2004].

The extreme amounts of rainfall lead to soils degradation and erosion, as the soils are no longer capable to absorb rainwater. On the other hand, the lack of rainfall and excessive temperatures lead to desertification and ultimately to the loss of cultivable land. There is a 20% chance of a 4°C increase in global warming by 2060, which further increases to 80% by 2100, despite efforts from the International Community to keep the temperature increase below 2°C [TONCEA et al., 2014].

As a consequence, the plant kingdom suffers from factors such as water or wind erosion, landslides, soil compaction, crust forming, acidification or alkalinization, salting, depletion of the humus content, improper supply of usable phosphorous and potassium, and chemical pollution [TONCEA et al., 2014].

Global warming also leads to melting glaciers, rising sea levels, which in turn will lead to the disappearance of large areas of currently cultivated land. Increasingly occurring forest fires not only destroy numerous species of plants and animals, but also release massive amounts of carbon dioxide in the atmosphere [DURY et al., 2011]. Reducing the biodiversity through the use of monocultures and converting grasslands and forests in agricultural lands has led to the extinction of many plant and animal species.

The use of conventional agricultural techniques led to deteriorating quality and contamination of agricultural products with toxic substances (i.e., nitrates, nitrites, hormones, etc) leading to food poisonings or the emergence or rampant evolution of several incurable diseases, in both animals and humans. The use of differentiated agricultural techniques, starting from the assessment of the resources used, and which optimizes the inputs to yield the best results in maintaining soil fertility and securing constant crop productions, is an important objective of the current research. Implementing regenerative agricultural techniques is also essential to reduce the greenhouse effect. These practices result in increasing the input of organic material in the soil, and in trapping the atmospheric carbon dioxide in the soil, and converting it in compounds useful for plant growth, and reducing the emissions of nitrous oxides and methane, gases that contribute to the greenhouse effect that affects the whole humanity. Fighting the destructive effects of global warming is now a global priority.

STRUCTURE OF THE DOCTORAL THESIS

This thesis, called "Differentiation of agricultural techniques applied in ecological agriculture for adaptation to climate changes", contains 106 pages and has been written according to the applicable writing and editing guidelines. The thesis is structured in two parts, consisting of 6 chapters, and contains 51 tables, 36 figures and graphs, and 152 literature references.

The first part of the thesis, focusing on the state of the current knowledge, is comprised of 2 chapters, which span over 32 pages. Chapters 1 and 2 summarize the relationship between organic agriculture and climate change and the impact of organic agriculture.

The second part of the thesis presents the own research, and is comprised of 4 chapters, spanning over 44 pages. Chapter 3 describes the scope and objectives of this research, the climate conditions, characterisation of the area and the observations carried out on the 5 types of crops under study. Chapter 4 describes the materials and methods used in the research. Chapter 5 presents the results and discussions of different features based on different methods of fertilization used in the organic system (fertilized or unfertilized). Chapter 6 presents the conclusions and recommendation formulated based on the results obtained in this research. The thesis concludes with the used bibliography, and a Romanian and English summary.

AIMS AND OBJECTIVES OF THE RESEARCH

Although ecological products are desired and sought after by many people, they are available in smaller quantities than in other cropping systems. This highlights the importance of increasing productivity in the organic farming sector. In this regard, in the framework of this thesis, we aimed to improve the cultivation technology within a crop rotation composed of 5 species, namely soybean, wheat, rapeseed, maize, sunflower in organic farming and to specify the necessary agrotechnical procedures.

To this end, the following objectives were set:

- Setting up an experimental field to highlight the role of fertilization in organic farming;
- Investigation of the behaviour of crops grown under organic farming conditions, by applying two fertilization variants: fertilized and unfertilized;
- The influence of fertilization in organic farming on the productivity traits of plants;
- The influence of fertilization in organic farming on productivity traits and crops obtained;
- Studying the interrelationships between production components and quality attributes by means of correlation;

- Determination of the influence of interrelationships between production elements, using linear regressions;
- Recommendations on optimizing the cultivation technology in organic farming.

MATERIALS AND METHODS

The improvement of the morpho-productive traits are important requirements for the development of the organic farming sector, with the aim of obtaining both higher and qualitatively better crops. To this end, the influence of fertilization on certain agricultural production traits was evaluated in an organic system, in a series of 5 different species of field crops, during the experimental years, namely 2020/2021 and 2021/2022.

Biologic material

The biologic material consisted of 5 plant species (soybean, wheat, rapeseed, maize, and sunflower), all of which were evaluated in terms of their main productivity components, each being grouped in 2 categories (fertilized and unfertilized). These 5 species included both varieties and hybrids, depending on the plant type.

Research method

Regarding to the 5 species, the characteristics: seeding date, seed density per m2, row spacing, quantity of seeds per hectare, sprouting date, number of sprouted plants per m^2, maturity end date, moisture and quality, were determined. Seeding was mechanized, depending on the crop, starting in 2020 respectively in 2021.

The experiment was designed using a randomized block method with three replications; the experimental plot was 1 ha. The amount of organic fertilizer (cattle manure: 77% water; 20% organic matter; 0.45% nitrogen; 0.23% P_2O_5; 0.50% K_2O; 0.40% CaO) was applied with a Fimaks FMGR 5 t manure spreader trailer, according to the amount required for each crop (soybean - 10 t/ha; wheat - 10 t/ha; rapeseed - 25 t/ha; maize - 20 t/ha; sunflower - 20 t/ha). The experimental variants were:

V1 – unfertilized (control)

V2 – fertilized (soybean – 10 t/ha; wheat – 10 t/ha; rapeseed– 25 t/ha; maize – 20 t/ha; sunflower– 20 t/ha)

Observations and determinations

For the biometric determinations of the production elements, 10 plants from each replicate were used for each species. The traits analysed in this study were for:

- Soybean: plant density (plants/m2); plant height (cm); pod insertion height (cm); number of pods/plant; number of grains/plant; mass of grains/plant; MMB (g) and yield (kg/ha).
- Wheat: plant height (plants/m2); plant height (cm); ear length (cm); number of ears/plant; number of grains/ear; mass of grains/plant (g); MMB (g) and yield (kg/ha).
- Rapeseed: plant density (plants/m2); plant height (cm); number of branches/plant; number of pods/plant; number of grains/plant; mass of grains/plant (g); MMB (g) and yield (kg/ha).
- Maize: plant density (plants/m2); plant height (cm); number of cobs/plant; cob length (cm); number of corns/plant; corn mass/plant (g); MMB (g) and yield (kg/ha).
- Sunflower: plant density (plants/m2); plant height (cm); plant height (cm); diameter of calathidium (cm); diameter of dry calathidium (cm); number of grains/plant; mass of grains/plant (g); MMB (g) and yield (kg/ha).

Statistical methods

Experimental data were statistically processed using Microsoft Excel 365, Polifact and R version 4.3.1.

The test for normal distribution was carried out using descriptive analysis, followed by a test for normal distributions (Shapiro-Wilk test) was also used, as the sample did not exceed a size of 50 samples.

ANOVA (analysis of variance) was used to test for differences in production parameters in organic farming, based on the fertilization method.

Pearson correlations were used to highlight the degree of association between the main characteristics analysed in this work. Once the variables which show relationships and which may have an influence on future yield were determined, another type of analysis was carried out, namely linear regression analysis. Linear regressions were used to establish relationships between production parameters, i.e. the extent to which certain traits are influenced by others.

RESULTS AND DISCUSSIONS

Chapter 5 presents the results and discussion of the differences between the fertilized and unfertilized variants of each crop, in the ecological system. Chapter 5 is divided into 3 sub-chapters, which present aspects related to the influence of fertilization on productivity traits, the influence of fertilization on productivity elements and the relationship between productivity elements and traits.

Regarding the influence of fertilization on productivity traits, in the soybean crop, all the studied traits showed significantly higher values compared to control group, represented by no fertilization. The plant density, height of stem, height of insertion and number of pods/plant were higher than the control.

In the wheat crop, most of the analysed traits showed significantly higher values than the control group. Plant density, and ear height and length were superior to the control group, and the number of ears/plant did not show a significant difference.

In the rapeseed crop, all the analysed characteristics (i.e., plant density, plant height, number of branches/plant and number of pods/plant, were higher than the control group.

In the maize crop, the plant density, cob height and length were greater than the control, while the number of cobs/plant did not differ significantly. In the sunflower crop, the plant density, plant height, calathidium diameter and calathidium dry diameter were higher than the control group (unfertilized).

With regards to the influence of fertilization on productivity elements, in the soybean crop, all the studied characteristics (i.e., number of pods/plant, grain mass/plant, MMB and yield) were higher than the control group.

In the wheat crop, all the analysed characteristics (i.e. number of grains/ear, grain mass/plant, MMB and yield, were higher than the control group.

In the case of the rapeseed crop, all the analysed characteristics (i.e. number of pods/plant, pod mass/plant, MMB and yield) were higher than the control group.

For the maize crop, the corn mass/plant, MMB and yield were above the control group. However, the number of grains/plant did not exceed the control group.

For the sunflower crop, the number of seeds/plant, MMB and yield were higher than the control group. No differences were recorded for seed mass/plant, between the study groups. It did not show values higher than the control for grain mass/plant.

In terms of the relationship between elements and productivity traits, a number of correlations and regressions were determined for most crops.

For soybean, a positive relationship was determined between MMB and first pod insertion height, and between yield and MMB, respectively.

For wheat, a positive relationship was determined between grain mass/plant and height, and a negative relationship between grain mass/plant and yield.

For rapeseed, positive relationships were found between grain mass/plant and number of branches/plant, and between number of grains/plant and number of pods/plant. Negative relationships were determined between plant density/m^2 and number of pods/plant, number of grains/plant and MMB. Other negative relationships were also found for rapeseed between grain mass/plant and MMB and between MMB and yield, respectively.

CONCLUSIONS AND RECOMMENDATIONS

Constant climate changes, such as droughts during summer, frosts that come too suddenly after warmer periods, or heavy rains that often come with hail, lead to imbalances that can affect crops, thus reducing yields. In the case of organic farming, the restrictions on the use of chemicals, in addition to the action of climate factors, lead to reduced yields. The aim is therefore to maintain and even increase yields by using natural means that meet the eligibility criteria for organic farming. Studies have shown that the application of natural fertilizers, such as manure, provides nutrients to the plants and thus increases yields. In the soybean crop, an increase in the quantity of each trait was observed following the application of fertilization, compared to the control group (which was not fertilized). Also in wheat crop, higher values were recorded in the fertilized group, compared to the control (unfertilized) group. In the case of rapeseed, the use of a fertilizer also had a positive influence, resulting in higher yields than the control group. Moreover, in maize and sunflower, fertilization also played an important role in increasing yields.

Fertilization had a positive influence both on the productivity elements and on the productivity traits, the yields obtained being higher than those obtained from the control groups. This highlights the fact that fertilization plays an important role in increasing the yields obtained in different crops.

In addition to fertilization, following correlation and regression analyses, a series of interactions (positive and negative) were identified, which have an influence on the final yield. Depending on the crop and the importance of each interaction, the information can be used to obtain better crops with higher yields.

THESIS ORIGINALITY

Organic farming, a major part of agriculture, has recently been gaining more and more interest from people due to its superior quality production. The study carried out in this doctoral thesis titled: " Differentiation of agricultural techniques applied in ecological agriculture for adaptation to climate changes", addresses a number of current and relevant factors that are important for the efficient development of this agricultural sector.

The initiation of this research was based on the importance of identifying the influence of applying natural fertilizers in organic farming crops, which leads to increased future yields.

The results obtained have highlighted the advantage of using these natural fertilizers in organic farming, providing valuable data that can be further used in new studies, with the aim of improving the protocols or methods used in organic farming.

The originality of the thesis resides in the applied research methods on the 5 crops under study, situated in different locations, in order to achieve the proposed objectives for differentiating the agricultural techniques applied by farmers, within organic farming, with respect to the climate changes taking place.

Differentiated fertilization based on the crop in the rotation would have a positive influence on crop development and maintenance of soil fertility.

SELECTED REFERENCES

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