
SUMMARY OF PhD THESIS

Research regarding the advantages of using sheep wool in different crops

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Introduction

The ground is involved in society's life, being the place and the space for population settlement and also the infrastructure for all anthropic activities. Indeed, for society fulfills many varied functions, ecological, economic , energetic, technical-industrial and IT, it helps to satisfy society's requirements and to continue life on Earth.

It is important householding the ground with care, protecting this essential resource, keeping its functions of fundamental significance for nature and also for human society. It brings a contribution for educating people who work with soil. Due to the conventional agriculture from the last years, soil degradation, it's a big problem for Europe. A thematic strategies given by Nitrates Directive (1991), stimulates the farmers to become more positives towards environmental protection, exploring new agriculture ways.

Sheep's wool it's a 100% natural material, sustainable, recyclable and biodegradable, which doesn't contains any chemical substance or others environmental pollutants.

Keywords: soil, crops, sheep's wool, substrate, organic, environmental protection

The main idea done for this research in the doctoral thesis, entitled *Research about using sheep's wool in horticultural dendroids crops* , reflects the developing a innovative strategies through using raw sheep's wool. A logistic concept, named briefly „ *sheep's wool from farm to land*” which refers using them like a substrate in horticultural dendroids crops.

The experiments done in the doctorate thesis follow up an actual evaluation of growing the tomatoes plants (*Solanum lycopersicum L.*) and the blackberries (*Rubus fruticosus*), which have at the base a sheep's wool substrate, therefore there are possibilities to obtain crops, competitive harvest, who can protect the soil and the resources given by it.

The research done, have the main purpose using sheep's wool in

horticultural dendroids crops, follow a specific objectives , like:

- describing, from the hydro-climato-geomorphological and pedological point of view, the zone where the research were done;
- identifying and analyzing from a psycho-chemical point of view the soil types present in the study area;
- describing plants species used in horticultural dendroids crops who were achieved in this research
- setting up the experimental field, which was made in two steps: first step of sowing the seeds in alveoli, the second step of planting seedlings in the ground;
- were followed clues of development and germination' s report for tomatoes(*Solanum lycopersicum L.*);
- for blackberry (*Rubus fruticosus*) were followed the next: the number, the plants' size and the number of leaves, developed on every substrate used;
- using sheep's wool in different alternatives of substrate for setting up of horticultural dendroids crops
- making physico-chemical analysis of soil from the experienced ground and from soil mixed with unwashed wool for identifying the contribution of nutritious substances brought by wool for the used substrate.

WORKS' STRUCTURE AND THE RESEARCHES' RESULTS

Using the theme “*Research about using sheep’s wool in horticultural dendroids crops*” was considered a general objective like using sheep’s wool like a substrate of growth in culture of tomatoes (*Solanum lycopersicum L.*) and the blackberry (*Rubus fruticosus*). Were followed the growth and the development for this species from the beginning of the crops to the maturity and it was statistically analysed the best variant of soil mixed with sheep’s wool.

The present work is structured on three main parts.

- **The current study of knowledge**, where was used bibliographic documentation so studying the specialised literature. It was made a retrospection regarding the prior research of hydroponic crops and using sheep’s wool like a substrate in different agriculture crops.
- **Personal contribution, results and discussions** which followed many directions, respectively the favorability using sheep’s wool in the two crops analysed in this study. It was highlighted the study of soil’s characteristics, climate and vegetation which influence the growing and the development of tomatoes and blackberry’s crops.

Medium temperature in Sandulesti county territory, is between 8 degrees Celsius and 8,5-9 degrees Celsius.

The cernisols class (CER), occupies an area of 1348.7 ha, respectively 73% of the total mapped territory being located at the level of slightly sloping surfaces and slopes, with different exposures, this class includes the following types and subtypes of soils: typical chernozem, typical chernozem with active slips in furrows and stabilized waves, cambic chernozem, gleic phaeozium, calcareous phaeozium, calcareous rendzine.

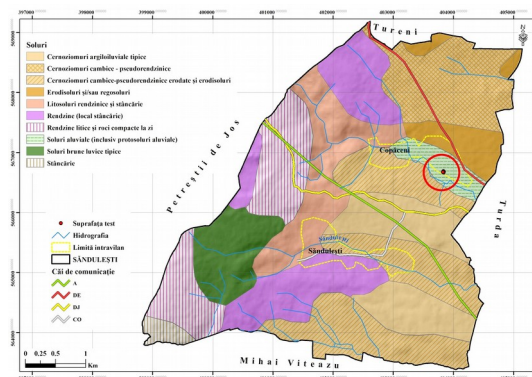


Fig. 1. Soil map in Sandulesti county

For tomatoes crops, the most favorable conditions, are those which ensure a medium yearly temperature over 100 C and July's temperature over 210C, with over 200 days without frost and over 30000 C yearly amount of active temperatures (over 100C).

The best soils for tomatoes crops are the medium, rich in humus; and sandy soils, warm and well drained which are fitted for early crops, the condition is to be well irrigated.

The optimum reaction of soil for tomatoes is neutral to easy acid (pH=5,5-6,5).

Therefore, biological material investigated is represented by tomatoes seeds indeterminate Oasis F1 from Clause, to which the maker ensures a 90% germination.

In the experiment was used sheep's wool, from Turcana breed, being the most known breed from Romania, the total number of sheep in our country is 80,5%, according to the latest technical bulletin issued by ANARZ.

Germination experiments and seedlings productions was made in two successive years 2016-2017, in Pedology laboratory from USAMV, Cluj-Napoca, the seedlings replanting was made in a experimental ground in a garden from Copaceni, Sandulesti county.

The experimental scheme for testing the effect of sheep's wool about germination of tomatoes seeds was presented in the image below and was involved the use of plastic 24 alveoli at 240C temperature.

- A1 - peat TS3 (witness sample);
- A2 - washed sheep's wool (LOS);
- A3 - peat TS3 + unwashed sheep's wool 1:1 (TLN);
- A4 - peat TS3 + washed sheep's wool 1:1 (TLS);



Fig. 2 Mini greenhouses with sprouted seeds

The amount water used was 400ml/ mini greenhouse, as the plants grow the amount of water rises. The amount of water used for maturity seedlings was 500ml/plant/day.

The seeds was sown in alveoli on four different substrates.

After the sprouting, when the seedlings reached 20 cm length were put in individual glasses.

After 4 weeks approximate, when the tomatoes' growth was sufficient (around 30-35 cm), were moved in 1 meter length crates, then were planted in open ground.

Sprouting results of tomatoes seeds were statistically interpreted for every substrate.

On experiment period , 2016-2017, the sprouting capacity of tomatoes seeds recorded a maximum of medium values of 77,09% in 2017, and a medium value in 2016 of 74,99%. It shows that the substrate A3 - peat TS3 + unwashed sheep's wool favorised the germination for both experimental years.

From a statistical point of view the medium values of developed number of plants on a duration of 30 days show differences recorded in 2016 compared to 2017, at the significance threshold of 5%.

Following the tomatoes evolution from the sowing to the maturity, it was noticed that, the favorable substrate was, A3 - peat TS3 + unwashed sheep's wool 1:1 (TLN).



Fig.3 Seedlings developed on four substrates

Because, the seedlings were moved in crates, was used garden soil, it was made a physico-chemical analysis of the soil, where was followed the content of N, P, K.

The same test was repeatedly also for the option with mixed unwashed wool, for noticing the contribution of nutritious substances brought by wool.

Table 1

The physico-chemical analysis of the soil

Nr. Crt./ Current No.	Identificare probă/ Identified sample		Denumire analiza/UM Analysis/MU			
	Nr. Lab./ Laborator y number	Nr. probă recoltare/ Number of recoltation	pH	N %	P ppm	K ppm
1	1	Sol	8,08	0,6	1140	6500
2	2	Sol+lână	8,24	2,18	1290	11450

After the result reading, it is noticing that the sheep's wool enriched the soil with nutritious elements like: +1,58% N; +150 ppm P; +4950 ppm K.

Even if the best developed and strong plants grew on option A2 - washed sheep's wool, it remained the fewest yarn of tomatoes compared with other variants.

Therefore, was quantified even the the influence of substrate' s type on the number of tomatoes at 50 days. It is noticing that option A3=TLN, has better results compared to the witness.

The option A2=LOS, washed sheep's wool, it is noticing with negative results, compared with the option A1- witness, even if to the plant height

criterion's for the same experimental period it is noticing with the best results from all alternatives.

Both experimental years, is presenting that, the medium number of plants at 50 days from the beginning of the experiment, is 20 plants at V3=TLN, peat TS3 + unwashed sheep's wool.

This positive growing trend, is noticing on the duration of 6 days, respectively 30 days from the beginning of the experiment.

The variant A2 - washed sheep's wool (LOS), is presenting the lowest value of the average number of plants, 91,21%, a negative difference compared to the witness.

The growing process of tomatoes' stem, at 50 days from setting up the crops, for both experimental years, 2016,2017, in a open ground conditions, it is noticing that all 3 variants have positive results compared to the witness variant, and from these is detaching option A2=LOS represented by sheep's wool, which exceeded the witness with 7.33 %, respectively A3=TLN with 5.33% percent.

At the blackberry crop, the soil has to have an easy acid pH, the optimum pH is around 6,2-6,5.

The blackberry varieties are less demanding at soil, the condition is to have sufficient humidity.

It is a friendly crop with high temperature and the light, but can't resist below -170 C temperature.

It was used for this experiment like biological material, the blackberry, *Rubus fruticosus*, Chester variety, vitro crops in multiplication phase from vitro crops laboratory from the Life Sciences Institution the Reign of Romania Mihai I, USAMV Cluj-Napoca.

The shoots obtained are still used in acclimatization experiments in substrates with sheep's wool.



Fig.4 Mini greenhouses with blackberry offshoots

The experiment continued after the plants were planted in mini greenhouses, in the first two weeks were covered and deposited in a room with light at a temperature between 22-24°C. The quantity of water used for watering the plants was 500 ml/ mini greenhouse.

The results of growing blackberry plants were statistically interpreted for each variant of substrate, regarding the influence of substrate's type on the number of roots/ the blackberry plant after 60 days and the influence of substrate's type on the number of leaves/ the blackberry plant after 60 days.

Analysing the influence of substrate's type on the number of leaves/ the blackberry plant after 60 days, on experimental period, 2016-2017, it doesn't noticing any difference compared with witness variant. The results obtained are insignificant on each option of substrate.

The year 2016, the number of blackberry leaves/ plant had representative values for plants which were developed on the substrate from peat, the year 2017, the options which were developed on a substrate mixed with washed sheep's wool had more high values but with insignificant differences. Representative values were recorded at the options where was used substrate from peat mixed with washed and unwashed sheep's wool, with differences of 0.66 leaves/plant to the witness.

Suggestions and conclusions

The emphasis was on the realisation of a concept, which correlate the environment protection with pedological and hydroclimatic factors through reusing raw material and the waste from other technological process.

Therefore the experiments, which were made in this doctoral thesis, for the period (2016-2017), followed the quantify of tomato and blackberry plants numbers (*Solanum lycopersicum* și *Rubus fruticosus*), and also their physiological development, having like a substrate for growing, sheep's wool in mixed with peat and garden soil.

1. Analysing sheep's breeders problems; like the management of sheep's wool and the problems, which results from its uncontrolled storage we value the framing of this organic waste as a substrate for crops without soil and there is a favorable using for this 2 crops.
2. Due to the crops without soil, several aspects are assured, related to the quality of soil: complete control of mineral nutrition, macro and microelements, of their concentration and the ratio between them, of the chemical reaction (ph); reducing the soil work and total control of diseases, the pests of soil and weeds; the ease of irrigation, the sterilization of the crop substrate, water and fertilizers saved.
3. The results obtained through this experiment based on sheep's wool like a substrate, emphasis the advantages of using it: big capacity of absorption and keeping the water, therefore it prevent the dry of soil, minimizing its erosion. Sheep's wool fibers are expanding when are becoming wet, ventilating the soil, it helps the roots. Due to the nutrient content of wool the efforts of the refertilization throughout the season could be reduced. Contrary to synthetic fertilizers, the sheep's wool does not destroy the soil, it maximizes the maintenance of biodiversity.
4. The results of land fund and the zootechnical situation from Sandulesti county, from 1020 ha arable, 15 ha are occupied with, growing vegetables and 11 farmers, who are growing 3250 sheeps, emphases , their correlation with the proposed research.
5. The research results and the statistical interpretations states that the best variants of substrate for those two crops are washed and unwashed wool mixed with the soil.
6. Therefore the problem of using sheep' wool, could find an efficient using, given that the sold wool doesn't cover the harvested costs.

The originality and the innovative contributions of the thesis

The genuine contribution to the doctoral thesis entitled “Research about using sheep’s wool in horticultural dendroids crops” are summaries, as follows:

1. Using sheep’s wool in 3 different variants of substrate, washed and unwashed wool mixed with treated soil and garden soil.
2. Within the thesis it was conceived and applied for the first time a model for identifying the favorability of wool’s substrate for tomato and blackberry crops.
3. Achieving the analysis made for the contribution of nutrients N, P, K, brought by the wool to the soil.
4. Monitoring of climatic factors and their influence to the plants development for the whole experiment.
5. It was made SWOT analysis for sheep’s wool used like a substrate in agriculture crops.
6. The using of statistical method (ANOVA) for interpreting the data obtained, in order to evaluate the characteristics resulting from using sheep’s wool like a substrate for those 2 crops, of tomatoes and blackberry.

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