



WROCLAW UNIVERSITY
OF ENVIRONMENTAL
AND LIFE SCIENCES

Effect of differently matured compost produced from willow (*Salix viminalis* L.) on growth and development of lettuce (*Lactuca sativa* L.)

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INTRODUCTION

Recent decades, a significant decrease in humus resources in terrestrial environments (especially cultivated areas), due to increased mineralization of organic matter, has been observed

What are the consequences?

Rapid reduction in soil fertility and productivity, catastrophic impact on crop production and conservation values of terrestrial ecosystems

How did the scientists respond?

Recommendations, resolutions, guidelines, programmes and projects developed by international organizations (FAO-WRB, IUSS, EGU-SSS, ISEB, etc.) in order to limiting the negative effects of environmental changes, increasing the soils quality and increasing the soil organic matter (SOM) content

How to do it?

The use of sustainable tillage and the introduction of organic or organic-mineral soil conditioners produced from exogenous organic matter (EOM)

How to produce them?

One of the solution is the use of products formed from biodegradable substances as a result of biological treatment : processed digestates and composts

What to use for production?

Using **alternative sources of EOM**: segregated "green waste", biodegradable municipal waste or biomass from the cultivation of various plant species, etc., with a particular **focus on** the concept of using biomass from the cultivation of **energy willow as a substrate** for compost production

AIM OF THE STUDY

The aims of the study:

- **to determine the possibility of using willow chips¹⁾ as the main substrate for composting,**
- **to determine the effect of mineral and organic additives on the intensity of composting,**
- **to determine the fertilizer value and potential use of composts,**
- **to determine the functional value of the obtained products**

¹⁾ Patent protection in progress. Copyright on the bases of application to the Polish Patent Office No. P.435103

MATERIALS AND METHOD

1. Selection of substrates for composting:

- energy willow chips: diameter of approx. 2,5 cm, obtained from 3-years old plants;
- hay obtained from extensive meadows: 50% grasses, 25% legumes (mainly lupins, clover) and about 25% other herbaceous plants;
- mineral supplement: ammonium nitrate 34% total nitrogen (17% ammonia nitrogen and 17% nitrate nitrogen)



MATERIALS AND METHOD

2. Determination of substrate composition and establishment of experimental piles variants:

A. willow chips (2 tons) with no additives

B. willow chips (1 ton) mixed with hay (1 ton) – mass ratio as 1:1 (in d.m.)

C. willow chips (1 ton) mixed with hay (1 ton) and ammonium nitrate (40 kg) – mass ratio as 1:1:0.04 (in d.m)



MATERIALS AND METHOD

3. Analysis of the basic composts properties.

Compost samples of different maturity stage were dried until air-dry, and then ground mechanically to a diameter of ≈ 2.0 mm. The following determinations were performed:

- pH in H 1 mol KCl · dm⁻³
- content of total organic carbon (TOC) and total nitrogen (TN) using Vario Macro Cube CN analyzer (Elementar Analysensysteme GmbH, Germany)
- Content of total phosphorus (TP) by MP-AES 4200 analyzer (Agilent, USA)

MATERIALS AND METHOD

4. Vegetation experiment - the effect of composts at different maturity stages on germination and initial growth stages of lettuce (*Lactuca sativa* L.)

Two-factor pot experiments were established:

- first factor - the type of composting variant: A, B and C.
- second factor - the compost maturity stage using samples collected after 1, 32, 71 and 167 days of composting.

The pots were filled with a 0.5 kg mixture of the inert mineral component (control sample) and the tested variants in the dose corresponding to approx. 200 tons of compost · ha⁻¹



MATERIALS AND METHOD

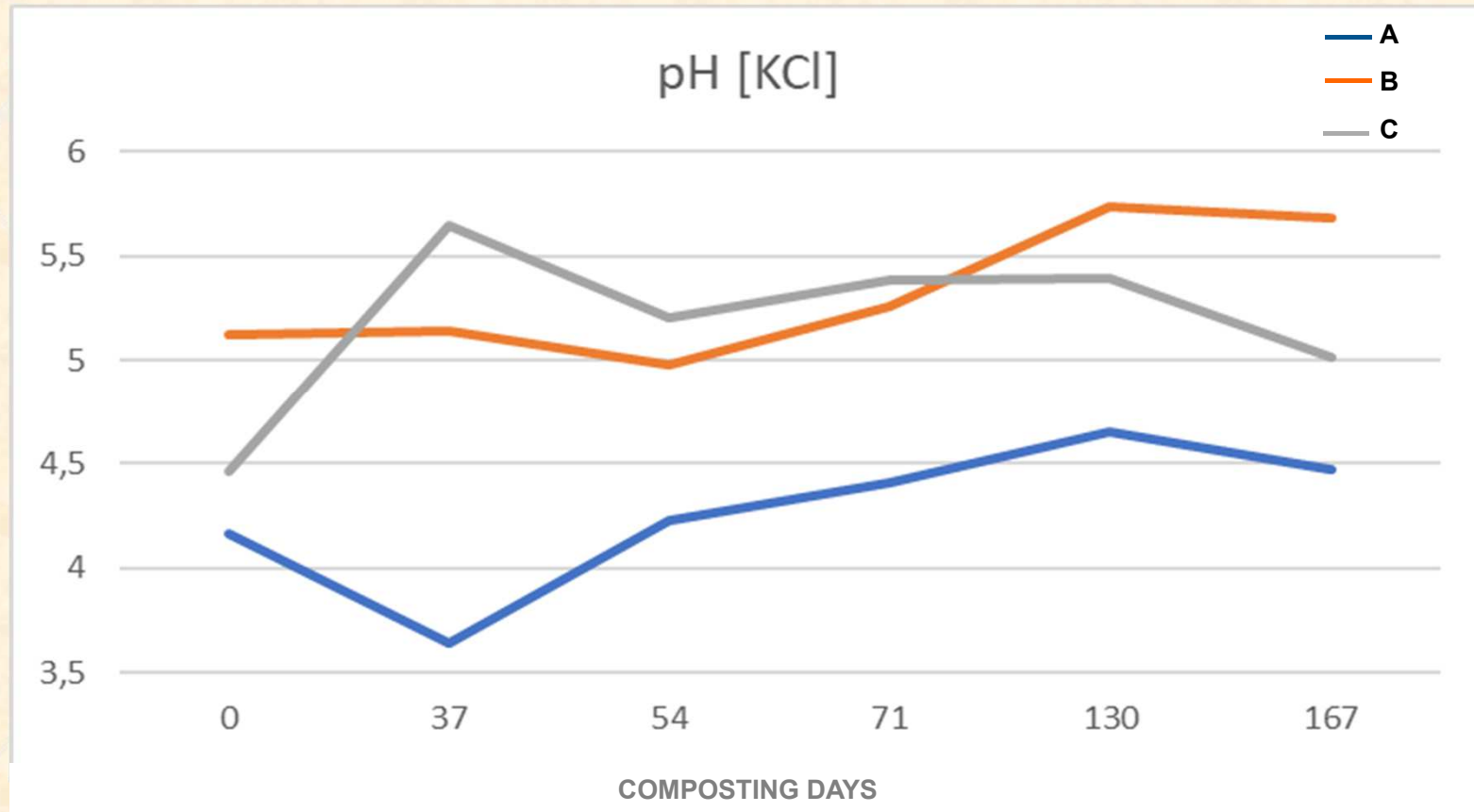
4. Vegetation experiment – continued

The experiment was conducted in two stages:

- **Stage 1 - germination of the test plant: time - 20 days, average temperature 20°C, irrigation at 5-day intervals of 20 cm³ H₂O; number of seeds sown 5 per pot**
- **Stage 2 - growth, development and yield of lettuce: lettuce seedlings from step 1 (1 piece per pot), time - 20 days, average temperature 20 degrees, irrigation at 5-day intervals until moisture content of 50% H₂O;**

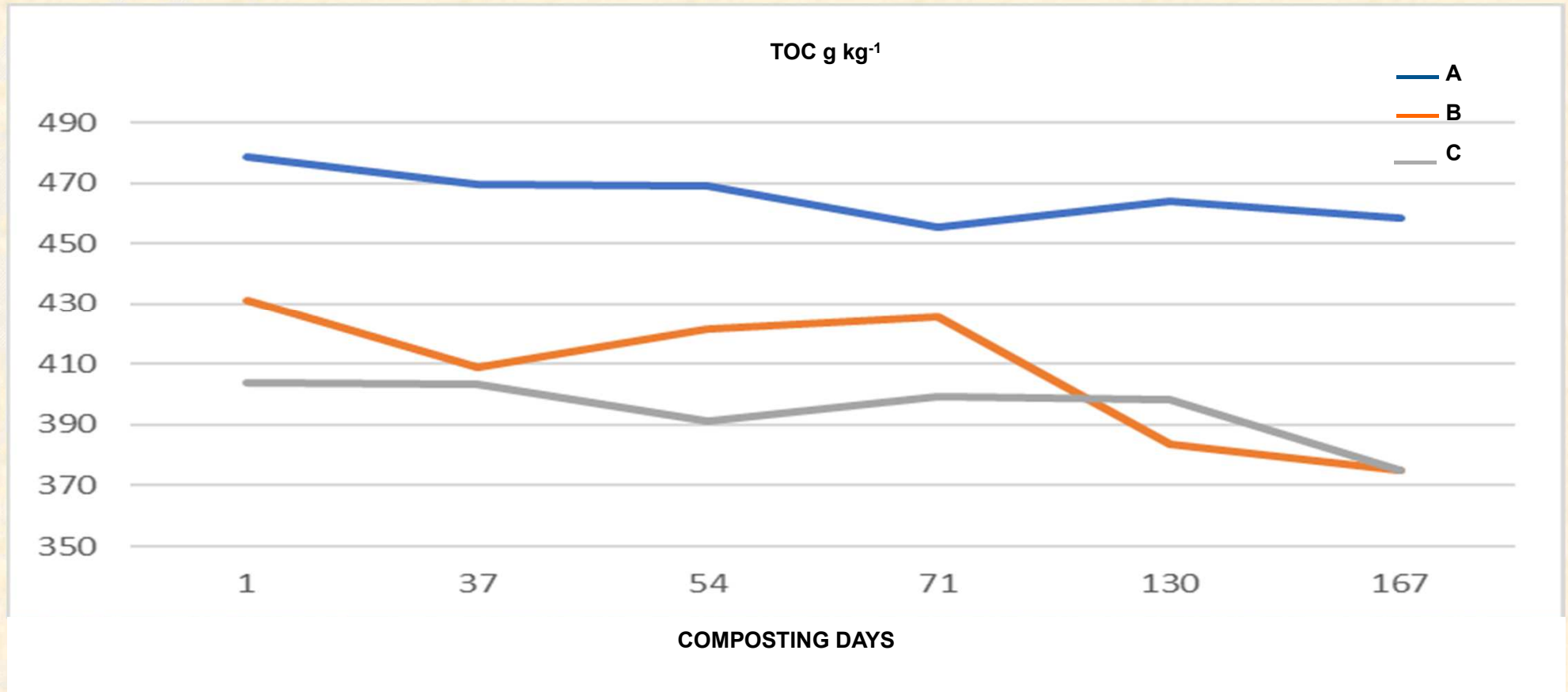


RESULTS



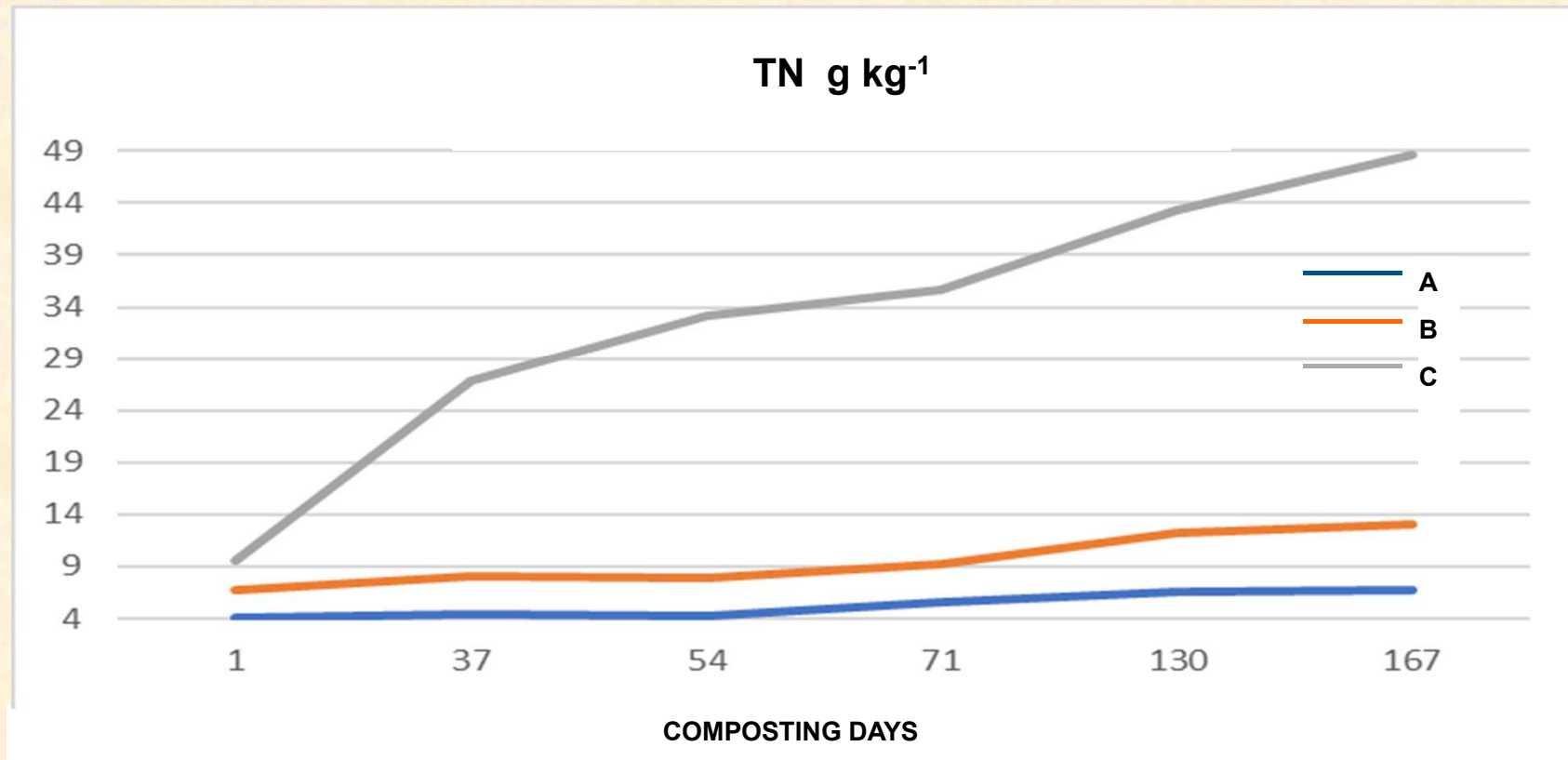
- All investigated samples were over-acidified
- The dynamics of reaction changes showed different intensity

RESULTS



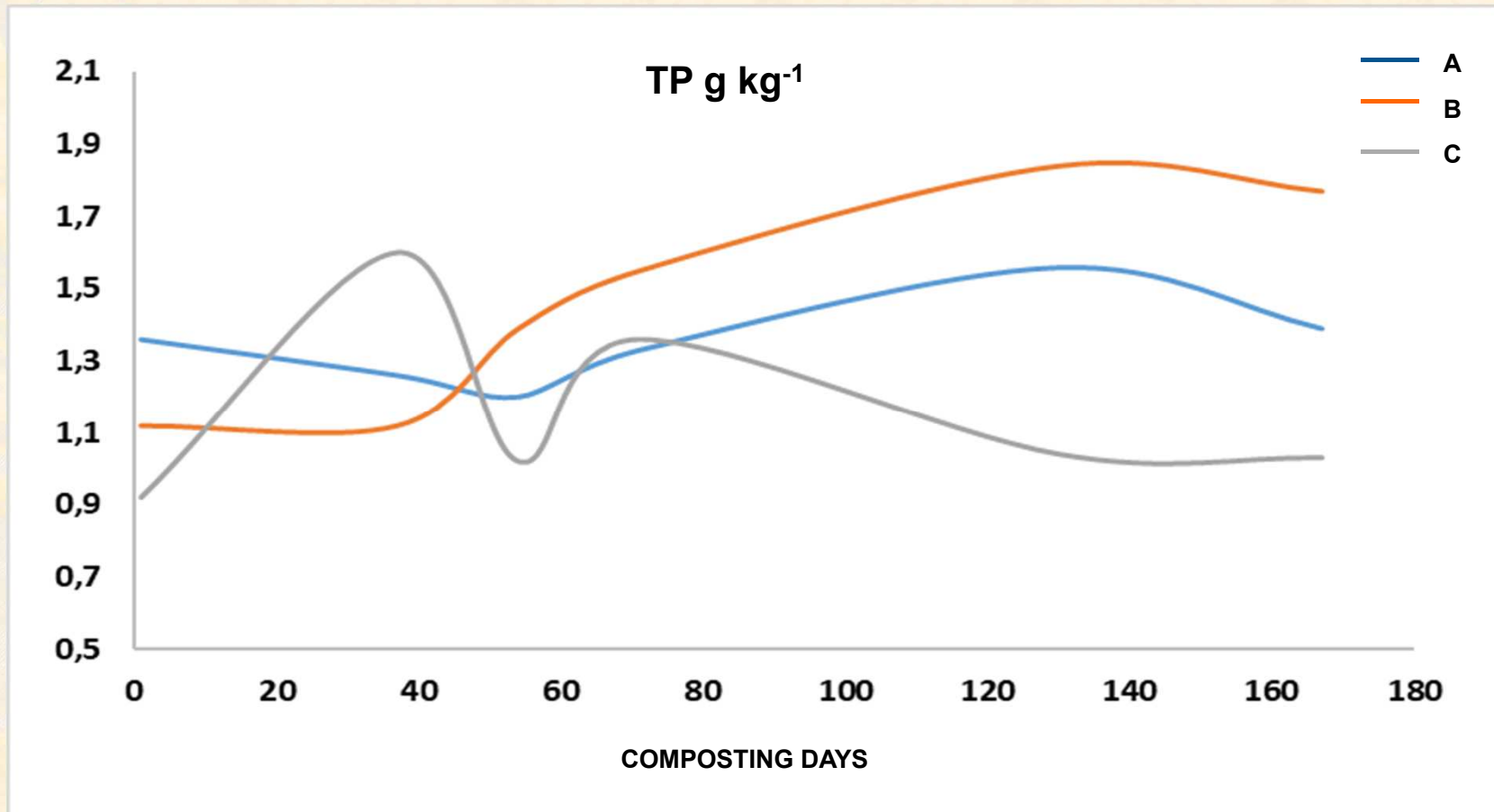
- In all investigated variants a decreasing trend in TOC content was observed
- The dynamics and intensity of TOC changes depended on the composition of the composted material

RESULTS



- In all tested variants, an increasing trend of total nitrogen (TN) content was observed, especially after 70 days of composting
- The dynamics and intensity of changes was the highest in variant C

RESULTS



- In all tested variants, very low contents of total phosphorus (TP) were observed
- The dynamics of changes in the content of phosphorus differed depending on the maturity of the compost and the composition of the composted mass

RESULTS

GEMINATION OF THE TEST PLANT

NUMBER OF LETTUCE (*Lactuca sativa L.*) SPROUTS AFTER 20 DAYS OF INCUBATION (PIECES PER POT, AVERAGE VALUE)

Variant	Composting day			
	1	32	71	167
A	10	9	10	12
B	14	15	15	13
C	0	9	12	14
Control	8			

LSD = 5

● - SIGNIFICANT AT $p < 0,05$

- The samples of variant B significantly stimulated germination regardless of composting time
- The low number of germinated seeds incubated in variants A (all samples) and C (samples after 1, 32 and 71 days of composting) may indicate the effect of the inhibitory factor present in these composts.

RESULTS

GROWTH AND YIELD OF LETTUCE

WEIGHT OF LETTUCE (*Lactuca sativa L.*) YIELD OBTAINED FROM SEEDLINGS AFTER 20 DAYS OF THE EXPERIMENT (GRAMS PER POT, AVERAGE VALUE)

Variant	Composting day			
	1	32	71	167
A	1,22	1,83	1,13	1,35
B	0,86	1,98	2,09	2,15
C	4,78	1,97	10,37	5,55
Control	2,17			

LSD = 2,52

● – SIGNIFICANT AT $p < 0,05$

- The addition of hay and nitrogen to composted willow significantly stimulated the amount of lettuce yield obtained
- Similarly to the germination experiment, samples of variant A showed an inhibitory effect on lettuce growth and yield

FUTURE PLANS:

- **Continuation of research on the usefulness of willow composts as an alternative fertilizer products**
- **Optimisation of substrate compositions based on willow and other mineral and organic additives***
- **Determine the effect of bioactive compounds, mainly phenolic glycosides (salicylates), on plant growth and yield**
- **Developing appropriate ways to stimulate the composting process using technical and microbiological methods***

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CONCLUSIONS

- 1. Willow chips can be a substrate for the production of alternative fertilizer substances; however, they require appropriate organic and mineral additives and optimized composting conditions.**
- 2. Despite the applied organic and mineral additives, the tested composts were characterized by a relatively low fertilizer value.**
- 3. The results of vegetation experiments showed that regardless of the maturity stage, composts made of willow chips without additives (variant A) had an inhibitory effect on germination, growth and yield of lettuce.**
- 4. The addition of hay and Nmin to willow chips significantly increased the properties of investigated products, especially in mature compost samples.**
- 5. The study demonstrated the utility of using both chemical test results and vegetation experiments to verify compost quality.**



Thank you for attention

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