# UTILIZATION OF ANAEROBIC DIGESTATE FOR FERTILIZATION PURPOSES - A NEW TECHNOLOGY PROPOSAL

Department of Advanced Material Technologies, Faculty of Chemistry, Wrocław University of Science and Technology, Wrocław, POLAND

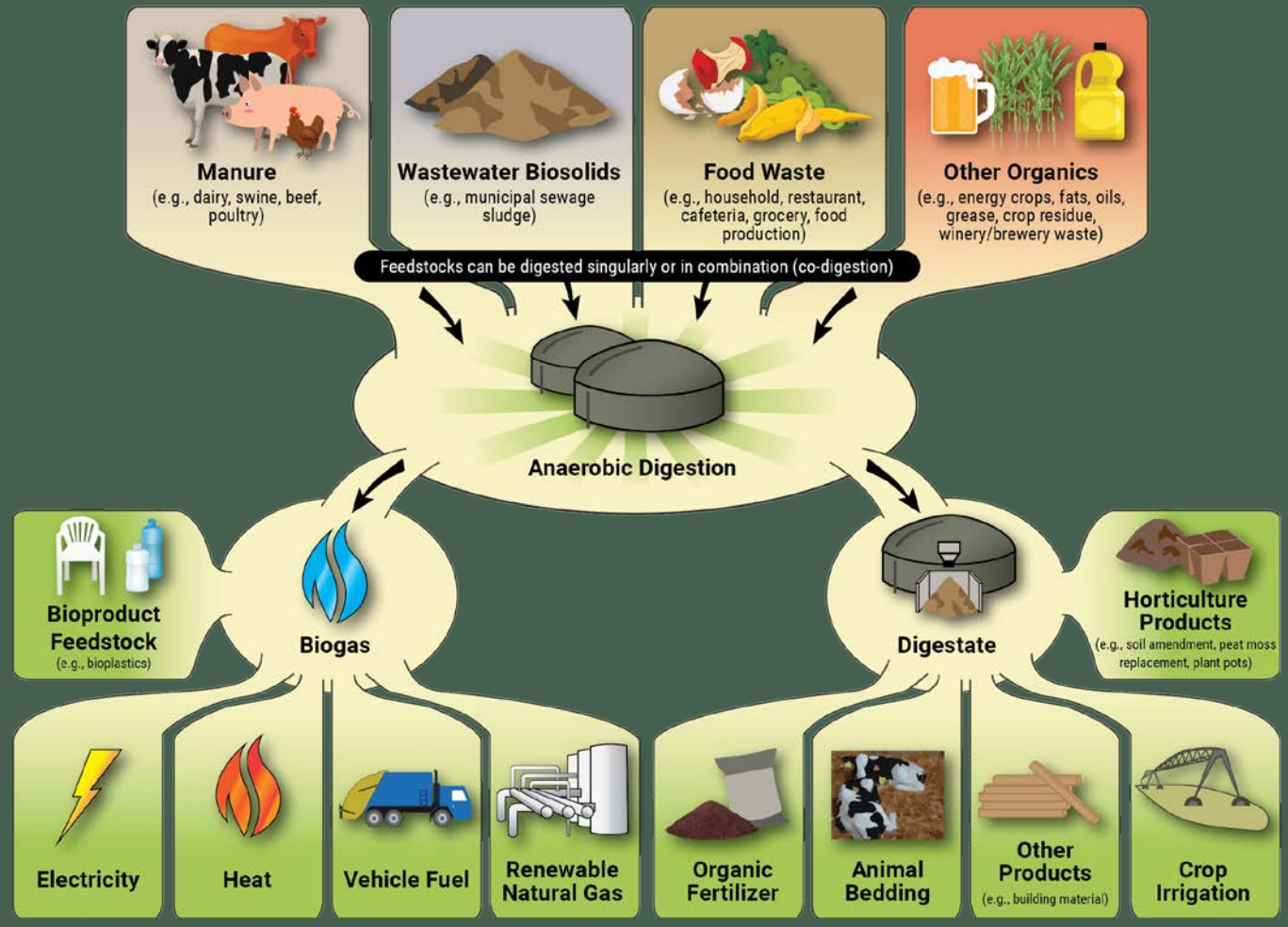
MAŁGORZATA MIRONIUK

9th International Conference of Sunstaniable Solid Waste Management, 15-18 June 2022

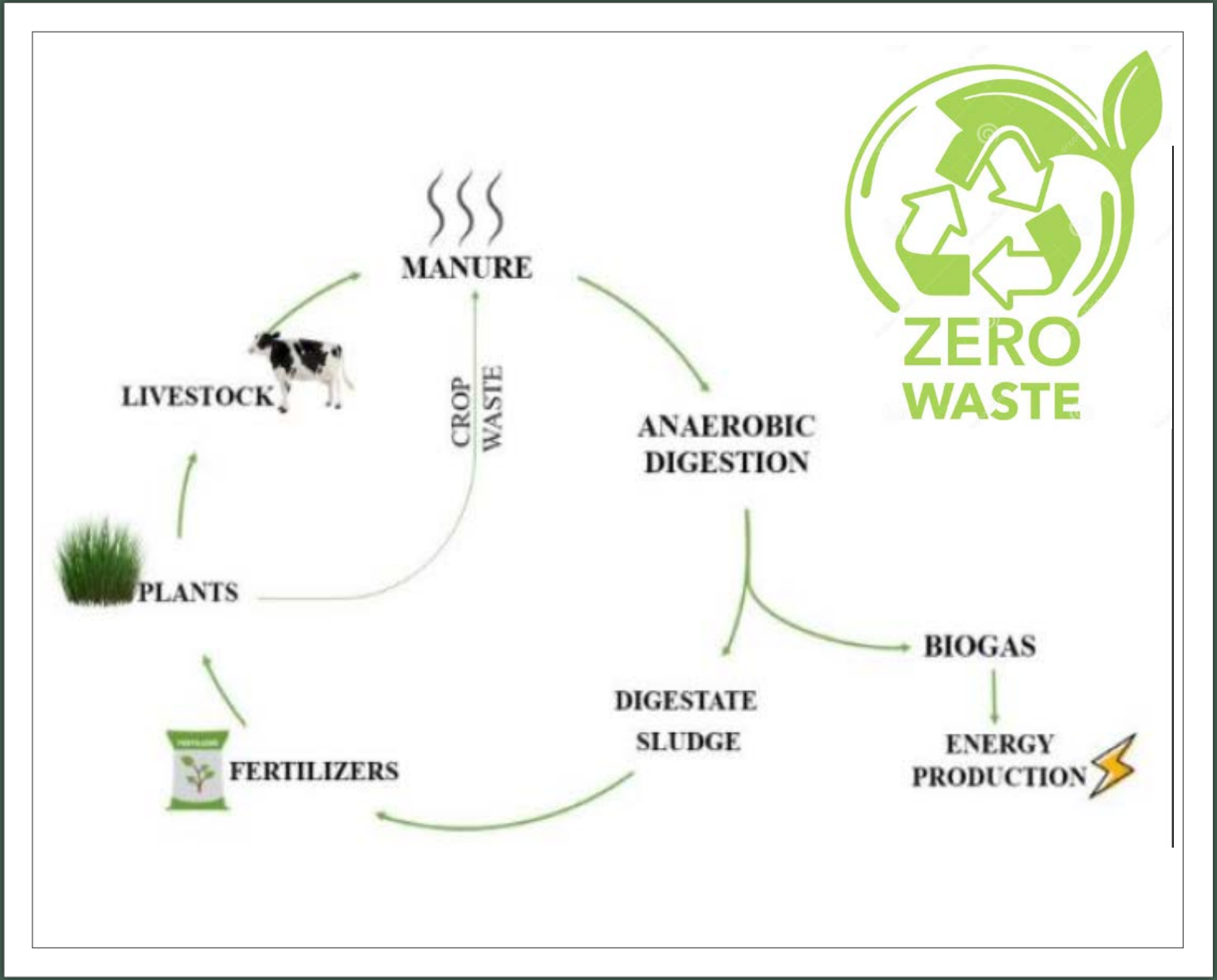
# PROBLEMS TO SOLVE

- Negative impact of the production of mineral fertilizers on the environment
- Low content of organic matter in arable soils
- Greenhouse gas emmisions from livestock production
- Depletion of nutrients from non-renewable sources

# ANAEROBIC DIGESTION




9th International Conference of Sunstaniable Solid Waste Management, 15-18 June 2022




# AIM OF THE RESEARCH

# SCHEME OF THE EXPERIMENT

- Obtaining different types of digestate
- Analysis of the composition of raw materials
- Alkaline hydrolysis (sanitization)
- Neutralization
- Granulation
- In-vitro tests

# SOURCE OF DIGESTATE

1. Sugar factory - Südzucker Polska S.A. – sugar beet

2. Agricultural Biogas Plant
- EPPO Sp. z o.o.
- plant parts, food (bread)

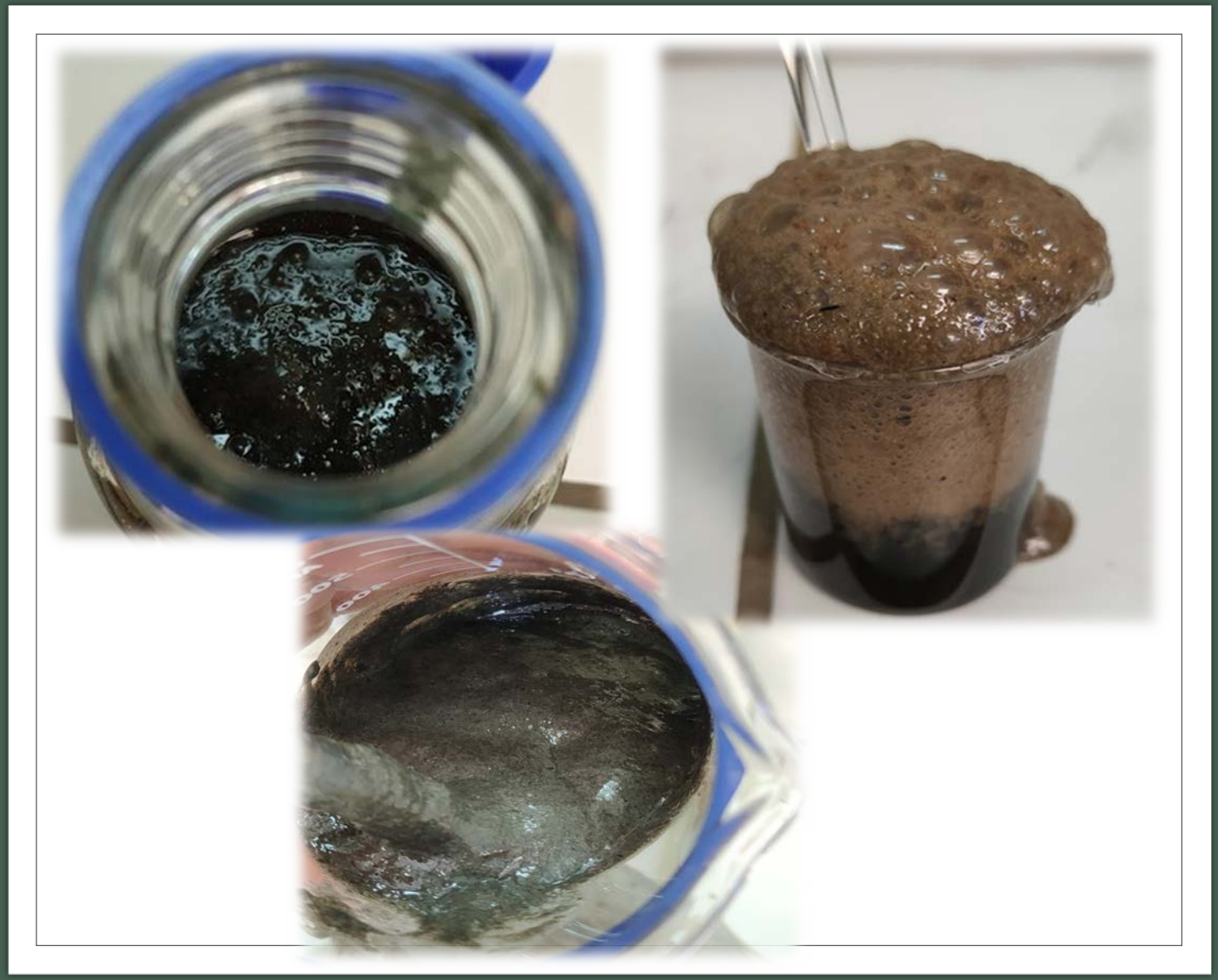
# ELEMENTAL COMPOSITION

| Macro-nutrient | Sugar digestate [%] | Agricultural digestate [%] |
|---|---|---|
| **N** | 0.49 | 0.61 |
| **P** | 0.013 | 0.15 |
| **K** | 0.15 | 0.33 |
| **C** | 1.53 | 2.23 |
| **Ca** | 0.12 | 0.16 |
| **Mg** | 0.034 | 0.0099 |
| **Na** | 0.032 | 0.35 |
| **S** | 0.028 | 0.054 |

| Micro-nutrient | Sugar digestate [mg/kg] | Agricultural digestate [mg/kg] |
|---|---|---|
| **B** | 10.9 | < LOD |
| **Co** | 0.967 | 0.55 |
| **Cu** | 3.20 | 1.39 |
| **Fe** | - | 336 |
| **Mn** | 15.5 | 12.5 |
| **Mo** | 4.24 | 4.85 |
| **Zn** | 7.66 | 10.3 |

| Impurities | Sugar digestate [mg/kg] | Agricultural digestate [mg/kg] |
|---|---|---|
| **As** | 10.9 | < LOD |
| **Cd** | 0.967 | 0.55 |
| **Cr** | 3.20 | 1.39 |
| **Ni** | - | 336* |
| **Pb** | 15.5 | 12.5 |
| **Hg** | <0.10 | <0.10 |

*exceeding the max level according to EU regulation 2019/1009

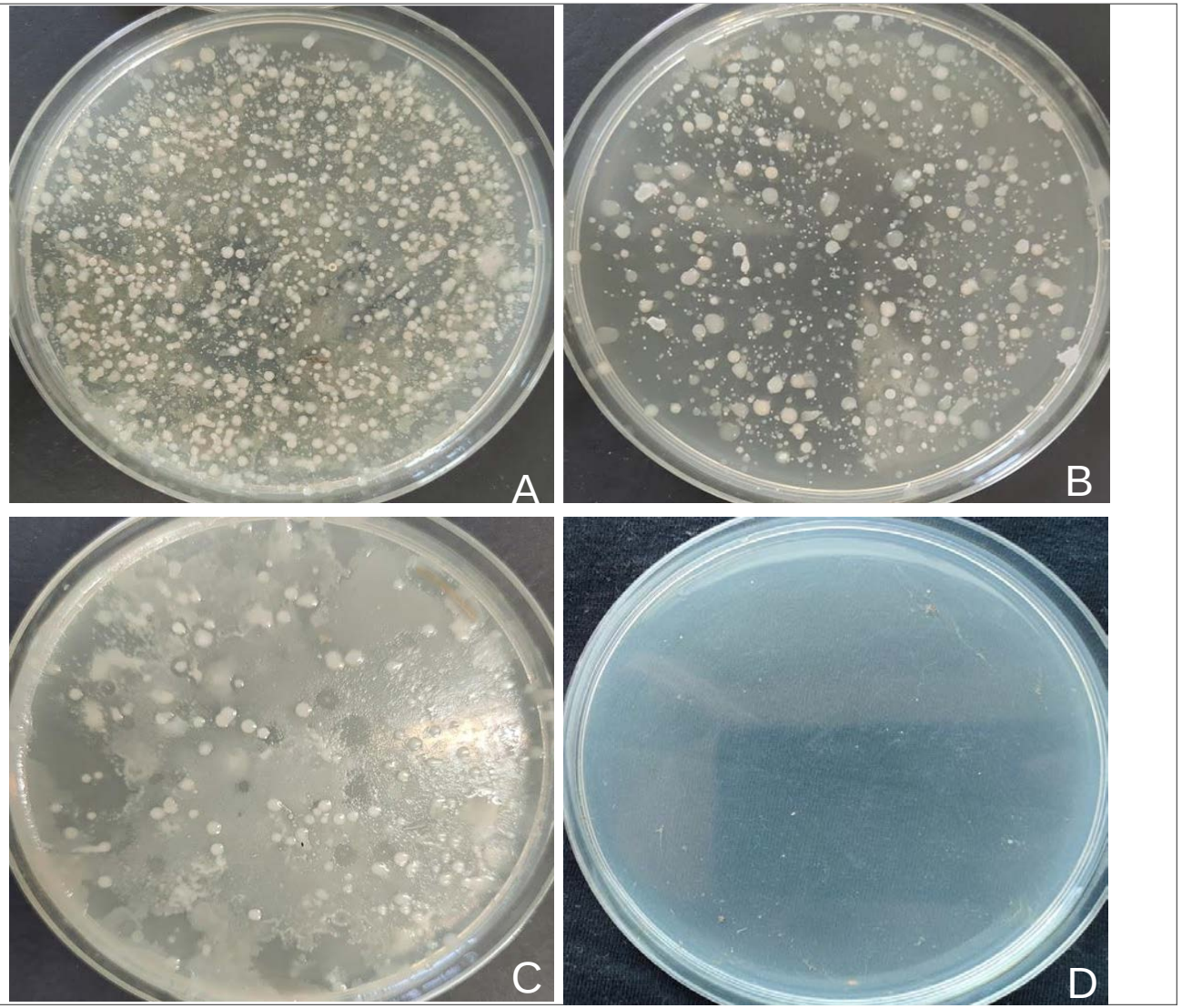


# ALKALINE HYDROLYSIS

**+ KOH**
**to pH approx.13,5**
time 72h

# NEUTRALIZATION

**+ H3PO4, H2SO4 to pH approx. 7**
time 30 min




# MICROBIOLOGICAL TESTS

**A - Raw digestate**

**B - Raw digestate, 1:10 dilution**

**C - After sanitization at pH=11, time 30 minutes**

**D - After sanitization at pH=13.5, time 72h**

# GRANULATION

## with waste materials

time 30 min

# ELEMENTAL COMPOSITION OF PRODUCED FERTILIZER

| Macro-nutrient | Granular fertilizer [%] | Micro-nutrient | Granular fertilizer [mg/kg] | Impuryties | Granular fertilizer [mg/kg] |
|---|---|---|---|---|---|
| N | 1,48 | B | 69.7 | As | 17.3 |
| P | 7.22 | Co | 15.1 | Cd | 1.77 |
| K | 2.09 | Cu | 780 | Cr | 63.9 |
| C | 4,98 | Fe | 38400 | Ni | 43.1 |
| Ca | 6.28 | Mn | 425 | Pb | 43.5 |
| Mg | 1.95 | Mo | 21,8 | Hg | <0.10 |
| Na | 0.68 | Zn | 1440 | | |
| S | 0.52 | | | | |


**METHODS:**

ICP-OES

AAS with amalgamation technique

ELEMENTAR ANALYSYS

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL (EU) 2019/1009 of 5 June 2019

Granular fertilzer – doses 5, 10, 50%, 100% and 200%

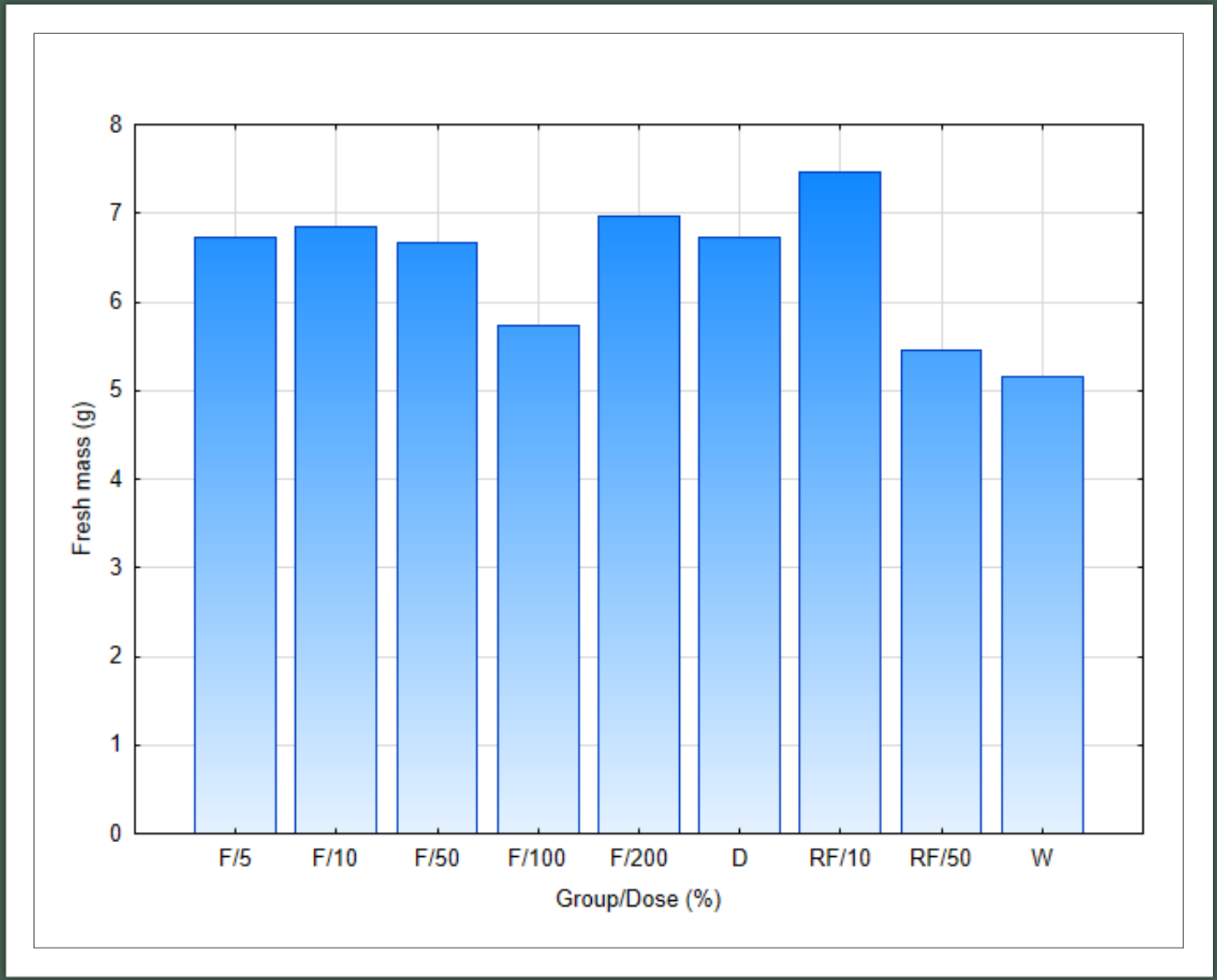
Raw digestate

Reference fertilizer (YaraMila)

Water

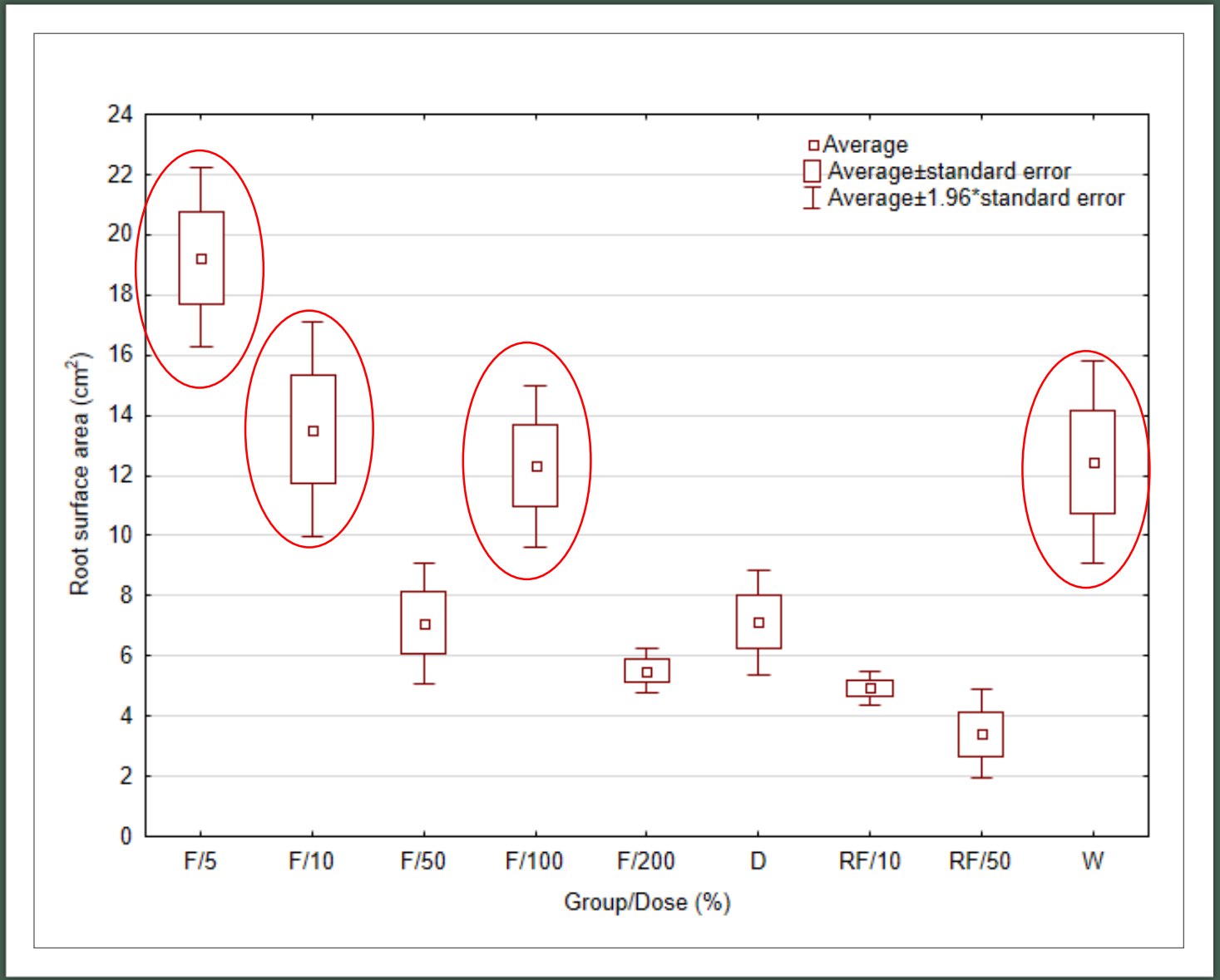
# GERMINATION TESTS

The dose was optimized for potassium supplementation.




# FRESH MASS

| | | |
|---|---|---|
| **F/5** | - granular fertilzer | dose 5% |
| **F/10** | - granular fertilzer | dose 5% |
| **F/50** | - granular fertilzer | dose 5% |
| **F/100** | - granular fertilzer | dose 5% |
| **F/200** | - granular fertilzer | dose 5% |
| **D** | - row digestate | |
| **RF/10** | - reference fertilizer | dose 10% |
| **RF/50** | - reference fertilizer | dose 50% |
| **W** | - water | |

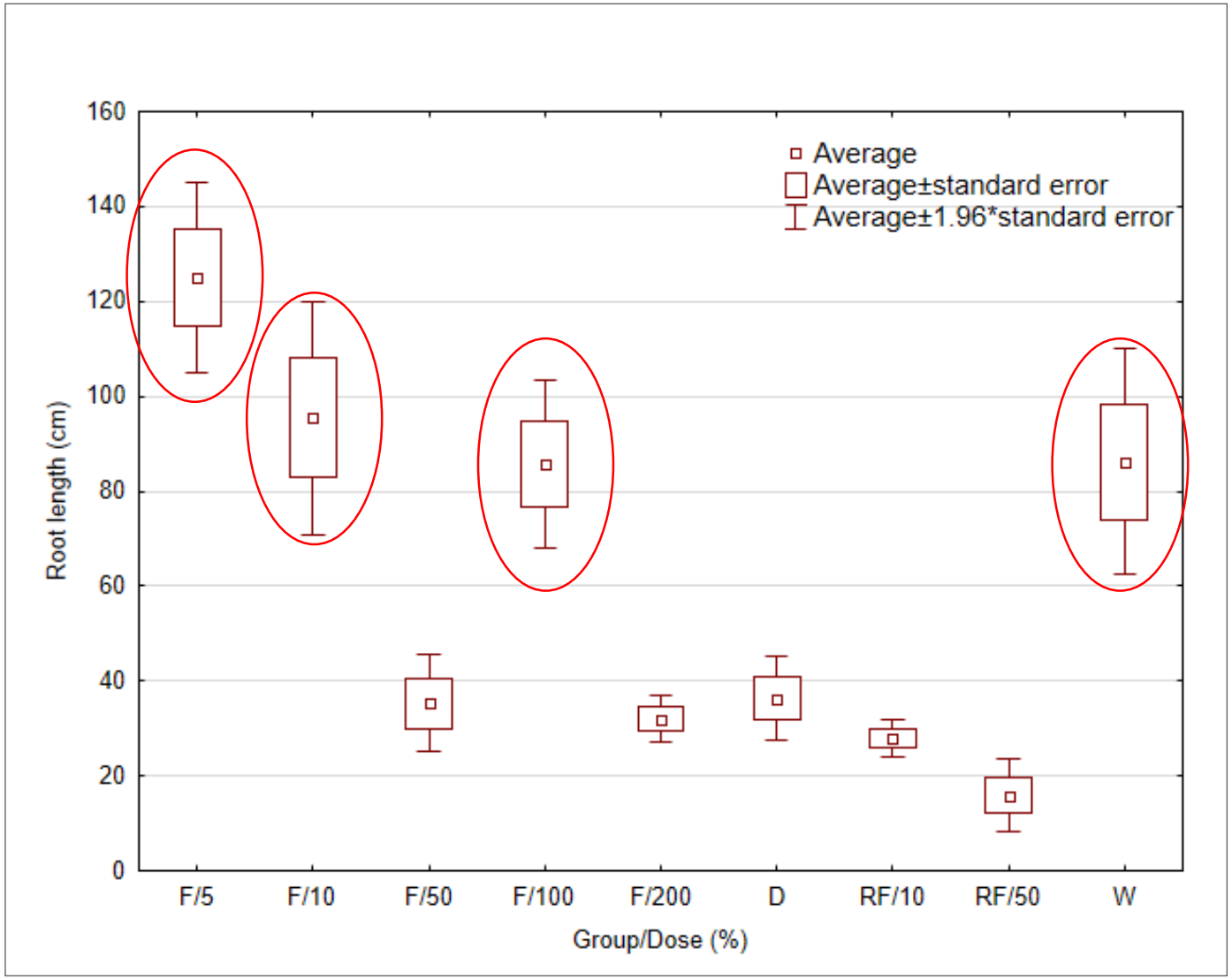



# ROOT SURFACE

| | | |
|---|---|---|
| **F/5** | - granular fertilzer | dose 5% |
| **F/10** | - granular fertilzer | dose 5% |
| **F/50** | - granular fertilzer | dose 5% |
| **F/100** | - granular fertilzer | dose 5% |
| **F/200** | - granular fertilzer | dose 5% |
| **D** | - row digestate | |
| **RF/10** | - reference fertilizer | dose 10% |
| **RF/50** | - reference fertilizer | dose 50% |
| **W** | - water | |

**WinRHIZO**

# ROOT LENGTH




**F/5** - granular fertilzer dose 5%

**F/10** - granular fertilzer dose 5%

**F/50** - granular fertilzer dose 5%

**F/100** - granular fertilzer dose 5%

**F/200** - granular fertilzer dose 5%

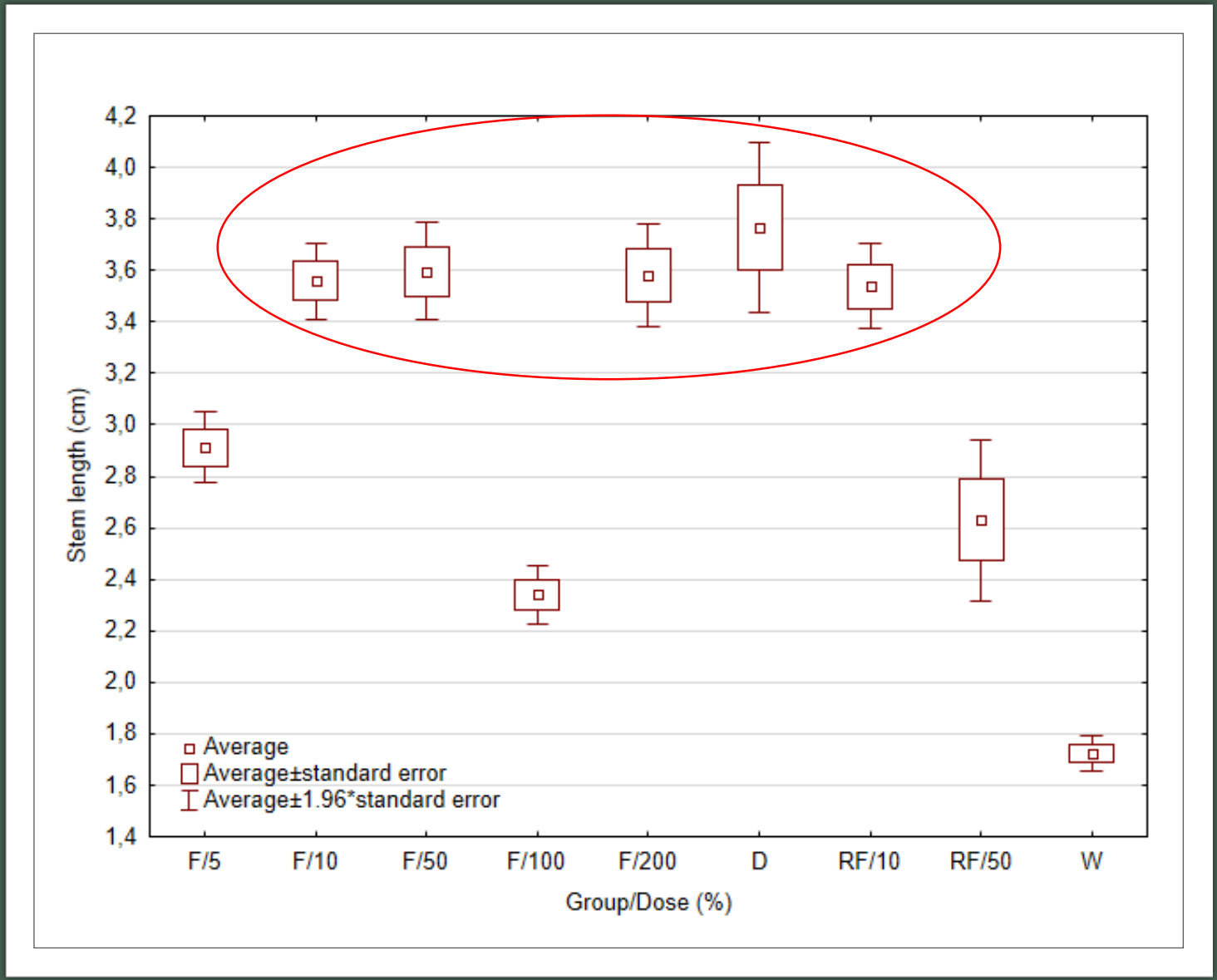
**D** - row digestate

**RF/10** - reference fertilizer dose 10%

**RF/50** - reference fertilizer dose 50%

**W** - water

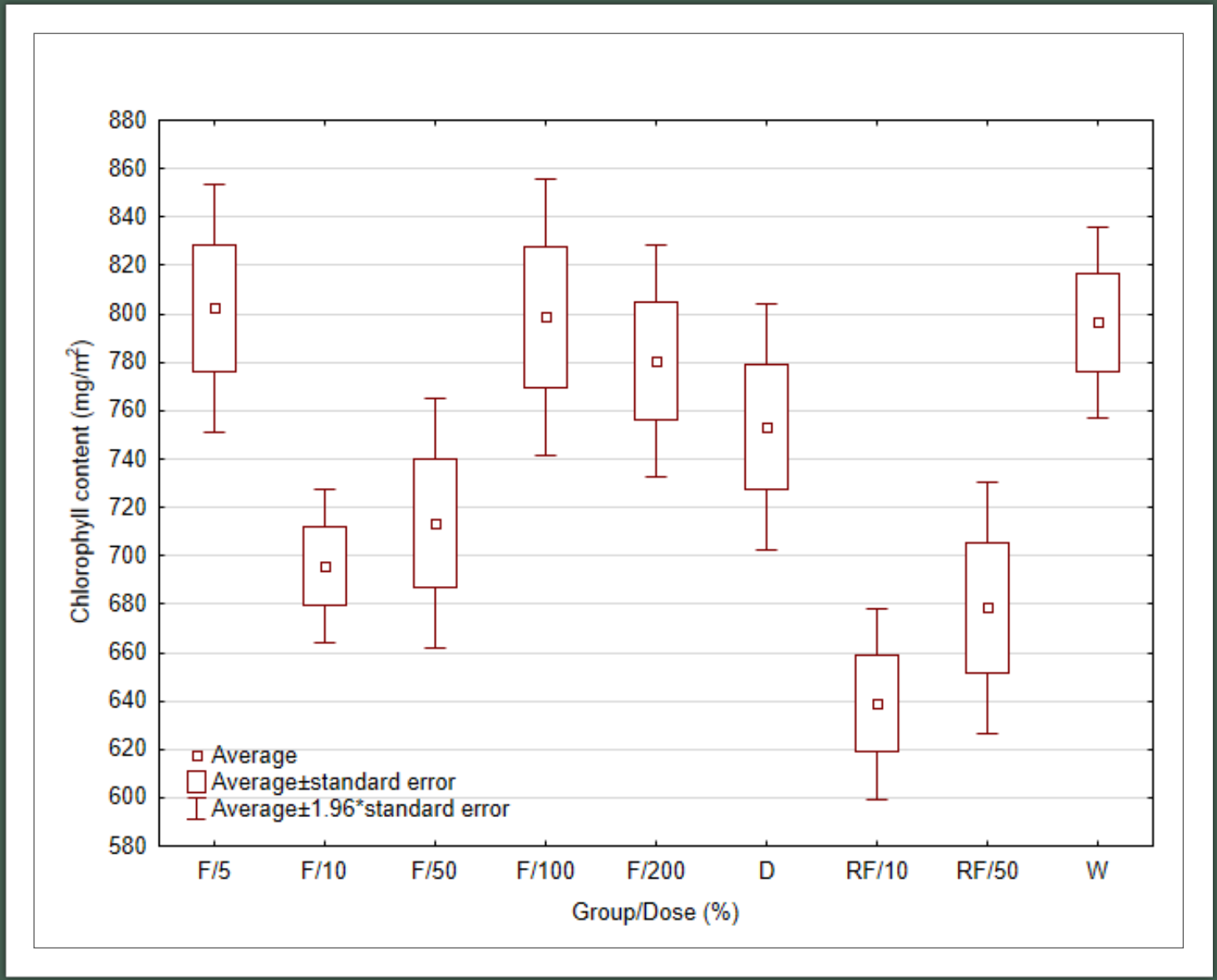
**WinRHIZO**




# STEAM LENGHT

| | | |
|---|---|---|
| **F/5** | - granular fertilzer | dose 5% |
| **F/10** | - granular fertilzer | dose 5% |
| **F/50** | - granular fertilzer | dose 5% |
| **F/100** | - granular fertilzer | dose 5% |
| **F/200** | - granular fertilzer | dose 5% |
| **D** | - row digestate | |
| **RF/10** | - reference fertilizer | dose 10% |
| **RF/50** | - reference fertilizer | dose 50% |
| **W** | - water | |

**WinRHIZO**




# CHLOROPHYLL

| | | |
|---|---|---|
| **F/5** | - granular fertilzer | dose 5% |
| **F/10** | - granular fertilzer | dose 5% |
| **F/50** | - granular fertilzer | dose 5% |
| **F/100** | - granular fertilzer | dose 5% |
| **F/200** | - granular fertilzer | dose 5% |
| **D** | - row digestate | |
| **RF/10** | - reference fertilizer | dose 10% |
| **RF/50** | - reference fertilizer | dose 50% |
| **W** | - water | |



**OPTI-SCIENCE CCM300**

# ERA-NET: Solution4Farming

- Utilization and valorization of problematic side streams
- Recovery of nutrients from renewable sources
- New bio-based fertilisers with beneficial environmental effect
- Popularization of affordable and environmentally friendly organic-mineral fertilisers
- Reduce the carbon footprint of the bio-based fertiliser production by at least 10%



## PARTNERS

Beia Consult International, ROMANIA

University of Agricultural Sciences and Veterinary Medicine of Bucharest, ROMANIA

Universidad Politécnica de Cartagena, SPAIN

Kajaani University of Applied Sciences, FINLAND

# PLANS FOR COMMING MONTHS


- optimization of hydrolysis and neutralization of the digestate
- optimization of granulation: search for the optimal powder fraction in terms of composition, adaptation of process conditions
- obtaining and testing other samples of the digestate
- testing the products on plants in pot experiments

This work was financed by European Union's Horizon2020 Research & Innovation Programme under grant agreement No 696356 and from the Executive Agency for Higher Education, Research, Development and Innovation Funding - UEFISCDI (Romania), the National Centre for Research and Development - NCBR (Poland), Agenda Estatal de Im/estigación - AEI (Spain), and the Ministry of Agriculture and Forestry- MMM (Finland).

# THANK YOU