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RESPONSIBLE USE OF GROUNDWATER RESOURCES - OBTAINING ECOLOGICAL LIQUID FERTILIZERS BASED ON PLANTS FROM THE WILD FLORA OF ROMANIA

Florin Tudor ZURINI, Aurelian IOAN, Elena ZURINI

Scientific Coordinator: Assoc. Prof. Biotech. PhD Irina GREBENIȘAN

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăşti Blvd, District 1, 011464, Bucharest, Romania, Phone: +4021.318.25.64, Fax: + 4021.318.25.67

Corresponding author email: florin.zurini@gmail.com

Abstract

Responsible use of groundwater resources should be the responsibility of every person, because our very existence on Earth depends on these invaluable resources. Due to the climate change we are currently going through, drinking water resources are becoming less and less qualitatively affected due to pollution and the infiltration of pollutants into groundwater. In agriculture, one of the major causes of groundwater pollution are chemical synthesis substances, which are used as an input for plant growth, for phytosanitary treatments against insects and phytopathogenic microorganisms and for weed removal. That is why the research direction that we approached was that of the responsible use of groundwater and the obtaining of ecological fertilizers based on plants from the wild flora of Romania. In order to obtain the ecological liquid fertilizer, we used plants from the wild flora of Romania, namely nettle (Urtica dioica), comfrey (Symphytum officinale) and horsetail (Equisetum arvense). We tested the organic fertilizers we obtained in the laboratory to see their ability to stimulate the germination and growth of bean seedlings (Phaseolus vulgaris L.). The organic liquid fertilizer we obtained had a very good effect on stimulating the germination and development of bean seedlings.
The groundwater sample was taken from the family well. The drilling is at a depth of 40 m and is located in Crucea de Piatră, Călugăreni commune, Giurgiu county. The groundwater sample was transported in a refrigerated box to the laboratory of Ecology and Environmental Microbiology within the Faculty of Land Reclamation and Environmental Engineering within the U.S.A.M.V. Bucharest. In order to achieve the proposed goal, the groundwater sample taken from the family well was analyzed in the laboratory of Ecology and Environmental Microbiology from an ecological point of view. The experiments performed and presented in this paper represent a part of the studies performed for the bachelor's thesis.

Key words*: comfrey (Symphytum officinale), eco-friendly, ecological liquid fertilizer, nettle (Urtica dioicahorsetail), horsetail (Equisetum arvense), responsible use of groundwater resources.*

INTRODUCTION

Groundwater is invisible, but its impact is visible everywhere. Out of sight, under our feet, groundwater is a hidden treasure that enriches our lives. Almost all of the liquid freshwater in the world is groundwater. As climate change gets worse, groundwater will become more and more critical. We need to work together to sustainably manage this precious resource. Groundwater may be out of sight, but it must not be out of mind (https://www.worldwaterday.org/).

Accounting for approximately 99% of all liquid freshwater on Earth, groundwater has the potential to provide societies with tremendous social, economic and environmental benefits and opportunities. Groundwater already provides half of the volume of water withdrawn for domestic use by the global population, including the drinking water for the vast majority of the rural population who do not get their water delivered to them via public or private supply systems, and around 25% of all water withdrawn for irrigation. However, this natural resource is often poorly understood, and consequently undervalued, mismanaged and even abused.

Groundwater is central to the fight against poverty, to food and water security, to the creation of decent jobs, to socio-economic development, and to the resilience of societies and economies to climate change. Reliance on groundwater will only increase, mainly due to growing water demand by all sectors combined with increasing variation in rainfall patterns. (https://www.unwater.org/publications/un-world-water-development-report-2022/)

This year the motto of the organization is "Groundwater: Making the invisible visible" and that is why we have chosen this topic for our work, to emphasize the importance of responsible groundwater use.

Bio-fertilizers have begun to gain increasing attention due to the environmental damage that synthetic chemical fertilizers cause. Some of the benefits associated with organic fertilizers include:

- The first and most important advantage of using bio-fertilizers is that they are environmentally friendly, unlike chemical fertilizers that are harmful to the environment.
- They have relatively low costs when used as farmer inputs.
- Their use leads to soil enrichment and soil quality improves over time.
- Although it does not show immediate results, the results displayed over time are spectacular.
- Microorganisms transform complex organic matter into simple compounds so that the plant can easily take up nutrients.
- These fertilizers capitalize on atmospheric nitrogen and make it directly available to plants.
- They increase the phosphorus content of the soil by solubilizing and releasing the phosphorus from the unavailable.
- Biological fertilizers improve root proliferation due to the release of growth-stimulating hormones.
- They help to increase the yield of the crop by 10-25%. (Hazra, 2016)

Organic fertilizers are naturally available mineral sources that contain moderate amount of plant essential nutrients. They are capable of mitigating problems associated with synthetic fertilizers. They reduce the necessity of repeated application of synthetic fertilizers to maintain soil fertility. They gradually release nutrients into the soil solution and maintain nutrient balance for healthy growth of crop plants. They also act as an effective energy source of soil microbes which in turn improve soil structure and crop growth. Organic fertilizers are generally thought to be slow releasing fertilizers and they contain many trace elements. They are safer alternatives to chemical fertilizers. However, the improper use of organic fertilizers leads to overfertilization or nutrient deficiency in the soil. Hence, controlled release of organic fertilizers is an effective and advanced way to overcome these impacts and maintain sustainable agriculture yield (Shaji et al, 2021).

An ecological fertilizer is a substance (free of chemicals) formed by the essential nutrients that the plant needs to grow and develop. Organic fertilizers or **ecological fertilizers** are obtained by mixing substances obtained by the degradation and mineralization of leftovers of an organic, plant and industrial nature, promoting **the circular economy**. This means extending their useful life, maintaining their value for as long as possible.

The main characteristics in favor of ecological fertilizers are:

- **Eco friendly**, this means that they do not carry chemical inputs that can damage the earth and respect the ecosystems. Although chemical fertilizers are a quick and effective solution in the short term, their use entails environmental problems such as water pollution, the risk of toxicity and the degradation of soil life in the long term.
- Organic fertilizers provide a series of **necessary nutrients**, the main ones being the NPK formula: nitrogen, phosphorus and potassium.
- They improve **the structure and properties of the soil, giving it strength, resistance, structure and aeration**. In addition, its ability **to absorb water and carbon fixation** in it also increases positively.
- Its production hardly generates energy expenditure and is a **more economical solution.**
- Has a **regulating effect** on soil temperature and prevents excessive evaporation helping to maintain soil moisture.
- They make it possible to take advantage of **organic waste favoring the circular economy (**https://defeder.es**).**

Liquid organic fertilizers can offer opportunities for more efficient nitrogen use when they are applied through a drip irrigation system - such an application is called fertigation. Any nutrient in a water-soluble form is readily available for plant uptake just after application, leading to a more efficient use of fertilizers. When nutrients are applied shortly before they are needed, growers can reduce loss of nutrients from the root zone. These liquid fertilizers may be applied on a regular basis, depending on the nutrient need of the crop. This allows the grower greater control over nutrient availability to their crop. Some of the liquid fish-derived and soybean-based fertilizer materials are widely used in organic vegetable production.

A few important considerations before using fertigation are: only use fertilizers that either dissolve completely or have particles that stay in suspension and pass through emitters without clogging, the drip irrigation system should be fully pressurized before injection begins, there should be a filter between the injector and the laterals to ensure that any particles are filtered out, and the irrigation system must be flushed of nutrients to keep drip lines clean and prevent clogging (Brust, 2019).

Responsible use of groundwater resources should be the responsibility of every person, because our very existence on Earth depends on these invaluable resources. Due to the climate change we are currently going through, drinking water resources are becoming less and less qualitatively affected due to pollution and the infiltration of pollutants into groundwater. In agriculture, one of the major causes of groundwater pollution are chemical synthesis substances, which are used as an input for plant growth, for phytosanitary treatments against insects and phytopathogenic microorganisms and for weed removal. That is why the research direction that we approached was that of the responsible use of groundwater and the obtaining of ecological fertilizers based on plants from the wild flora of Romania. We tested the organic fertilizers we obtained in the laboratory to see their ability to stimulate the germination and growth of bean seedlings (*Phaseolus vulgaris L.*).

The groundwater sample was taken from the family well. The drilling is at a depth of 40 m and is located in Crucea de Piatră, Călugăreni commune, Giurgiu county. The groundwater sample was transported in a refrigerated box to the laboratory of Ecology and Environmental Microbiology within the Faculty of Land Reclamation and Environmental Engineering within the U.S.A.M.V. Bucharest. In order to achieve the proposed goal, the groundwater sample taken from the family well was analyzed in the laboratory of Ecology and Environmental Microbiology from an ecological point of view. The experiments performed and presented in this paper represent a part of the studies performed for the bachelor's thesis.

MATERIALS AND METHODS

1. The groundwater sample was taken from the family well. The drilling is at a depth of 40 m and is located in Crucea de Piatră, Călugăreni commune, Giurgiu county.
2. The groundwater sample was transported in a refrigerated box to the laboratory of Ecology and Environmental Microbiology within the Faculty of Land Reclamation and Environmental Engineering within the U.S.A.M.V. Bucharest.
3. In order to achieve the proposed goal, the groundwater sample taken from the family well was analyzed in the laboratory of Ecology and Environmental Microbiology from an ecological point of view.
4. Ammonia, nitrite, nitrate and pH determination. To determine the ammonia, nitrites, nitrates and pH we used the water analysis kit from Hanna Instruments

   Nitrites are an intermediate form of nitrogen produced when ammonia is converted into nitrate during the nitrogen cycle. As organic matter decays, it produces ammonia; the highly toxic ammonia is converted into nitrite by bacteria; and the nitrite is then converted into nitrate by another bacteria.
5. We determined the turbidity of the water sample with the WTW laboratory turbidimeter.
6. We determined the pH of the water sample with the WTW laboratory pH-meter.
7. Production of liquid organic fertilizer. We used plants from the wild flora of Romania - nettle, comfrey and horsetail. After weighing the plant material, we put it in recycled plastic containers, then we added

1 l of well water. The sample was kept at room temperature. The fermentation process of the macerate took 19-20 hours. After the fermentation stopped, the plant biomass began to settle. We analyzed the N, P and K content of organic liquid fertilizer. We also analyzed the pH.

RESULTS AND DISCUSSIONS

In vitro experiments

Figure 1 shows the results of the analysis using the Hanna Instruments water analysis kit. The results of the analysis of the concentrations of ammonium, nitrites, nitrates and pH of the well water sample. The maximum values allowed by law for nitrites are 0.5 mg / L and for nitrates 50 mg / L.

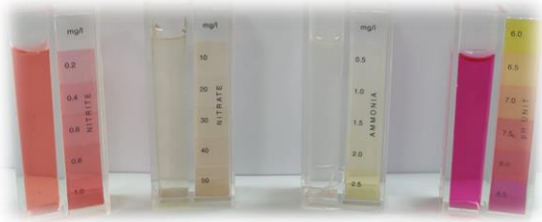

Figure 1. The results of the analysis using the Hanna Instruments water analysis kit.

Figure 2. The result of determining the pH

Figure 2 shows the result of determining the pH. The value obtained, 8 indicates a slightly alkaline pH.

Determining the turbidity of the well water sample. We determined the turbidity of the well water with the WTW laboratory turbidimeter. The value obtained was 0.01 NTU. For drinking water the value accepted by the standard is between 0 and 5 NTU.

Figure 3. Determining the turbidity of the well water sample

The figure 4 shows the positioning and adjustment of the analytical balance.

Figure 4. The positioning and adjustment of the analytical balance

Figure 5 shows the biological material used to obtain the fertilizer – nettle (*Urtica dioica*), horsetail (*Equisetum arvense*) and comfrey (*Symphytum officinale*).

Figure 5. The biological material used to obtain the fertilizer – nettle (*Urtica dioica*), horsetail (*Equisetum arvense*) and comfrey (*Symphytum officinale*)

Figures 6, 7 and 8 show the weighing stages of the plants from the wild flora of Romania used to obtain the liquid ecological fertilizer.

Figure 6. Nettle (*Urtica dioica*)

Figure 7. Horsetail (*Equisetum arvense*)

Figure 8. Comfrey (*Symphytum officinale*)

Figure 9 shows the moment of the fermentation process and that of the cessation of fermentation, respectively.

Figure 9. Fermentation process (left) and cessation of fermentation (right)

Figure 10 shows the determination of the pH value of the liquid ecological fertilizer, dry biomass. The biomass was dried in an oven for 1 hour at 180 degrees Celsius and the containers with liquid fertilizer and dry residual biomass.

Figure 10. Determination of the pH value of the liquid ecological fertilizer

CONCLUSIONS

The results obtained in this experiment allow us to draw the following conclusions:

- In order to obtain the ecological liquid fertilizer, we used plants from the wild flora of Romania, namely nettle (Urtica dioica), comfrey (Symphytum officinale) and horsetail (Equisetum arvense).
- We made determinations of the concentration N, P, K, pH of the liquid ecological fertilizer obtained and we noticed that it is rich in P and K and less in N. The pH value was weakly acidic.
- Regarding the organoleptic quality parameters of the groundwater - taste, color and smell, it had an acceptable taste for consumers and no abnormal changes, it was colorless and had no odor.
- The sampling temperature of the water sample was 10 degrees Celsius.

- The pH is alkaline (basic) with a value of 8 pH units.
- The turbidity was 0.01 NTU (Nephelometric Turbidimetric Units), a value that falls within the range established by law 0 - 5 NTU.
- The determinations of the chemical quality parameters of the groundwater - ammonia (NH3), nitrites (NO2), nitrates (NO3) had values below the maximum allowed limits:

• 0.5 mg / l ammonia;
• 0.5 mg / l nitrites;
• 50 mg / l nitrate.

- Responsible use of groundwater involves its use for domestic consumption, garden and in this case study for the production of liquid organic fertilizer. It is important to use water as wisely as possible because due to the drought we are going through it is a resource that can become limited.
- To obtain liquid organic fertilizers we used plants from the spontaneous flora of our country, which we subjected to a biotechnological process - fermentation and maceration:

• nettle (Urtica dioica);
• sorrel (Symphytum officinale);
• horsetail (Equisetum arvense).

- The experiment was carried out in two variants, a static fermentation, without continuous stirring, which lasted 5 days and a variant with continuous stirring 120 rotations / minute at the incubator with orbital stirring at a temperature of 25 degrees Celsius for 3 days.
- After obtaining the liquid ecological fertilizer, we carried out studies to determine the quality organoleptic and physico-chemical parameters. Observation of the color of the liquid organic fertilizer - it had a matte dark yellow color.
- When determining the content of macroelements N, P, K in liquid organic fertilizer we obtained the following values:

• trace concentrations for nitrogen (N);
• high concentrations of phosphorus (P);
• high concentrations of potassium (K).

- For the use of by-products resulting from the production of liquid organic fertilizer:

• we transferred the liquid and weighed the remaining residual biomass;
• we dried for 1 hour in an oven at 180 degrees Celsius for conditioning the residual biomass.
• the obtained conditioned solid fertilizer was further processed and turned into powder using a grinding machine;
• conditioning of solid fertilizer allows it to be stored for long periods of time without it molding.

- The pH value obtained after the fermentation process was determined with the help of the laboratory pH meter and had the value of 5.063 pH units, which means a weakly acidic value.

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