The effect of the liquid plant growth stimulant seaweed seychelles on the germination of seeds of microgreens of coral radish (Raphanus sativus var. Sativus)

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Abstract. The article presents the results of a model experiment to study the effect of a liquid plant growth stimulant Seaweed Seychelles on the germination of seeds of microgreen of coral radish (Raphanus sativus var. Sativus). Seaweed is a source of natural plant growth hormones. Each of them is an important biostimulant of health. Auxin is known for its positive effect on the roots. It is used in synthetic hormones for rooting. Seaweed contains more than 60 trace elements and nutrients. First of all, it is potassium, nitrogen, phosphorus, iodine, manganese, molybdenum and boron. In the course of this study, it was found that the liquid plant growth stimulant Seaweed Seychelles significantly increases the germination of seeds of coral radish (Raphanus sativus var. Sativus). Seed germination was 98%. The phosphorus content increased by 14.5%, and the nitrogen content by 30%, the pH remained neutral. Seaweed Seychelles liquid stimulant actively affects radish sprouts and contributes to an increase in growth rate and quality.

1 Introduction

Soil fertility is its ability to maintain plant growth and optimise yield. This characteristic can be improved by applying organic and inorganic fertilisers to the soil [1].

Promoting food security and environmental sustainability in agricultural systems requires an integrated approach to soil fertility management that helps increase crop production by minimising the extraction of nutrient reserves from the soil and the deterioration of its physical and chemical properties, which can lead to soil erosion, and ultimately to land degradation.

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Rational use of soil resources contributes to the preservation of soil fertility. Such a method of soil fertility management involves the use of organic fertilisers, crop rotation with legumes and the use of improved germ plasm, and also requires knowledge of how to adapt these practices to local conditions [2-3].

Currently, the use of organic fertilisers instead of mineral and chemical ones is actively developing. Fertiliser improves the sowing qualities of seeds. The sowing qualities of seeds include a set of signs and properties that characterise the suitability of seeds for sowing. The main sowing qualities of seeds include purity, germination, germination energy, humidity, weight of 1000 seeds, infection with diseases and pests.

Currently, seaweed-based fertiliser is actively used. Seaweed is a source of natural plant growth hormones. Each of them is an important biostimulant of health. Auxin is known for its positive effect on the roots. It is used in synthetic hormones for rooting. Seaweed contains more than 60 trace elements and nutrients. First of all, it is potassium, nitrogen, phosphorus, iodine, manganese, molybdenum, and boron. The chelated form allows the nutrients to be easily absorbed. Seaweed fertiliser does not contain weed seeds, spores of pathogenic fungi and helminth eggs. Algal polysaccharides improve the surface layer of the soil, and vitamins and amino acids favour the growth and development of plants. A large amount of carbohydrates supports their energy base. Seaweed refers to a variety of species. These are representatives of red (Palmaria), brown (Alaria, Fucus, Laminaria, Ascophyllum), and green (Enteromorpha, Ulva) algae. The products obtained from them form the basis of powdered, dry, and liquid fertilisers [3-4].

Researchers of Yildiz Technical University, Faculty of Environmental Engineering (2020) investigated the optimisation of the production of liquid fertilisers from seaweed waste. In the course of their research, liquid fertiliser from seaweed (SLF) was produced. They obtained results on the biological extraction of seaweed; it was found that SLF increases seed germination and plant growth, as well as moisture retention capacity can be increased with SLF [5].

The use of seaweed extracts as a fertiliser acts as a plant stimulant and supports its growth parameters, including a faster seed germination rate, root system development, as well as an increase in the number and area of leaves and fruits, plant weight and strength [6,9]. This potential of seaweed stands out as an environmentally friendly commercial product, as the demand for inorganic fertilisers is currently declining due to limited natural resources [7].

In studies by Cuiping Meng, Xue Gu, Haiyan Liang et al. by studying the effect of highly effective seaweed fertiliser on peanuts, it was found that liquid seaweed fertiliser positively affected the growth of peanuts; papain or cellulase enzymatic liquid fertiliser enhanced leaf photosynthesis, and also affected the morphology of peanut roots. To investigate the effect of liquid seaweed fertiliser on peanut growth, in 2020, scientists conducted the following experiments: three types of liquid seaweed fertilisers were prepared by enzymatic hydrolysis using the enzymatic enzyme papain and enzymatic cellulase. The results showed a positive effect of using these fertilisers. In their studies, it was found that foliar spraying led to better growth of the aboveground part and affected the elongation of the roots. The seaweed fertiliser increased the activity of urease and dehydrogenase during composting, and also improved the microbial metabolic activity of the compost [10].

They found that the abundance of the main types of microorganisms increases due to the addition of fertilisers from seaweed. The NO^3-N content demonstrated a positive association with *Aeromicrobium* microorganisms.

Organic additives can optimise the C/N ratio, stimulate microbial activity and accelerate decomposition during composting [11]. Organic additives have become widespread

because they can improve the composting process, and seaweed is a natural organic additive that is harmless to the environment.

In studies, seaweed increases the content of zinc chlorophyll in grape leaves. In particular, nanoscale fertilisers based on seaweed should be recommended for sustainable viticulture.

In the studies of scientists Ali Sabir, Kevser Yazar et al., it was found that the flowering and maturation periods of the treated vines were 1-4 days faster than the control ones.

General studies have shown that nano-fertilisers have made a significant contribution to improving the growth of the vine, yield, berry quality and nutrient content in the leaves of the vine ("Narinche" variety) grown in alkaline soil [12]. Therefore, this product is recommended to be used to mitigate the adverse effects of abiotic stress on sustainable grape production.

2 Matherials and methods

In December 2022 model experiments on the effect of a liquid plant growth stimulant Seaweed Seychelles on the germination of microgreen seeds: coral radish (Raphanus sativus var. sativus) (AgroSidsTrade).

The choice of indicator plants is associated with the spread of this plant species in our region, as well as their popularity and unpretentiousness. Microgreens are young edible seedlings of vegetables and herbs, that is, not new plant species, but an original way of growing crops familiar to us. They are harvested a few days after planting, when the first leaves appear on the stems. Growing microgreens requires minimal time and space. It can be planted almost anywhere: on window sills, under phytolamps, outdoors or in a greenhouse. [1] It is an easy and cheap way to get fresh nutritious food all year round.

The object of the study was selected ordinary chernozem of the South European facies, since in the Rostov region most of the fertile lands belong to ordinary chernozem. Despite the high natural fertility of soils, ordinary chernozems are poor in mobile forms of phosphorus. The soils have an optimal water-air regime, are well structured, and the structure is water-resistant. Soils are widely used in agriculture. The basis for obtaining sustainable harvests is the joint application of organic and mineral fertilisers, snow retention, early spring harrowing, furrowing, and slitting of fields, the fight against soil erosion.

Test samples: microgreen is coral radish (Raphanus sativus var. sativus) (manufacturer: AgroSidsTrade).

Fertiliser is Seaweed Seychelles Liquid plant growth.

The soil was moistened with distilled water as the top layer dried for control and experimental samples. Experimental samples were sprayed 3 times a day with a diluted liquid stimulant (dosage: solution in a ratio of 1:200 according to the manufacturer's recommendation). The model experiment lasted 15 days.

The research methodology is indicated in Table 1.

After completing the model experiment, the samples were analysed for the content of nutrients such as nitrogen and phosphorus. The nitrogen content in the microgreen was determined according to GOST 10846-91. The mass fraction of phosphorus in the microgreen was determined according to GOST 26657-97. The pH of the soil was determined by water extraction was determined according to GOST 26423-85.

Fig. 1. Seaweed Seychelles Liquid plant growth fertiliser

Fig. 2. Ordinary Chernozem of the South European facies

Table 1. Scheme of a model study on the effect of seaweed on the germination of microgreen seeds and soil acidity *(Raphanus sativus var. Sativus*)

Radish Microgreens *(Raphanus sativus var. sativus)*		
№	Samples	Dosage, ml
1	Control	0, without fertiliser application
2	Dose 1	2
3	Dose 2	3

3 Results and Discussion

During the study, it was found that Seaweed Seychelles Liquid plant growth fertiliser significantly affects the germination and germination rate of seeds. 98% of the seeds rose on the 5th day after planting when applying fertiliser, the average height of the shoot is 5

cm. On the 15th day, the sprouts had a height of 12 cm on experimental samples No. 2, 3. (Fig. 3,4)

According to the results of the study, it was revealed that Seaweed Seychelles Liquid plant growth fertiliser accelerates germination and growth of sprouts. Seed growth on experimental samples No. 5, 6 is much more intense than on the control sample. 100 seeds were planted and germination on experimental samples was 98%.

The phosphorus content increased on sample No. 2 by 12% of the control, on sample No. 3 by 17%, the nitrogen content increased on sample No. 2 – by 25%, on sample No. 3 by 35%. The pH of the soil is neutral on all samples (7, 1). The fertiliser did not affect the pH of the soil, which proves its uniqueness.

Fig. 3. Radish germination, 1 th day

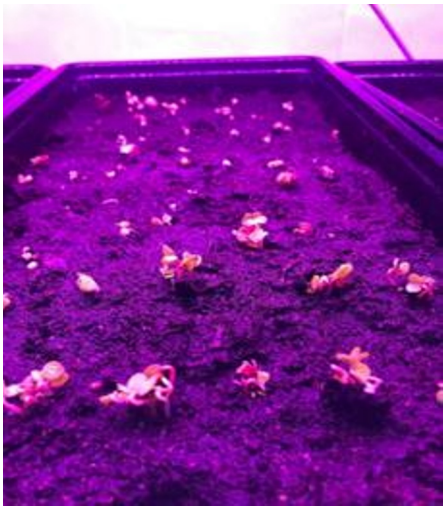

Fig. 4. Radish germination, 5th day

Fig. 5. Radish germination, 10th day

Fig. 6. Radish germination, 15th day

4 Conclusion

According to the results of the study, it was revealed that Seaweed Seychelles Liquid plant growth fertiliser accelerates germination and growth of sprouts. Seed growth on experimental samples No. 5, 6 is much more intense than on the control sample. 100 seeds were planted and germination on experimental samples was 98%.

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References

1. A. Sabir, K. Yazar, F. Sabir, Z. Kara, M. Atilla Yazici, N. Goksu, Vine growth, yield, berry quality attributes and leaf nutrient content of grapevines as influenced by seaweed extract (Ascophyllum nodosum) and nanosize fertilizer pulverizations, Scientia Horticulturae, **175**, 1-8 (2014) https://doi.org/10.1016/j.scienta.2014.05.021.
2. S. Zhang, L. Sun, Y. Wang, K. Fan, Q. Xu, Y. Li, Q. Ma, J. Wang, W. Ren, Z. Ding, Cow Manure Application Effectively Regulates the Soil Bacterial Community in Tea Plantation. BMC Microbiol, **20**, 190 (2000)
3. S. Barot, V. Allard, A. Cantarel, J. Enjalbert, A. Gauffreteau, I. Goldringer, J.-C. Lata, X. Le Roux, A. Niboyet, E. Porcher, Designing Mixtures of Varieties for Multifunctional Agriculture with the Help of Ecology. A Review. Agron. Sustain. Dev., **37**, 13 (2017)
4. H. Niu, Z. Pang, N. Fallah, Y. Zhou, C. Zhang, C. Hu, W. Lin, Z. Yuan, Diversity of Microbial Communities and Soil Nutrients in Sugarcane Rhizosphere Soil under Water Soluble Fertilizer. PLoS ONE **16**, e0245626 (2021)
5. M. Köberl, M. Dita, A. Martinuz, C. Staver, G. Berg, Members of Gammaproteobacteria as Indicator Species of Healthy Banana Plants on Fusarium Wilt-Infested Fields in Central America. Sci. Rep., **7**, 45318 (2017)
6. G. F. Sinong, M. Yasuda, Y. Nara, C. G. Lee, K. M. G. Dastogeer, H. Tabuchi, H. Nakai, S. Djedidi, S. Okazaki, Distinct Root Microbial Communities in Nature Farming Rice Harbor Bacterial Strains With Plant Growth-Promoting Traits. Front. Sustain. Food Syst., **4**, 314 (2021)
7. V. A. Milyutkin, V. Shakhov, V. Lebedenko et al., *An Effective Innovative Complex of Sprayer and Multi-injector for Applying Liquid Fertilizers in One Operation and in Complex, Networked Control Systems for Connected and Automated Vehicles*. Volume 1 : Proceedings of the International Conference, Zlin: Springer Nature Switzerland AG, **509**, 1449-1459 (2023)
8. A. Michas, G. Pastore, A. Chiba, M. Grafe, S. Clausing, A. Polle, M. Schloter, M. Spohn, S. Schulz, Phosphorus Availability Alters the Effect of Tree Girdling on the Diversity of Phosphorus Solubilizing Soil Bacterial Communities in Temperate Beech Forests. Front. For. Glob. Chang., **4**, 79 (2021)
9. V. A. Milyutkin, V. Buxmann, B. Ch. Meskhi et al., *Innovative Complex for In-Soil Fertilizer X Tender + Cenius for Mini-Till Technology*, XIV International Scientific Conference “INTERAGROMASH 2021". Precision Agriculture and Agricultural Machinery Industry, Precision Agriculture and Agricultural Machinery Industry, **1** , 122-129 (2021)
10. V. A. Milyutkin, V. Shakhov, V. Lebedenko, An Effective Innovative Complex of Sprayer and Multi-injector for Applying Liquid Fertilizers in One Operation and in Complex, Networked Control Systems for Connected and Automated Vehicles. Volume 1: Proceedings of the International Conference, St. Petersburg, Zlin: Springer Nature Switzerland AG, **509**, 1449-1459 (2023)
11. V. Milyutkin, V. Buxmann, A. Mozgovoy, D. Rudoy, A. Olshevskaya, Modern Technology for Cultivation of Agricultural Crops in Zones of "Risk Farming" with Conservation and Accumulation of Atmospheric Moisture, Lecture Notes in Networks and Systems, EDN: GJVVNC, **246**, 138-146 (2022)
12. V. Milyutkin, S. Mashkov, D. Rudoy et al., Efficient Technology of Potato Cultivation with Top Dressing with Liquid Fertilizers During Fertigation, XV International

Scientific Conference "INTERAGROMASH 2022" : Collection of materials of the 15th International Scientific Conference. Global Precision Ag Innovation, **575**, 1705-1715 (2022)

13. D. W. Nelson, L. E. Sommers, Total Carbon, Organic Carbon, and Organic Matter. In Methods of Soil Analysis, John Wiley & Sons, Ltd.: Hoboken, NJ, USA, 539–579 ISBN 978-0-89118-977-0 (1983)
14. D. E. Krasavin, O. L. Tomashova, D. V. Rudoy et.al. The main advantages of no-till direct seeding technology in comparison with traditional tillage technology, Innovative technologies in science and education (ITNO 2020 conference): collection of scientific papers of the VIII International Scientific and Practical Conference, using remote technologies, 444-446 (2020)
15. Y. Jiang, X. Huang, X. Zhang, X. Zhang, Y. Zhang, C. Zheng, A. Deng, J. Zhang, L. Wu, S. Hu, et al., Optimizing Rice Plant Photosynthate Allocation Reduces N2O Emissions from Paddy Fields. Sci. Rep., **6**, 39333 (2016)
16. G. Jo, T. I. Todorov, Distribution of Nutrient and Toxic Elements in Brown and Polished Rice. Food Chem., **289**, 299–307 (2019)