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ORIGINAL PAPER

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PRODUCTIVITY OF HULLESS OATS UNDER THE EFFECT OF MICROBIOLOGICAL PREPARATION AND A PLANT GROWTH REGULATOR

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ABSTRACT

Background. Investigations were performed to clarify the complex effect of different rates of microbial preparation Melanoriz (*Glomus* sp., *Aspergillus terreus*, *Trichoderma lignorum*, *Trichoderma viride*, *Bacillus macerans*, *Arthrobacter* sp., *Bacillus subtilis*, *Paenibacillus polymyxa*, total number of viable cells 2.5×10^7 $CFU \cdot ml^{-1}$) under the different methods of using plant growth regulator Agrolight (polyethylene glycol–400 + polyethylene glycol–1500, total content of 770 $g \cdot dm^{-3}$, salts of humic acids, 30 $g \cdot dm^{-3}$) on the formation of the aboveground biomass by hulless oats plants, net productivity of photosynthesis and grain yield.

Material and methods. The experiments were performed in the hulless oats (*Avena sativa* subsp. *nudisativa* (Husnot) *Rod. et Sold*., *Avena sativa* L. species) of Myrsem variety using generally accepted methods in agronomic practice.

Results. During the experiment, it was found that the aboveground biomass, net productivity of photosynthesis, grain yield of hulless oats and the thousand grain weight varied depending on the combination of the microbial preparation use in different rates with the plant growth regulator. However, these indicators were the highest in variants of Melanoriz at the rate of 1.5 $dm^3 \cdot Mg^{-1}$ + Agrolight at the rate of 0.26 $dm^3 \cdot Mg^{-1}$ (pre-sowing seed treatment) followed by spraying the crops with Agrolight (1.0 $dm^3 \cdot ha^{-1}$).

Conclusion. The aboveground biomass of oats plants in the flowering stage (BBCH 61–69) increased by 21%, net productivity of photosynthesis – by 13%, grain yield – by 0.86 $Mg \cdot ha^{-1}$, thousand grain weight – by 12% under this combination of preparations, which gives grounds for the further use of this composition of preparations in hulless oats with the aim of biologization of its cultivation technologies.

Key words: crops productivity, hulless oats, microbial preparation, plant growth regulator

INTRODUCTION

In world grain production, oats rank fifth after crops such as wheat, rice, corn and barley. It is undemanding as regard to soils, has a relatively short growing period, so it is widely grown in the countries with mild climates. In recent years, oats are widely used for receiving food for healthy and dietary nutrition. In this regard, special interest is shown to hulless oats, which has improved quality, in particular, higher grain nature and nutrients content compared to husk oats. The lack of husk in this type of oats can significantly reduce the cost of its dehulling and elimination of waste (Batalova, 2015; Vargach *et al*., 2017).

Taking into account the widespread use of oats in food industry, the problem of technologies development for its cultivation with minimal negative impact on the environment which can be realized by introducing

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modern biological preparations, plant growth regulators of natural origin and microbial preparations in the technology of crop cultivation is relevant. These preparations increase the immunoprotective properties of plants, their resistance to abiotic and biotic stress under reduced negative effect of highly toxic chemical agents of protection (Tsygankova *et al*., 2017; 2018).

Introduction of biological preparations to the farming practice is an important step towards strengthening the ecological balance of agroecosystems (Ivanina, 2011).

Biological preparations of different groups (Domaratskiy *et al*., 2019) affect the course of physiological-and-biochemical reactions in plants from germination to harvest, improving plants growth and development (Schilling, 2001, 2006). Changes in the linear size of the stem, the development of mechanical tissues and the conductive system, the structure of the leaf apparatus and its functioning under the action of biological preparations on plants are observed (Prusakova *et al*., 1999; Datsenko *et al*., 2017; Pyda *et al*., 2018; Novikova *et al*., 2019a).

Biological preparations are used in technologies of agricultural crops cultivation for both – spraying vegetating plants, and for pre-sowing seed treatment. They can also be used in a complex – treatment of seed before sowing + spraying of plants during the vegetation period. This complex use of preparations is more justified, because the productivity of sowing increases many times (Zemlianov, 2003; Voskobulova, Novikova, 2011).

Considering the given material, the use of biopreparations in agricultural crops, including the hulless oats, their influence on the processes of biomass formation, course of photosynthesis, and formation of the grain yield hasn't been studied. In this connection it was important to establish if the microbial preparation Melanoriz and plant growth regulator Agrolight, at different rates and combinations, has influence on the formation of hulless oat's productivity, particularly, aboveground biomass, net productivity of photosynthesis, grain yield, and thousand grain weight.

MATERIAL AND METHODS

The research was performed in the field and laboratory conditions of the Department of Biology of Uman National University of Horticulture during 2019–2021. The experiment field was located in the forest-steppe zone of Ukraine, geographic coordinates – 48.783715, 30.255002. The effect of microbial preparation Melanoriz (*Glomus* sp., *Aspergillus terreus*, *Trichoderma lignorum*, *Trichoderma viride*, *Bacillus macerans*, *Arthrobacter* sp., *Bacillus subtilis*, *Paenibacillus polymyxa*, total number of viable cells 2.5×10^7 $CFU \cdot ml^{-1}$), producer – "TORHOVYI DIM "BTU-CENTER" LLC, Ukraine, and plant growth regulator Agrolight (polyethylene glycol–400 + polyethylene glycol–500, total content of 770 $g \cdot dm^{-3}$, salts of humic acids, 30 $g \cdot dm^{-3}$, producer – groups of companies DOLYNA, Ukraine) was studied in the hulless oats (*Avena sativa* subsp. *nudisativa* (Husnot) *Rod. et Sold*., *Avena sativa* L. species) of Myrsem variety.

Meteorological conditions during the years of research were typical for the region with slight deviations in moisture supply, but in general they were favorable for the cultivation of agricultural crops, including hulless oats. In particular, the amount of precipitation in 2019 was 127.8 mm, in 2020 – 192.4 mm, in 2021 – 211 mm at the mean multiannual indicators 190 mm respectively (Fig. 1).

Field experiments were carried out on endocalcic chernozem (loamic) (FAO and IUSS, 2015) with the content of humus of 3.5%, mobile compounds of phosphorus and potassium (by Chyrykov method) – 88 and 132 $mg \cdot kg^{-1}$, respectively, compounds of easy hydrolysable nitrogen (by Cornfield method – 103 $mg \cdot kg^{-1}$, pHsol – 6.2, hydrolytic acidity – 2.26 $cmol \cdot kg^{-1}$ of soil in the arable layer (Hrytsaienko *et al*., 2003). The size of one experimental plot (variant) was 25 m^2. Variants were placed in a systematic way sequentially in threefold replication. The predecessor of the hulless oats was pea. Before the sowing NPK fertilizers were added to the soil at the rates of 40, 45 and 40 $kg \cdot ha^{-1}$ of active substance respectively. The scheme of the experiment included variants with the pre-sowing seed treatment by microbial preparation Melanoriz at the rate of 1.0, 1.25 and 1.5 $dm^3 \cdot Mg^{-1}$ separately and in combinations with plant growth regulator Agrolight at the rate of 0.26 $dm^3 \cdot Mg^{-1}$. Oats seeds were treated with the microbial preparation, plant growth regulator and their mixtures before the sowing. Plants were sprayed with the plant growth regulator Agrolight at the rate of 1.0 $dm^3 \cdot ha^{-1}$ in the stage of tillering (BBCH 21–29).

The treatment was performed by an accumulator knapsack sprayer DS–3WF–3 at the rate of working mixture 200 $dm^3 \cdot ha^{-1}$. The detailed scheme of the experiment is given in the Fig. 2.

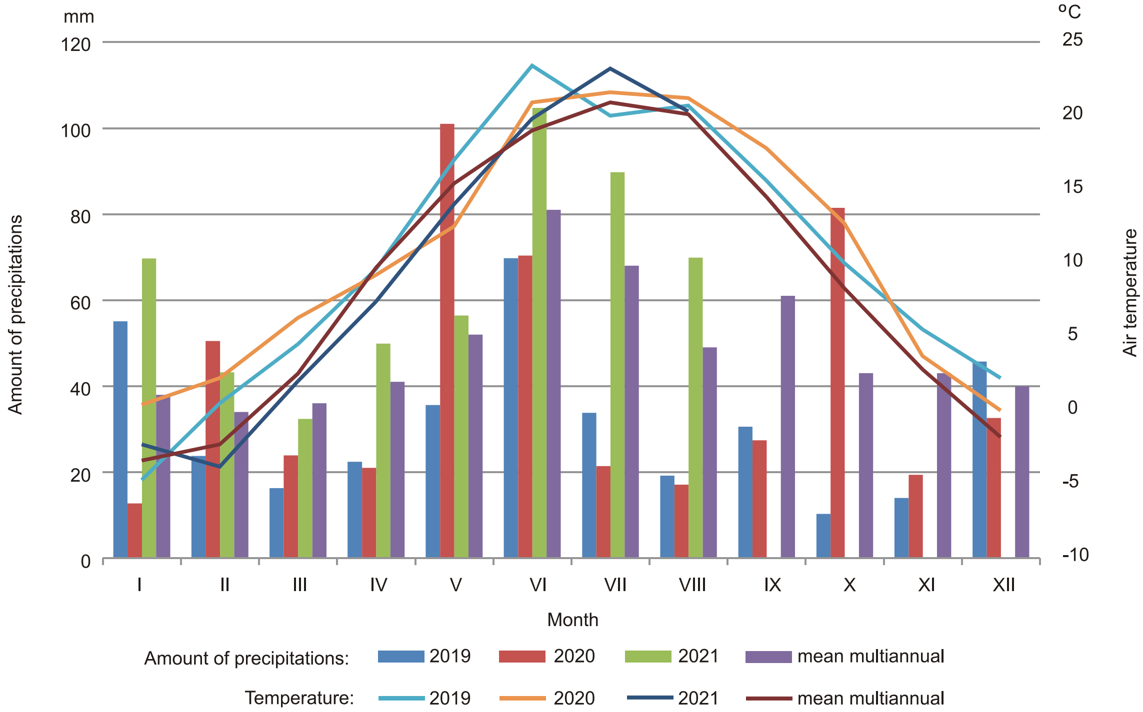


Fig. 1. Weather conditions in the area of field experiments

The plant procedures and analysis were performed according to these methods:

- aboveground biomass of hulless oats plants in the flowering stage (BBCH 61–69) was determined by the weight method according to Hrytsaienko *et al.* (2003);
- net productivity of photosynthesis during the plant stages of stem elongation (BBCH 30–39) – flowering (BBCH 61–69) was calculated according to Nichiporovich (1963), by the formula:

$$NPP = \frac{B_2 - B_1}{0,5(L_1 + L_2) \cdot n}$$

where:

NPP – net productivity of photosynthesis, $g \cdot m^{-2}$ per day,

B_1 and B_2 – mass of dry plant matter at the beginning and the end of the accounting period, m^2,

(B_2–B_1) – gain of dry matter mass for n days, g,

L_1 and L_2 – leaf area at the beginning and the end of the accounting period, m^2,

0.5 (L_1 + L_2) – average working area of the leaf surface during the experiment,

n – period between two observations, days;

- accounting of hulless oats grain yield was performed in plots, by harvesting with a “Sampo” combine, followed by weighing and conversion the result to the standard humidity (14%);
- thousand grain weight was calculated according to the Hrytsaienko *et al*. (2003).

Statistical processing of the research results was performed by ANOVA test followed by calculations of the t critical value and least significant difference (LSD). All the analysis, including correlation analysis were performed in Microsoft Office Excel.

RESULTS

Formation of highly productive agrophytocenoses depends on a complex of interconnected physiological-and-biochemical and growth processes of plants, which are reflected in the formation of biomass.

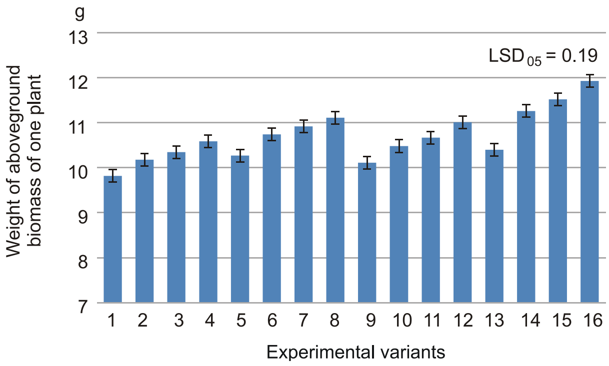
The results of the performed researches showed that pre-sowing seed treatment of hulless oats with microbial preparation Melanoriz both separately and in mixtures with plant growth regulator Agrolight, had a positive effect on the growth processes. Thus, on average over the years of research, the aboveground plant biomass exceeded the control indicator by 0.36; 0.53 and 0.77 g in the variants where seeds of hulless oats were treated before sowing with the microbial preparation Melanoriz at the rates of 1.0; 1.25 and 1.5 $dm^3 \cdot Mg^{-1}$ (Fig. 2).

The aboveground plant biomass increased to the control by 0.92; 1.10 and 1.29 g when the seeds were pre-treated before sowing with preparation Melanoriz (1.0; 1.25 and 1.5 $dm^3 \cdot Mg^{-1}$) in a mixture with plant growth regulator Agrolight (0.26 $dm^3 \cdot Mg^{-1}$). Compared to the variants where only Melanoriz was used this indicator increased by 0.56; 0.57 and 0.52 g.

Under the complex use of Melanoriz (seed treatment at the rate of 1.0; 1.25; 1.2 $dm^3 \cdot Mg^{-1}$) and Agrolight (seed treatment at the rate of 0.26 $dm^3 \cdot Mg^{-1}$) with subsequent spraying of the crops with Agrolight at the rate of 1.0 $dm^3 \cdot ha^{-1}$ the aboveground plant biomass increased compared to the control by 1.44; 1.70 and 2.11 g, which was significant at LSD_{05} 0.19.

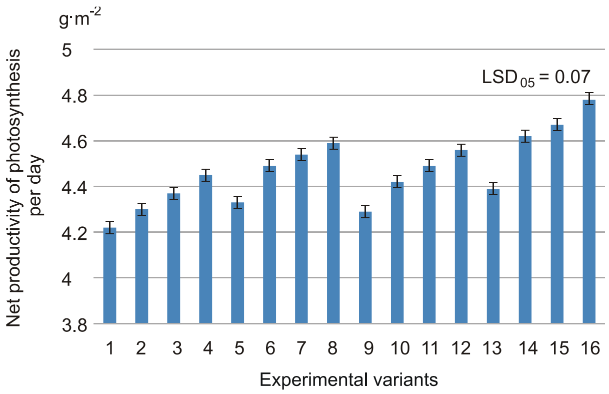
The highest indicators of oats plants biomass were obtained under the complex use of the studied preparations (seed treatment + plant treatment), which indicates the activation of the growth processes in plants. Such activation is the consequence of stimulating influence of exogenous phytohormones, on the one hand, and improved conditions of mineral provision due to the microorganisms introduced into the root system, on the other hand.

The photosynthetic productivity of crops directly depends on the formation of plant biomass. According to the results of research, net productivity of photosynthesis of the crops increased by 1.9–5.5% in relation to the control under the pre-sowing seed treatment of hulless oats with microbial preparation Melanoriz (1.0; 1.25 and 1.5 $dm^3 \cdot Mg^{-1}$) (Fig. 3).



Experimental variants: 1 – without use of preparations (control); 2, 3, 4 – Melanoriz 1.0, 1.25 and 1.5 $dm^3 \cdot Mg^{-1}$; 5 – Agrolight 0.26 $dm^3 \cdot Mg^{-1}$; 6, 7, 8 – Melanoriz 1.0, 1.25 and 1.5 $dm^3 \cdot Mg^{-1}$ + Agrolight 0.26 $dm^3 \cdot Mg^{-1}$; 9 – Agrolight 1.0 $dm^3 \cdot Mg^{-1}$; 10, 11, 12 – Melanoriz 1.0, 1.25 and 1.5 $dm^3 \cdot Mg^{-1}$ + Agrolight 1.0 $dm^3 \cdot ha^{-1}$; 13 – Agrolight 0.26 $dm^3 \cdot Mg^{-1}$ + Agrolight 1.0 $dm^3 \cdot ha^{-1}$; 14, 15, 16 – Melanoriz 1.0, 1.25 and 1.5 $dm^3 \cdot Mg^{-1}$ + Agrolight 0.26 $dm^3 \cdot Mg^{-1}$ + Agrolight 1.0 $dm^3 \cdot ha^{-1}$

Fig. 2. Aboveground plant biomass under the effect of biological preparation and a plant growth regulator (flowering stage (BBCH 61–69), mean for 2019–2021)



Explanation as in Fig. 2

Fig. 3. Hulless oat's net productivity of photosynthesis under the effect of biological preparation and a plant growth regulator (stage of stem elongation – flowering (BBCH 30–69), mean for 2019–2021)

Higher indicators of photosynthetic productivity were formed in the variants where microbial preparation

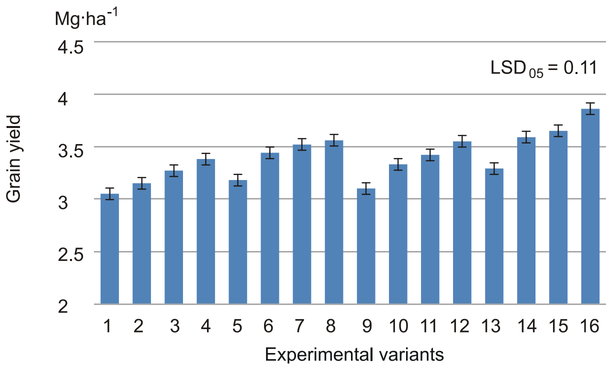
Melanoriz (1.0; 1.25 and 1.5 dm^3·Mg^{-1}) was used for the pre-sowing seed treatment in combinations with the plant growth regulator Agrolight (0.26 dm^3·Mg^{-1}), which exceeded the control by 6.4–8.8%.

The indicators of net productivity of photosynthesis increased by 4.7–8.1% compared to the control when the plant growth regulator Agrolight (1.0 dm^3·ha^{-1}) was used on the background of pre-sowing seed treatment with microbial preparation Melanoriz at the rate of 1.0–1.5 dm^3·Mg^{-1}.

The highest indicators of net productivity of photosynthesis were obtained using Melanoriz (1.0; 1.25; 1.5 dm^3·Mg^{-1}) with Agrolight (0.26 dm^3·Mg^{-1}) for the pre-sowing seed treatment, followed by treatment of the crops with Agrolight at the rate of 1.0 dm^3·ha^{-1}. In these variants excess to the control was 9.5; 10.7 and 13.3%, which was more than in the variants of single Melanoriz use by 7.4; 6.9 and 7.4%.

Thus, the highest increase in net productivity of photosynthesis was obtained in the variants of complex preparations use, which was by 0.4–0.56 g·m^{-2} per day higher than the control and it was significant at LSD_{05} 0.07.

Analysis of the hulless oats grain yield showed that this indicator increased by 0.1; 0.22; 0.33 Mg·ha^{-1} compared to the control when the microbial preparation Melanoriz was used at the rates of 1.0; 1.25 and 1.5 dm^3·Mg^{-1} for the pre-sowing seed treatment (Fig. 4).



Explanation as in Fig. 2

Fig. 4. Grain yield of the hulless oats under the effect of biological preparation and a plant growth regulator (mean for 2019–2021)

Higher grain yield was observed in the variants where seeds were treated before sowing by the mixture of Melanoriz at the rates of 1.0; 1.25; 1.5 dm^3·t^{-1} and Agrolight at the rate of 0.26 dm^3·Mg^{-1}, where excess of control was 0.39; 0.47 and 0.51 Mg·ha^{-1}.

When the crops of hulless oats were sprayed with Agrolight (1.0 dm^3·ha^{-1}) on the background of pre-sowing seed treatment by Melanoriz (1.0; 1.25 and 1.5 dm^3·Mg^{-1}) gain of grain was 0.28; 0.37 and 0.50 Mg·ha^{-1} compared to the control. However, it decreased by 0.11; 0.10 and 0.01 Mg·ha^{-1}, respectively, in relation to the correspondent variants with the complex pre-sowing seed treatment with Melanoriz and Agrolight.

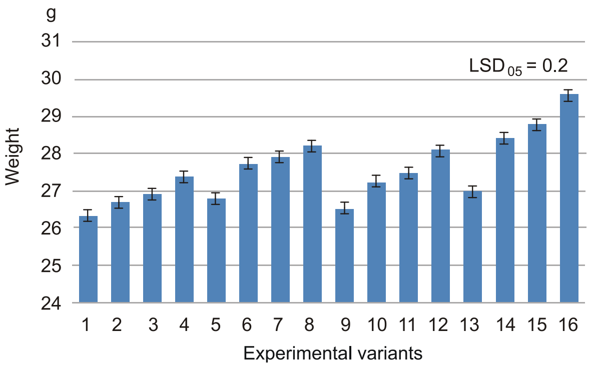
The grain yield of hulless oats increased relatively to the control by 0.54; 0.60 and 0.81 Mg·ha^{-1} in the variants where Melanoriz (1.0; 1.25; 1.5 dm^3·Mg^{-1}) and Agrolight (0.26 dm^3·Mg^{-1}) were used in mixtures for the pre-sowing seed treatment, followed by treatment of crops with Agrolight at the rate of 1.0 dm^3·ha^{-1}. These variants also showed increase by 0.15; 0.13 and 0.30 Mg·ha^{-1} at LSD_{05} 0.11 compared to the similar variants, where the treatment of vegetative plants with Agrolight was not performed.

Apparently, complex use of biological preparations for the pre-sowing seeds treatment and crops provided improved conditions for the formation of the aboveground biomass and net productivity of photosynthesis. As the result, action of the microbial preparation Melanoriz increased the colonization rhizosphere surface, and thus, improved conditions for the plant mineral nutrition which is the basis of yield formation.

The positive correlation relationship between the mean indicators of net productivity of photosynthesis and grain yield was established (r = 0.74).

Among the investigated variants of the experiment, the highest grain yield of hulless oats was obtained under the use of Melanoriz at the rate of 1.5 dm^3·Mg^{-1} along with Agrolight at the rate of 0.26 dm^3·Mg^{-1} for the pre-sowing seed treatment, followed by spraying the crops by Agrolight at the rate of 1.0 dm^3·ha^{-1}. It can indicate that the most favorable conditions were formed at this combination of preparations which promoted to form high grain productivity of the crops.

Qualitative indicators of grain yield also changed depending on the use of studied preparations. Particularly the thousand grain weight of hulless oats increased by 0.4, 0.6 and 1.1 g compared to the control when the seeds were treated before sowing with Melanoriz at the rates of 1.0; 1.25; 1.5 dm^3·Mg^{-1} (Fig. 5).



Explanation as in Fig. 2

Fig. 5. Thousand grain weight of hulless oats under the effect of biological preparation and a plant growth regulator (mean for 2019–2021)

When Melanoriz in mentioned rates was mixed with Agrolight (0.26 dm^3·Mg^{-1}) for the pre-sowing seed treatment, the thousand grain weight exceeded control by 1.4; 1.6 and 1.9 g. At the same time when Agrolight was sprayed on the vegetative plants at the rate of 1.0 dm^3·ha^{-1} on the background of pre-sowing seed treatment with Melanoriz, this indicator was by 0.9; 1.2 and 1.8 g higher than the control. The highest thousand grain weight of hulless oats was observed when Melanoriz (1.0; 1.25; 1.5 dm^3·Mg^{-1}) and Agrolight (0.26 dm^3·Mg^{-1}) were used in mixtures for the pre-sowing seed treatment followed by spraying of the vegetating plants with Agrolight 1.0 dm^3·ha^{-1}. The thousand grain weight in such conditions exceeded the control by 2.1; 2.5 and 3.3 g, which is more than in the variants of single Melanoriz use by 2.5; 7.1 and 8.0%.

DISCUSSION

The formation of the aboveground plant biomass depends on the varietal characteristics of culture, weather and agronomic conditions (Levchenko *et al.*, 2018), as well as on the use of exogenous growth stimulating compounds. Thus, Smolin *et al.*, (2012) noted an increase in vegetative mass of plants by 15% under the seed treatment of winter wheat with Epin-extra (50 cm^3·ha^{-1}). Similar results were obtained by Vlasenko *et al.*, (2013) under the seed treatment of spring wheat with Bioklad (40 g·Mg^{-1}, 125 g·ha^{-1}), Bius (10 g·Mg^{-1}), Larus (200 g·ha^{-1}), where the increase of the aboveground and underground plant biomass was 10–15%.

Cherneha (2012) investigated that the seed treatment of winter barley with plant growth regulator Biolan at the rate of 20 cm^3·Mg^{-1} caused an increase in the aboveground plant biomass in the earing stage by 8%, milk ripeness of grain – by 13%, and the increase in the aboveground plant biomass was 6 and 10%, respectively, under the use of this plant growth regulator at the rate of 10 cm^3·ha^{-1} on the seedlings (in the above stages).

The above experimental data from the literature show the growth of the aboveground plant biomass under the use of growth controllable preparations for both seed and crops treatment, and are consistent with the data of our research concerning the use of Melanoriz and Agrolight in the crops of hulless oats. At the same time it is necessary to note that the aboveground plant biomass was the highest and exceeded the control by 1.42; 1.68 and 2.03 g when the hulless oats was growing on the background of complex use of Melanoriz (treatment of seed at the rate of 1.0; 1.25; 1.2 dm^3·Mg^{-1}) + Agrolight (treatment of seed at the rate of 0.26 dm^3·Mg^{-1}) + Agrolight (treatment of plants at the rate of 1.0 dm^3·ha^{-1}).

Net productivity of photosynthesis reflects the real productivity of the agrobiocenosis. It is the main parameter with which the level of grain yield of agricultural crops correlates (Caulfield *et al.*, 1988; Vazhov, 2012).

Literature data show that microbial preparations and plant growth regulators stimulate the passage of physiological processes in agricultural crops, as evidenced by data on the use of plant growth regulator Biolan (10 cm^3·ha^{-1}) in the crops of winter triticale where the excess to the control was 4% (Prytuliak, 2010); under the action of plant growth regulator Vuxal BIO Vita (1.0 dm^3·ha^{-1}) in the sowings of hulled wheat where net productivity of photosynthesis exceeded the control by 7% (Pavlyshyn, 2018); under the action of plant growth regulators Humifield (0.8

$dm^3 \cdot Mg^{-1}$, 0.4 $dm^3 \cdot ha^{-1}$), MIR (6 $g \cdot Mg^{-1}$, 6 $g \cdot ha^{-1}$), PROLIS (5 $g \cdot Mg^{-1}$, 2 $g \cdot ha^{-1}$) in the crops of spring barley where net productivity of photosynthesis at the pre-sowing seed treatment and under the use of preparations on vegetative plants increased to the control by 13–20% (Zaiets *et al*., 2019).

The results of our research show that net productivity of photosynthesis under the action of microbial preparation Melanoriz and plant growth regulator Agrolight under the use of preparations for pre-sowing treatment of hulless oats seed and application of Agrolight in the crops exceeded the control on average by 2–15%. This growth may be caused by the formation of a more powerful aboveground plant biomass under the action of the studied preparations, which may be a consequence of improved conditions of plant nutrition by introduction into the rhizosphere of the root microbiota. This is consistent with the data of the scientists (Patyka *et al*., 2011; Volkohon *et al*., 2013; Novikova *et al*., 2019b).

The analysis of scientific studies (Ernst-Detlf Schulze *et al*., 2002; Schilling, Panero, 2002; Russel, 2013; Dobrovolskyi, 2019) proves that seed treatment by microbial preparations and post-seedling application of plant growth regulators is indisputably one of the most effective and safest measures for the grain yield increasement. According to Hryhoriev (2010), the use of microbial preparation Polymyxobacterin (100 ml per hectare sowing rate) and plant growth regulator Neitrino (10 $cm^3 \cdot ha^{-1}$) causes an increase in the yield of spring barley of 0.22 and 0.21 $Mg \cdot ha^{-1}$. The use of Rhizoagrin (300 $g \cdot Mg^{-1}$) for pre-sowing seed inoculation of oats, spring wheat, barley provides an increase in yield at the level of 0.3–0.9 $Mg \cdot ha^{-1}$ (Kozhemiakov *et al*., 2008); Agrobacterin (0.6 $dm^3 \cdot Mg^{-1}$) in crops of winter rye provides an increase in grain yield by 0.41 $Mg \cdot ha^{-1}$ (Kalenska, Tsiuk, 2006).

Sliusar *et al*., (2020) states that the use of plant growth regulators Humisol (3.0 $dm^3 \cdot ha^{-1}$) and Reakom (1.0 $dm^3 \cdot ha^{-1}$) in the crops of hulless oats provides an increase in grain yield by 0.6–0.8 $Mg \cdot ha^{-1}$ compared to the control.

The above literature data are consistent with our studies, which found that grain yield of hulless oats increased by 0.40–0.52 $Mg \cdot ha^{-1}$ in comparison with the control in the variants with pre-sowing seed treatment by microbial preparation Melanoriz (1.0; 1.25 and 1.5 $dm^3 \cdot Mg^{-1}$) in a mixture with the plant growth regulator Agrolight (0.26 $dm^3 \cdot Mg^{-1}$). The highest indicators of yield were observed in the variants with the pre-sowing seed treatment by the mixture of preparations Melanoriz (1.0; 1.25 and 1.5 $dm^3 \cdot Mg^{-1}$) and Agrolight (0.26 $dm^3 \cdot Mg^{-1}$) with post-seedling application of Agrolight (1.0 $dm^3 \cdot ha^{-1}$), where the excess to the control was 0.55–0.86 $Mg \cdot ha^{-1}$.

Summarizing the above material, it can be stated that the formation of the aboveground biomass, net productivity of photosynthesis and grain yield of the hulless oats depends on the application of the microbial preparation separately and in mixtures with plant growth regulator. However, the most optimal conditions for the formation of the hulless oats crop productivity are under the use of Melanoliz at the rate of 1.5 $dm^3 \cdot Mg^{-1}$ in a mixture with Agrolight at the rate of 0.26 $dm^3 \cdot Mg^{-1}$ for pre-sowing seed treatment followed by spraying the crops with Agrolight at the rate of 1.0 $dm^3 \cdot ha^{-1}$.

CONCLUSIONS

1. It was investigated that the highest biomass and net productivity of photosynthesis of hulless oats plants are formed in the variant of the experiment with the application of plant growth regulator Agrolight (1.0 $dm^3 \cdot ha^{-1}$) on the background of pre-sowing seed treatment with the mixture of microbial preparation Melanoriz (1.0; 1.25 and 1.5 $dm^3 \cdot Mg^{-1}$) and plant growth regulator Agrolight (0.26 $dm^3 \cdot Mg^{-1}$). Average excess to the control in these variants was 14–21% in the flowering stage, while the net productivity of photosynthesis of the crops increased by 9–13%.
2. The crops of hulless oats formed the highest grain yield after application of plant growth regulator Agrolight (1.0 $dm^3 \cdot ha^{-1}$) on the background of pre-sowing seed treatment with the mixture of microbial preparation Melanoriz (1.0–1.5 $dm^3 \cdot Mg^{-1}$) and plant growth regulator Agrolight (0.26 $dm^3 \cdot Mg^{-1}$). The yield under the effect of this combination of preparations increased to the control in average by 0.4–0.56 $Mg \cdot ha^{-1}$.
3. It was found that the highest indicators of the aboveground biomass, net productivity of

photosynthesis, grain yield and thousand grain weight of hulless oats were in the variant with Melanoriz use at the rate of 1.5 $dm^3 \cdot Mg^{-1}$ + Agrolight at the rate of 0.26 $dm^3 \cdot Mg^{-1}$ (pre-sowing seed treatment), followed by spraying the crops with Agrolight (1.0 $dm^3 \cdot ha^{-1}$). The aboveground biomass of oats plants in the flowering stage increased by 21%, net productivity of photosynthesis – by 15%, grain yield – by 0.86 $Mg \cdot ha^{-1}$, thousand grain weight – by 12% under this combination of preparations.

4. The most favorable conditions for the forming of the high thousand grain weight indicators were also observed in the variants where Agrolight (1.0 $dm^3 \cdot ha^{-1}$) was used on the background of pre-sowing seed treatment by Melanoriz (1.0–1.5 $dm^3 \cdot Mg^{-1}$) and Agrolight (0.26 $dm^3 \cdot Mg^{-1}$). In such conditions this indicator exceeded control by 8–12%.

RESEARCH FUNDING SOURCE

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WYDAJNOŚĆ OWSA BEZŁUSKOWEGO W ZALEŻNOŚCI OD ZASTOSOWANIA PREPARATU MIKROBIOLOGICZNEGO I REGULATORA WZROSTU ROŚLIN

Streszczenie

Badania przeprowadzono w celu wyjaśnienia złożonego działania różnych dawek preparatu mikrobiologicznego Melanoriz (*Glomus* sp., *Aspergillus terreus*, *Trichoderma lignorum*, *Trichoderma viride*, *Bacillus macerans*, *Arthrobacter* sp., *Bacillus subtilis*, *Paenibacillus polymyxa*, ogólna liczba żywych komórek $2{,}5 \times 10^7$ $CFU \cdot ml^{-1}$) w ramach różnych metod stosowania regulatora wzrostu roślin Agrolight (polyethylene glycol-400 + polyethylene glycol-1500, ogólna zawartość 770 $g \cdot dm^{-3}$, sole kwasów humusowych, 30 $g \cdot dm^{-3}$) na kształtowanie nadziemnej biomasy, produktywność netto fotosyntezy i plon ziarna owsa bezłuskowego. Badania przeprowadzono na owsie bezłuskowym (*Avena sativa* subsp. *nudisativa* (Husnot) *Rod. et Sold*., *Avena sativa* L.) odmiany Myrsem przy użyciu metod ogólnie przyjętych w praktyce rolniczej. W trakcie eksperymentu stwierdzono, że biomasa nadziemna, produktywność netto fotosyntezy, plon oraz masa tysiąca ziaren owsa bezłuskowego uległy zmianie w zależności od zastosowanego preparatu mikrobiologicznego w różnych dawkach z regulatorem wzrostu roślin. Okazało się, że oceniane parametry owsa bezłuskowego były największe w wariantach Melanoriz w dawce 1,5 $dm^3 \cdot Mg^{-1}$ + Agrolight w dawce 0,26 $dm^3 \cdot Mg^{-1}$ (zaprawa przedsiewna) z opryskiwaniem upraw Agrolightem (1,0 $dm^3 \cdot ha^{-1}$). W fazie kwitnienia owsa bezłuskowego (BBCH 61-69) uzyskano wzrost biomasy nadziemnej o 21%, produktywności netto fotosyntezy – o 13%, plonu ziarna – o 0,86 $Mg \cdot ha^{-1}$, masy tysiąca ziaren – o 12% – w wyniku łącznego stosowania preparatów. Daje to podstawy do zastosowania Melanoriz 1,5 $dm^3 \cdot Mg^{-1}$ + Agrolight 0,26 $dm^3 \cdot Mg^{-1}$ + Agrolight 1,0 $dm^3 \cdot ha^{-1}$ w uprawie proekologicznej owsa bezłuskowego.

Słowa kluczowe: owies bezłuskowy, preparat mikrobiologiczny, produktywność upraw, regulator wzrostu