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ORIGINAL ARTICLE

Regulation of winter wheat productivity

O. Voloschuk, I. Voloschuk, O. Stasiv, V. Hlyva, L. Baistruk-Hlodan

Institute of Agriculture of Carpathian Region National Academy of Agrarian Science, Obroshyno Village, Pustomyty District, Lviv Region, Ukraine

**Corresponding author E-mail: glodanlesa@ukr.net*

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The forest-steppe zone occupies 34% of the Ukrainian territory. in which 40.1% of agricultural land is concentrated. The climate is moderately continental; in the soil there is more often an excess of moisture than a lack. The sum of active temperatures during the growing season is 2780°C. The annual radiation balance is 1800-1850 MJ/m^2, and the total radiation for the year is 95-107 kcal/cm^2. Soil cover is complex and variegated, represented by 160 soil differences. Such soil and climatic conditions cause a low winter wheat yield (4.0 t/ha). Therefore, the objective of our research was to establish the effect of biological preparations used in pre-sowing treatment on the adaptive and productive properties of plants. The high efficiency of the growth stimulator Emistim C and the bacterial drug Rizoplan was achieved both for separate and combined use with Vitavax 200 FF, 34% w.s. (2.5 l/ha) for seed germination in the field, growth and development in the autumn, which ensured the best wintering of plants, the formation of high seed yields and sowing qualities.

Keywords: Winter wheat, Seed yield, Seed quality, Mineral nutrition level, Biological preparations.

Introduction

At the present stage of agriculture in Ukraine, an important place in environmentally friendly technologies for growing crops is given to biopreparations, which complement or replace chemical preparations. Due to the need for ecologization, the biological method of plant protection is the basis for the strategic ecological and biological control of pests in crops. Biologically active substances that contain a balanced complex allow activating basic life processes in plants, increasing plant resistance to adverse environmental factors, such as high and low temperatures, phytotoxic effects of pesticides, and diseases and pest damage (Zubets et al., 2010; Gritsaenko et al., 2008; Chabanyuk et al., 2015). It should be noted that the cost of biological products is 2-3 times lower compared to chemical preparations, and biological plant protection differs by selectivity of action on diseases and pests of plants and ensures efficiency by 60-80%, and under favorable conditions-90-95%, then as chemical-90% and destroys the useful fauna (Smetanko et al., 2018; Andreichenko et al. 2010).

The complex use of traditional means with new innovative elements of biologization capable of performing a number of functions to increase plant productivity and the quality of cultivated products in various soil-climatic zones (Fischer et al., 2014; Gathala et al., 2014; Tkalenko, 2015).

Biological preparations make it possible to fully realize the potential capabilities of varieties when the cultivation technology does not match their genetic capabilities to ensure a sufficient degree of reliability and genotype protection from the adverse effects of biotic and abiotic environmental factors (Fokin, 2008; Bilovus et al., 2015; Bilovus and Voloshchuk, 2015).

The selection of highly efficient, competitive biological products of the new generation for seed technologies remains an important issue, as seeds are the carrier of all important biological and physiological properties of the variety and affect the quality and quantity of the yields obtained in subsequent reproduction. Widespread use in the production of various mechanisms and machines leads to its injury, penetration of microorganisms, which adversely affects the growth and development of plants and leads to a decrease in yield properties and sowing qualities of seeds (Borovaya, 2009; Kotchenko and Sichevoj, 2017; Voloshchuk et al., 2014; Voloshchuk, 2011; Voloshchuk et al., 2017).

Materials and Methods

The studies were carried out in the Seed Laboratory of the Institute of Agriculture of the Carpathian region of the NAAS during 2015-2017.

The topsoil on the experimental plots was characterized by such agrochemical parameters: humus content (according to Tyurin)-1.9%, salt extract pH (potentiometric method)-4.8, hydrolytic acidity (Kappen-Gilkovits)-2.93 mg eq./100 g of soil, mobile phosphorus and potassium content (according to Kirsanov)-98 and 86 mg per 1 kg of soil, tin hydrolyzed nitrogen (according to Cornfield)-88 mg per 1 kg of soil. Weather conditions in the years under study were characterized by a certain variability; however, no extreme events were observed. The temperature regime of the third decade of September (the optimal time to sow winter wheat) in 2014 was within the average long-term indicators and the amount of precipitation is lower (65%). This period was wet in 2015, when precipitation was dominated by perennial data by 207% and air temperature by 2.3°C. In 2016, their amount was 16.6 mm (19 mm) and 12.4°C (11.2°C).

The technology of growing wheat seeds of winter varieties of Polesskaya-90, Lesnay pesnay, Romantyka included options for presowing seed treatment with a Vitavaks disinfectant 200 FF, 34% i.c. (2.5 l/t), growth stimulator Emistim C (200 ml/t) and bacterial preparation Rizoplan (0.5 ml/t). Mineral fertilizers were applied normally $N_{30}P_{90}K_{90}$ for sowing+N_{30} at stages IV and VII of organogenesis. Protection of planting against weeds included herbicides-Grodil Maxi, 37.5% o.d. (0.10 l/ha)+Zenkor liquid, 60% c. (0,2 l/ha), plants: fungicide-Lamardor PRO, 18% tks (0.5 l/ha), insecticide-Fastak, 10% k.s. (0.12 l/ha). The area of the experimental plot is 56 m^2, accounting for 50 m^2. Placement options systematic, repetition threefold. The seeding rate of winter wheat seeds is 5.5 mill. viable seeds/ha. The sowing qualities of the varieties sown over the years were answered by DSTU 4138-2002 (Crop seeds, the method..., 2003). Processing and generalization of research results were performed using Microsoft Excel by dispersion and correlation analysis (Dospekhov, 1985).

Results and Discussion

Studying the effect of the growth biostimulant Emistim C and the bacterial fertilizer Rizoplan, we identified a number of their important properties. Therefore, the development of the root system, depending on the pre-sowing treatment of the Emistim C seeds with the growth stimulator Emistim C, took place with different intensities. If in control (seed treatment with Vitavax 200 FF, 34% vsk. (2.5 l/t), the plants formed 3.8-4.2 pcs. germinal roots, then in variants using Emistim C, their number was 22.5-35.5% more, the length ranged from 4.5 cm (on control) to 6.8 cm in the joint treatment variant of Vitavax 200 FF, 34% vs.k.+Emistim C+Rizoplan, or increased by 12.6-15.1%. The daily weight gain reached 2.0-2.6 g and was 33.0-50.7% higher compared to the control; the absolutely dry weight of 100 plants grew by 18.5-30.8%.

An important indicator of the strength, development and intensity of the initial growth of the root system is the ratio to the aboveground organs, this indicator in our experiments was high and was 0.46-0.50.

The good development of the root system of plants in the initial stage of growth ensured their high viability under both laboratory and field conditions (Table 1). With the same mass of 1000 seeds (42.1-42.4 g), the germination energy in the control was 88.1%, laboratory germination rate 92.5%. These figures were 5-7% and 4-5% in variants using Emistim C and Rizoplan.

Table 1. The effect of pre-sown seed preparation for winter wheat with biological preparations on field germination and wintering of plants (2014-2017),%.

Experience Option	Field Germination		Wintering of Plants	
	The Average	± To Control	The Average	± To Control
Vitavax 200 FF, 34% vsk. (2.5 l/t) (control)	63.6	-	82.3	-
Vitavax 200 FF, 34% vsk. (2.5 l/ha)+Emistim C (200 ml/t)	72.6	9.0	95.8	11.6
Vitavax 200 FF, 34% vsk. (2.5 l/ha)+Rizoplan (0.5 ml/t)	72.5	8.9	94.6	11.5
Vitavax 200 FF, 34% vsk. (2.5 l/ha)+Emistim C (200 ml/t)+Rizoplan (0.5 ml/t)	77.7	14.1	96.1	11.7
SSD_{05}	2.5		1.9	

The experimental data confirmed that the field germination of seeds was directly dependent on the sowing qualities of the seeds, the weather conditions of the year, and the biological preparations used. The seed quality of the experimental options was characterized by different resistances to the effects of adverse environmental factors. Despite the different field germination over the years, the effect of the use of Emistim C and Rizoplan was significant and amounted to 8.9-14.1%. The highest field germination rate (77.7%) was provided by the option of joint treatment of seeds with Vitavaks 200 FF disinfectants, 34% vsk.+with Emistim C biostimulator+Rizoplan bacterial fertilizer, which is 14.1% higher than the control (seeds treated with Vitavaks disinfectant 200 FF, 34% vsk).

The growth and development of plants, their number per unit of area, and preservation before harvesting are adversely affected by winter stress. The favorable weather conditions in the winter periods and the varieties good adaptability of the studied varieties to the growing conditions, an adequate level of mineral nutrition, the effect of the precursor and the biological product, and bacterial fertilizer had a positive effect on the overwintering of plants. A high percentage of their overwintering (82.3-96.1%) was observed in all variants of the experiment, but it was 11.5-11.7% lower in the control, which is reliable for the smallest significant differences of varieties: Polesskaya-90-1.3, Lesnay pesnay-2.1, Romantyka-2.4.

Adequate plant nutrition from the first stages of organogenesis increased the productive tillering of plants. According to SSD_{05} 0.1, the combined use of a treatment with a growth stimulator and a bacterial preparation significantly increased the tillering coefficient by 0.2-0.3, ensuring an increase in the number of productive stems per unit area of 432 to 738 pcs/m^2 or 171-306 pcs/m^2 for control. The seed mass per spike also increased from 1.3 to 1.8 g.

Both the winter hardiness and the productivity of the forest-steppe ecotype varieties were formed under favorable environmental conditions for them from the first days of life; therefore, the statement of the scientific literature that the higher the winter resistance of the plants, the lower the yield according to our research was not confirmed and is controversial.

The level of the productivity of crops of the studied varieties of winter wheat was quite high (5.4-5.7 t/ha of seeds), and a reliable increase in yield was 0.6-0.7 t/ha, or 10.2-17.2% higher than when sowing seeds, pickled only Vitavaks 200 FF, 34% vsk (Fig. 1).

The highest seed yield was ensured by the joint treatment option (disinfectant, biostimulant, and bacterial fertilizer), in which the yield exceeded the control by 0.8 t/ha, or 15.7%.

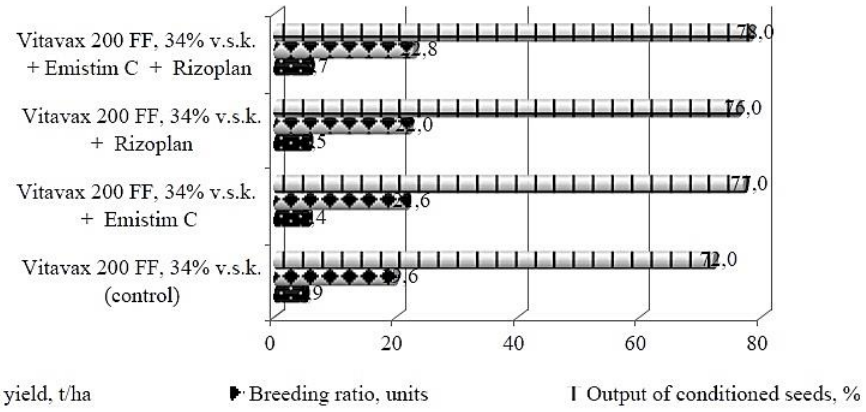

Fig. 1. Yield, reproduction rate and yield of conditioned winter wheat seeds, depending on pre-sown treatment with biological preparations (2015-2017).

The seed multiplication factor increased from 19.6 units to 22.8, or 3.2 units compared to the control, by 1.2 units with the Emistim C use option and by 0.8 units with the bacterial preparation Rizoplan. Combining a growth stimulator with a bacterial preparation in the background of the mineral nutrition of plants N90 90 90 with a phased introduction of nitrogen in the phases of plant development has a positive effect on the yield of conditioned seeds. Under this option, the figure increased by 6% compared to the control.

Studies on the influence of biostimulants and bacterial fertilizers on seed quality are of great scientific interest, especially in the area of risky seed production in grain crops of the Western Forest-Steppe of Ukraine. In our experiments, a high mass of 1000 seeds (44.2-45.1 g) was obtained, the germination energy (85.2-88.7%) and the laboratory germination (94.5-95.3%) of winter wheat was the result of a favorable relationship between the weather conditions and the optimal level of plant nutrition during the growing season, which was influenced by both the growth promoter and the bacterial preparation (Table 2).

Table 2. Indicators of the the sowing qualities of winter wheat seeds harvested, depending on presowing treatment with biological preparations (2015-2017).

Experience Option	Weight 1000 seed		Germination		Laboratory Germination	
	g	±%	%	±%	%	±%
Vitavax 200 FF, 34% vsk. (2.5 l/t) (control)	42.3	-	83.6	-	93.4	-
Vitavax 200 FF, 34% vsk. (2.5 l/ha)+Emistim C (200 ml/t)	44.5	5.2	85.2	1.6	94.5	1.1
Vitavax 200 FF, 34% vsk. (2.5 l/ha)+Rizoplan (0.5 ml/t)	44.2	4.9	85.3	1.7	94.6	1.2
Vitavax 200 FF, 34% vsk. (2.5 l/ha)+Emistim C (200 ml/t)+Rizoplan (0.5 ml/t)	45.1	6.6	88.7	5.1	95.3	1.9
SSD_{05}	0.9		0.8		0.6	

Conclusion

The use of biological preparations Emistim C and Rizoplan in presowing treatment of seeds simultaneously with dressing is one of the agro-approaches for increasing yields and sowing qualities of seeds of winter wheat varieties. High efficacy of drugs is achieved both for their separate and for their joint use.

Biological preparations have a positive effect on the development of the root system by increasing the absolutely dry weight of 100 roots by 39.6-51.4%, plants by 24.1-30.8%, which caused a high percentage of field germination by 9.0-14.0% and overwintering of plants by 11.5-11.7%.

Presowing treatment of seeds with Vitavaks 200 FF disinfectants, 34% vsk. (2.5 l/ha)+Emistim C (25 ml/t)+Rizoplan (0.5 ml/t) (against the background of the N909090 mineral nutrition of plants N909090 with phased introduction of nitrogen into stages IV and VII of organogenesis) provides a higher seed yield of 17%, increasing by 3 units the multiplication factor and 6% the yield of conditioned seeds and the high sowing qualities of the collected seeds.

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