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To cite this article: A L Lukin *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **422** 012015

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The effect of biological and chemical seed treatment on oats production capacity

A L Lukin, N V Podlesnykh, V A Zadorozhnaya and T P Nekrasova

Voronezh State Agricultural University named after the Emperor Peter the Great, 1, Michurina st., Voronezh, 394087, Russia

E mail: Loukine@mail.ru

Abstract. The article describes the effect of fungicide and microbial protectors used for pre-sowing seed treatment on oat production capacity. It analyses agents of various origins and functions (Vial Trust® Maxim® Selest® Top, Extrasol®) and the results of the tests. The research demonstrates that pre-sowing seed treatment with Vial Trust® had a positive effect on the length of the whisk. Maxim® contributed to the increase in the 1000-grain weight, whereas seed treatment with Extrasol® showed a positive effect on the field germination rate of the oat plants, the height of the plants, the number of the cones in the whisk. It also contributed to the decrease in the number of defective cones, increased the number of grains in the whisk, boosted grain weight in the whisk and enhanced the crop productivity. In all cases, the results of the treated variants exceeded the control variants, thus demonstrating their efficiency and sustainability effect.

1. Introduction

Oat has always played an important role in agricultural sphere for being both valuable forage and food supply. For example, oat is part of the diet of the grain-fed young stock such as calves, horses and poultry. Ground oat is a biologically valuable nutrient in forage due to a large amount of protein fractions, having the most balanced amino acid profile in comparison with the rest of the cereals [5]. One of the most important farm practices in growing crops is pre-sowing seed treatment [1-4]. Such treatment aims at disinfection and growth enhancement. Today, there is a variety of agents based on chemical, biological, microbiological effect, etc.). However, we believe intensive farming should be based on biological and eco-friendly technology [1,8]. Research into such farming practices is being conducted in all regions of Russia as well as abroad [6,7,9-10]. Obviously, the choice of the agent depends on a number of relevant factors, including types of crops and climatic conditions [1-4,6-10,13-16].

In regard to this, the area providing favorable conditions is found in the Voronezh region. Being the largest area in the Central black-earth region (CBER) of Russia, it also boasts having moderate continental climate and highly fertile soil, which provides for high oats crop production.

According to statistics, the oats crop production in different parts of the CBER in 2017 was the following: Voronezh Region – 23.9 c/ha, Belgorod Region – 27.0 c/ha, Kursk Region – 26.0 c/ha, Lipetsk Region – 26.9 c/ha, Oryol Region – 23.3 c/ha and in Tambov Region – 21.8 c/ha. On average, in Russia the figure was 19.6 c/ha [13].

The aim of this research is to identify the effect of different agents used for pre-sowing seed



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treatment on oat production capacity.

2. Materials and methods of research

We conducted an experiment in the territory of the Botanical Garden of the Voronezh State Agricultural University in 2016-2017 yrs. []. The technology of oats growing is common and standard for the CBER. The soil of the experimental plot is leached, middle loamy chernozem. It contains 4.5 % of humus, with 6.1-6.9 pH degree, 74...76 % of the degree of base saturation, 11.7...14.4 mg of K₂O and 7.3...11.8 mg/ (per 100 g of soil) of P₂O₅.

The most favorable weather conditions were in 2017. It was warm, sunny and moderately humid. In 2016, the weather was mostly dry and hot, which affected the second half of the plants vegetation.

The experiment was based on the sub-type of oat called Yakov, which is recommended to grow in a number of Russian regions, namely in Kaliningrad region, Kaluga region, Moscow region, Smolensk region, Kursk and Voronezh regions. The sort species is mutica, the mass of 1000 grains is 34...42 g. In the north-western region, the crop production was 39.4 c/ha, exceeding the average norm by 2.7 c/ha, and demonstrating the gain weight of 1.8 c/ha. In the Central region, and CEBR the gain weight was 3.3 c/ha, with an average crop production of 39.3 and 45.0 c/ha, respectively. It is a mid-ripening variety with a vegetation period of 82...95 days [12].

The agents used in the experiment for pre-sowing oat seed treatment included: Vial Trust® Maxim® Selest® Top, Extrasol®. The aim was to study the effect of these agents on oat production capacity. Before the experiment, the seeds were watered (the control variant) and treated with the agents.

Vial Trust® is a fungicide protectant of cereal seeds, and it has anti-stress components. A balanced combination of two components, each having a different spectrum of biological activity, but used together they produce a strong protectant effect against diseases. The anti-stress elements in the fungicide helps to avoid the retarded effect when the seeds are put deep in the soil and the weather is dry. This protectant enhances the growth, increases seed germination, germination vigor and thus provides for even sprouts.

Maxim® is a fungicide which is used for pre-sowing oat seed treatment of grain crops and other crop species, protecting them from pathogens found in soil and seeds. The advantages of this agent include the opportunity to treat seeds well in advance, its liquid preparative form containing a special coloring pigment, which signals the quantity and quality of the treatment. This agent can successfully combine with other fungicides and insecticides for pre-sowing seed treatment.

Selest® Top is used to protect the cereal sprouts from a number of insects, found in soil and on land, as well as fungi. The advantages of this agent include the protection of the sprouts from a large number of insects and diseases, providing for even sprouting, roots growth and development, decreasing the development of rottenness of various etiology. In addition, it enhances the plant resistance against unfavorable environmental conditions.

Extrasol® is a microbial agent in the liquid form containing *Bacillus subtilis* Ч-13. It is used to enhance the plant growth, production capacity and the quality of the crops, as well as protecting from diseases and negative impact of chemical agents.

3. Results and discussion

Well-developed and even sprouts are the guarantee of high yield productivity of any crop, including oat. Therefore, the experiment aimed at studying the effect of pre-sowing seed treatment on the field germination rate of oat. The results are given in Table 1 below.

The data in the table demonstrate that all the agents used in the experiment contributed to the increase of the field germination rate of oat by 8.0 ... 22.3 % in comparison with the control variant. Extrasol® showed the best result (89.9 %) and exceeded the control by 22.3 %.

In most cases, the application of microbial agents does not produce a negative effect, unlike their chemical counterparts [3, 6]. The experiment also revealed that the application of such agents as Vial Trust® Maxim® Selest® Top demonstrated lower results in comparison with the Extrasol® effect. It

should be accounted for the fact that Extrasol® provides much better for starting growth (from grain germination till sprouting), which positively affected the further development of the plants.

Table 1. Field germination rate of oat after pre-sowing seed treatment (%).

Variant	Field germination rate, %		
	2016	2017	Average value
The control	60.67	74.62	67.6
B Vial Trust®	73.54	77.69	75.6
Maxim®	76.54	77.69	77.1
Selest® Top	-	76.67	76.7
Extrasol®	98.25	81.54	89.9

The main elements of the oat yield structure include density of plant population, productive stooling, grain content and 1000-grain weight. The proportion of these characteristics is largely affected by the sort type, quality of the seeds, weather conditions and farming practices.

Our experiment is also aimed at studying the effect of the used agents on the elements of oat yield structure (see Table 2).

Table 2. Values of the elements of oat yield structure analysis after pre-sowing seed treatment (on average in 2016-2017 yrs.)

Variant	Height of the plant, cm	Number of plants within 0,25 m ² before harvesting	Number of stems within 0,25 m ²	Stooling (number)	Length of the whisk, cm	Number of cones in the whisk	Including defective ones	Number of grains in the whisk	Grain weight in panicle, g	Weight, 1000 PCs., g
The control	98.6	81.5	97.7	1.2	15.7	27.8	1.2	49.8	1.9	37.1
Vial Trust®	102.6	87.5	99.7	1.2	16.0	28.1	1.1	51.5	2.0	37.8
Maxim®	106.3	90.7	107.1	1.2	15.9	28.6	1.0	51.5	2.1	39.3
Selest® Top	100.7	92.3	107.0	1.2	16.6	29.6	1.3	56.2	2.1	37.4
Extrasol®	106.9	98.9	118.5	1.2	15.8	30.2	0.9	57.7	2.2	38.9

*Selest® Top (according to the data in 2017)

The data show that all the agents used in the experiments enhanced the height of the plants by 2.1...8.3 cm. The maximum height was found after seed treatment with Maxim® and Extrasol®, increasing the stems by 106.3 and 106.9 cm respectively. It exceeded the control variant by 7.7 cm (7.8 %) and 8.3 cm (8.4%), respectively.

Extrasol® also provided for the biggest number of plants and stems within 0.25 m² - 98.9 and 118.5, respectively. which exceeded the control variant by 17.4 and 20.8 items, respectively.

As for the stooling results, the experiment did not reveal any additional effect of the used agents. This value was 1.2 across the board and, apparently, was not affected by the agents.

The length of the whisks varied slightly and was about 15.7-16.6 cm. The biggest values were found in the crops treated with Selest® Top (16.6 cm) and Vial Trust® (16.0 cm), exceeding the control variants by 5.7 % and 1.9 %, respectively.

The biggest number of cones in the whisk was found in the plants treated with Extrasol® (30.2 items). This variant also showed the smallest number of defective cones (only 0.9 items per the

whisk). By contrast, the number of grains was the biggest across the board (57.7 items, exceeding the control variant by 15.9 %).

The grain weight in the whisk varied from 1.9 to 2.2 gr, revealing the biggest value in regard to the seeds treated with Extrasol® (2.2 gr), exceeding the control variant by 15.8 %.

The 1000-grain weight was found in seeds treated with Maxim® (39.3 gr), exceeding the control variant by 5.9 %. The rest of the variants showed 37.1-38.9 gr.

On balance, the results of the research demonstrate that pre-sowing seed treatment does affect the elements of the oat yield structure, thus being an efficient farming technology. Oat productivity for the variants studied in the experiment is given per 2016 and 2017 yrs. (see Table 3).

Table 3. Oat productivity after pre-sowing seed treatment, c/ha.

Variant	Crop productivity, c/ha		
	2016	2017	Average value
The control	24.6	31.8	28.2
Vial Trust®	30.9	35.0	33.0
Maxim®	33.2	37.6	35.4
Selest®	-	36.6	36.6
Extrasol®	37.1	42.3	39.7
HCP _{0.5}	4.35	2.78	

The data in Table 3 show that during the studied period the highest crop productivity resulted from the treatment with Extrasol® (39.7 c/ha), exceeding the control variant by 11.5 c/ha (40.8%). the rest of the agents also contributed to the increase in crop productivity by 4.8-8.4 c/ha (i.e. by 17-30%).

4. Conclusion

According to the results of the research, we can conclude the following:

1. Pre-sowing seed treatment with Vial Trust® had a positive effect on the length of the whisk (16 cm).
2. Pre-sowing seed treatment with Maxim® contributed to the increase in the 1000-grain weight (39.3 gr).
3. Pre-sowing seed treatment with Extrasol® demonstrated a positive effect on the field germination rate of the oat plants (exceeding the control by 22.3 %); the height of the plants (exceeding the control by 8.3); the number of the cones in the whisk (exceeding the control by 2.4 items); contributing to the decrease in the number of defective cones (0.9 items); increasing the number of grains in the whisk (exceeding the control by 7.9 items); increasing the grain weight in the whisk (exceeding the control by 0.3 gr.) and the crop productivity (exceeding the control by 11.5 c/ha).

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