BIOSCIENCES BIOTECHNOLOGY RESEARCH ASIA, December 2016. Vol. **13**(4), 1997-2001

Effectiveness of Biologics Application Against Root Rot of Grain Crops

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http://dx.doi.org/10.13005/bbra/2355

(Received: 10 November 2016; accepted: 30 November 2016)

The article studies the application of biologics in agriculture. Laboratory and field experiments were conducted on spring wheat. The effect of biologics on germination and biomass accumulation of wheat was studied. Also, laboratory and field experiments were conducted with "Baisheshek" barley variety. Rating of winter wheat biometrics in soil salinity conditions was conducted as well. The effect of biologics on germination and yield of wheat was studied.

Key words: Wheat, agriculture, biologics, strain, yield, disinfectant, Biologics effectiveness, plant protection, root rot.

In today's environment it is the challenge of finding new promising areas in agriculture for the use of technology safe for human health, animals, and the biosphere in general. In this regard, there is a gradual transition from intensive industrial agricultural production to alternative production (biological or environmental, in particular), which provides for the rational use of energy resources and reduction of environmental pollution, production of high quality agricultural products, the preservation and increase of soil fertility, and non-waste use of agricultural products[1].

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An integral part of ecological agriculture is the application of biologics, which improve plant nutrition, as well as biological means of plant protection. BioHumate is one of such biologics, produced through phytogenic waste bioconversion. Since cereals are major source of food, enzymes, trace elements, mineral salts and other biologically active substances and are the components of indispensable products of human rational nutrition, the requirements concerning their quality is quite high[2-3]. To ensure high quantitative and qualitative productivity indicators it is necessary to observe technology of cropper cultivation. Application of biologics at cultivation of grain crops initiates plants growth and development, improves nitrogen and phosphorus nutrition, increases their resistance against

pathogens and as a result helps to increase productivity and product quality, gives the opportunity not only to save significant amounts of energy, but also creates a favorable environment for agriculture in general, since it helps to increase fertility of soils using much smaller amounts of mineral fertilizers and, consequently, reducing the level of environmental pollution[4-5].

In this regard, we have conducted laboratory and field experiments.

Objects and research methods

The tests were carried out at the experimental facility of Kazakh Research Institute of Plant Protection and Quarantine ("Kapal" farm situated in the village of "Akyn Sara" in the Eskeldy District of the Almaty Region). Spring wheat variety "Kazakhstan 10" was the research object in the current study.

The mechanical composition of the soil was made up of dark brown soil, medium loamy soil, and humus (3.0 – 3.5%), pH 7.0. Forecrop was spring wheat plowed to the depth of 15-17 cm by "BD" disc header, pre-sowing cultivation, rolling after sowing. Sowing of seeds was produced on May 11 employing "SZ-3.6" tractor seeder. Seed application rate was 4.0 mln pcs/ha, while depth was 5-6 cm.

Eight variants were tested in the experiment:

1. Control – seeds treated with water;
2. Vial TT disinfectant – 0.4 l/t;
3. Tank mix of Vial TT – 0.4 l/t + TS3 Strain – 0.25 l/t;
4. Tank mix of Vial TT – 0.4 l/t + GZ14 strain – 0.2 l/t;
5. Tank mix of Vial TT – 0.4 l/t + Extrasol– 0.1 l/t;
6. Extrasol– 0.1 l/t;
7. Strain 2 – 0.15 l/t;
8. BL01 Strain – 0.05 l/t.

The experiments were conducted under field conditions in four replications. The size of the plots was 0.25 ha. Biologics were applied using seed treatment technique before sowing. Seed pickling machine (PS-10) was employed for seeds treatment, water consumption rate was 10 l/t. The results of biological effectiveness are presented in Tables 1 and 2.

Currently, environmentally focused technologies are increasingly used in crop production to achieve clean production, which is the most promising in the development of agriculture[6]. The lack of any substances in grain crops leads to disturbance in carbohydrate and nitrogen metabolism, protein synthesis, as well as reduces the resistance of plants to adverse environmental conditions[7-8].

The aim of our study at this stage consisted in testing of biologics prepared on the basis of a rhizosphere bacteria strain of *Bacillus suptilis*.

The experiments were laid out in the Almaty Region, in Talgar District, in the village of "Panfilov", LLP "Bayserke Agro", at the Experimental Base of Kazakh Research Institute of Plant Protection and Quarantine. Laboratory and field research methods were used when conducting experiments. "Baisheshek" barley variety was taken as a research object.

Mechanical composition of the soil consisted of dark chestnut soil, medium loam soil, and humus (3.0 – 3.5%), pH was equal to 7.0. Sowing of barley seeds was produced on April 24 employing SZ-3.6 tractor seeder, seeding rate was 3.5 mln pcs/ha, at a seeding depth of 5-6 cm.

Field experiments were carried out according to the following scheme:

1. Control – seeds treated with water;
2. Disinfectant Vial TT – 0.4 l/t;
3. Tank mix of Vial TT – 0.4 l/t + TS3 Strain – 0.25 l/t;
4. Tank mix of Vial TT – 0.4 l/t + GZ14 Strain – 0.2 l/t;
5. Tank mix of Vial TT – 0.4 l/t + Extrasol – 0.1 l/t;
6. Extrasol – 0.1 l/t;
7. Strain 2 – 0.15 l/t;
8. BL01 Strain – 0.05 l/t.

Registration plot area was 0.25 ha. The experiments were carried out in four replications. Biologics were applied using seed treatment technique before sowing. Seed pickling machine (PS-10) was used for seeds treatment, water consumption rate was 10 l/t. Biological effectiveness of biologics and the infestation of plants with root rot are presented in Tables 3 and 4.

The results of study have shown that in the pre-sowing treatment of barley seeds, biologics did not significantly affect the germination energy and laboratory seed germination, but at the same

time slightly inhibited the infestation of seeds by mold fungi (15.8 – 86.8%). This resulted in increased seedling density by 7.3-13.6 pcs/m^2. The biologics reduced the infestation of barley with root rot at the plant tillering phase by 31.5-66.3% (Table 3). Besides, the biologics increase physiological growth of plants and contribute to accumulation of crops biomass in comparison with the control variant (Table 4).

In this experiment, treatment of seeds and crops by biologics positively affected the sowing qualities of the resulting seeds as compared to control.

In Kazakhstan, wheat is the most important grain crop in terms of food significance and scale of production. Production of this crop in all continents amounts to 615 mln tones per year. About half of the global wheat grain production accounts for just five countries: Canada, USA, China, India, and Russia [9].

Winter wheat is a valuable crop in field rotation and a good forecrop for a number of crops (maize, sunflower, sugar beet, winter barley, stubble crops, etc.).

Yielding capacity refers to the average size of particular crop produced per unit of cultivated area, measured usually in hundredweight per hectare [10]. Yield characterizes the total amount of given crop production, while yielding capacity of the crop is its productivity under specific conditions of cultivation. In accordance with the specifics of these concepts, the yield is characterized by a number of indicators. These indicators include specific yield, yield before the beginning of timely harvesting, the actual yield, the so-called crop in storage, and net yield. In the beginning, crop harvesting is estimated in the original recorded weight, and then in the actual weight of the grain after modifications, as well as based on the conversion with regard to standard humidity[11].

Crops yield and yielding capacity are direct statistical characteristics of the level of crop production development and total agricultural production. Yield (bulk yield) is the total amount of production of any agricultural crops (group of crops) in real terms, obtained from the entire area of the crops[12]. In relation to the importance of the crop yield index, we have investigated the plant biometrics and yield of winter wheat.

Biometric analysis and yield estimate were conducted at the phase of full ripeness. To carry out proper recording, 50 plants were selected in four replications. The results of the biometric analysis and the yield index are shown in Tables 5 and 6.

RESULTS AND DISCUSSION

The results of field and laboratory studies, presented in Table 1, have shown that pre-sowing treatment of wheat seeds with biologics slightly increases laboratory germination of seeds, enhances field germination rate (7.8-15.4 pcs/m^2), inhibits the development of mold fungi by 26.9-90.4% and root rot – by 29.4-66.7%. Besides, the biologics increase physiological growth of plants and accumulation of crops biomass in comparison with the control variant.

According to the above data we can

Table 1. Effect of biologics on spring wheat seeds germination and the infestation of plants with root rot

Drug	Consum-ption rate Rg/t, l/t	Germination index, %			Seeding density pcs/m^2	Infestation of plants with root rot at tillering phase, %	Biological effectiveness, against root rot, %
		Viability	Labora-tory germination	Mold deterior ate			
Vial TT	0.4	90.5	93.8	0.25	270.5	2.8	62.7
Vial TT + TS3 Strain	0.4 + 0.25	92.0	94.9	0.5	276.8	2.7	64.0
Vial TT +GZ14 Strain	0.4 + 0.2	91.9	96.1	0.75	277.5	2.5	66.7
Vial TT +Extrasol	0.4 + 0.1	91.8	95.5	0.75	275.9	2.6	65.3
Extrasol	0.1	90.9	94.0	1.8	271.6	4.7	37.3
Strain 2	0.15	91.2	93.9	1.7	269.9	5.0	33.3
BL01 Strain	0.5	90 .8	95.1	1.9	271.0	5.3	29.4
Control with no treatment	-	89.7	92.1	2.6	262.1	7.5	-

Table 2. Effect of biologics on plant growth and biomass accumulation in the wheat (at the germination-tillering phase)

Drug	Consumption ratekg/t, l/t	Plants length,cm	Biomass of 50 plants, g
Vial TT	0.4	18.9	63.5
Vial TT + TS3 Strain	0.4 + 0.25	21.7	66.6
Vial TT + GZ14 Strain	0.4 + 0.2	21.5	67.1
Vial TT + Extrasol	0.4 + 0.1	22.1	65.9
Extrasol	0.1	19.4	64.1
Strain 2	0.15	18.7	62.9
BL01 Strain	0.5	19.2	63.8
Control with no treatment	-	16.2	61.0

Table 3. Effect of biologics application on the germination of barley seeds a nd the infestation of plants with diseases

Drug	Consum-ption rate Rg/t, l/t	Germination index, %			Seeding density pcs/m^2	Infestation of plants with root rot at tillering phase, %	Biological effectiveness, against root rot, %
		Viability	Labora-tory germination	Mold deterior ate			
Vial TT	0.4	92.5	99.3	0.5	165.8	3.2	64.1
Vial TT + TS3 Strain	0.4 + 0.25	94.1	98.7	0.25	167.7	3.4	61.8
Vial TT + GZ14 Strain	0.4 + 0.2	93.7	98.7	0.25	169.2	3.1	65.2
Vial TT + Extrasol	0.4 + 0.1	95.2	98.7	0.5	170.1	3.0	66.3
Extrasol	0.1	92.8	98.5	1.4	164.9	5.4	39.3
Strain 2	0.15	93.1	98.3	1.5	163.8	5.6	37.1
BL01 Strain	0.5	92 .5	99.5	1.6	165.1	6.1	31.5
Control with no treatment	-	91.9	98.7	1.9	156.5	8.9	-

Table 4. Effect of biologics on barley plant growth and biomass accumulation (tillering phase)

Drug	Consumption ratekg/t, l/t	Plants length,cm	Biomass of 50 plants, g
Vial TT	0.4	21.8	70.9
Vial TT + TS3 Strain	0.4 + 0.25	23.1	72.2
Vial TT + GZ14 Strain	0.4 + 0.2	22.9	71.2
Vial TT + Extrasol	0.4 + 0.1	24.3	73.1
Extrasol	0.1	21.9	70.6
Strain 2	0.15	21.7	68.8
BL01 Strain	0.5	20.9	67.9
Control with no treatment	-	19.1	66.1

Table 5. Biometric analysis of winter wheat after application of biologics

Biologics	Plants height, cm	Ear length, cm	Number of productive stems	Tilling capacity, psc.	Root rot, score	Weight of 50 plants. g	Weight of 1000 seeds, g
GZ14 Strain	85.2	7.046	1.12	12.8	0.2	162	48
BL01 Strain	86.564	7.88	1.54	14.48	0.14	239	46
Extrasol	83.06	8.716	3.36	15.86	0.18	369	48
TS3 Strain	87.424	8.704	1.74	15.94	0.14	291	48
MEGA	82.298	7.582	1.18	14.48	0.02	176	46
Control with no treatment	71.99	6.8	1.08	11.24	0.14	108	42

Table 6. Yield indices of winter wheat in saline soil using biologics

Biologics	Area (ha)	Yield (hwt/ha)
GZ14 Strain	1	3400
BL01 Strain	1	3100
Extrasol	1	2850
TS3 Strain	1	2500
MEGA	1	2000
Control with no treatment	1	3150

conclude that the optimal results relative to the control were obtained in the variants with Extrasol and TS3 Strain biologics. In terms of the infestation with root rot, less involvement was indicated in the variants with application of MEGA and GZ14 Strain biologics. From the above data it can be assumed that the high yielding capacity was observed in a variant with GZ 14 Strain. Justifying our experimental data, we can recommend Extrasol and GZ 14 Strain biologics for application in agriculture.

CONCLUSION

As a result of the study it was revealed that the effectiveness of Vial TT disinfectant amounted to 178.1% in comparison with the control, while effectiveness of Vial TT + TS3 Strain was 161.8% relative to the control. Effectiveness of Vial TT + GZ14 Strain equaled to 187.0%, Vial TT + Extrasol – to 166.7%, Extrasol – to 64.8%, Strain 2 – to 58.9%, and BL0 Strain – to 45.9%. In terms of the susceptibility to root rot, the lowest rate was indicated in the variant of Vial TT + GZ 14 Strain, while high level of susceptibility was shown by BL 01 Strain.

The study of seed germination, the susceptibility of agricultural crops by different fungal diseases, and study of the biologics application effectiveness play very important role both round the world and in Kazakhstan. Therefore, concerned problem is extremely urgent in providing the population with a healthy nutrition and receiving high crop yields.

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