



Impact of Seed Treatments Pre-sowing and Organo-mineral Fertilizer on Spring Barley Production

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ABSTRACT

The results of this experiment showed the effect of barley seeds pre-treatments and organo-mineral fertilizer on the morpho-physiological evaluation of seedlings, seed quality and productivity of spring barley (Mikhailovsky). Variance analysis results (ANOVA) showed extremely significant ($p < 0.05$) variations between different treatments in all traits, where the treatments led to increasing the germination energy, laboratory germination, growth force and weight of 100 sprouts compared with control. There was a positive effect on the development of the barley root system. Pre-treatment of seeds in wet years have been proven to be the most effective, while the efficiency of seed treatment pre-sowing decreased when soil moisture was low. Therefore, in 2017 barley productivity increased when the seeds were treated with a mixture of Polaris with Siliplant by 25% compared to control, while in 2018 the yield increased (7.1%) when mixture of Siliplant with Polaris was applied compared to control.

Key words: Barley, Fertilizer, Germination, Polaris, Seed treatments, Siliplant.

INTRODUCTION

Cereals account for about 60% of the world's agricultural land. In accordance with international standards, cereal production is the main criterion of the welfare and food independence of countries. Food security requires one ton of grain per person per year (FAO, 2014). At present, the main task of agriculture is to increase the yield of cultivated crops, including cereals and which is one of the main sectors of the agricultural system, where more than half of the land of Russia (53%) is occupied by cereals and leguminous plants (FAO, 2007). Barley is one of the most important cereals, which ranks fourth after wheat, rice and corn in the world (Kumar *et al.*, 2013, Pal *et al.*, 2012, Zhou, 2010, Lapitan *et al.*, 2009). In Russia barley ranks second in terms of production after wheat, this accounts for 25% of total grain production (Medvedev *et al.*, 2015). According to the United Nations Environment Program (UNEP) and WHO statistics, about 3 million are suffering from acute pesticide poisoning and nearly 20,000 die in developing countries yearly (UNEP/GEMS, 1992 and FAO, 2011). As a result of the widespread use of agricultural chemicals (pesticides and fertilizers), that led to the accumulation of these chemicals in the plant and soil for a long time, which adversely affects both human and environment. The excessive and unbalanced use of nutrients has become a cause for concern as it may lead to soil degradation and less fertility, which ultimately leads to lower crop productivity (Gul, *et al.*, 2019). One way to find a solution to such problems has been to introduce new methods and techniques that increase the quality and productivity of crops and preserve the environment.

At present, pre-sowing seed treatment one of the most effective ways to increase the productivity of agricultural crops by plant growth regulators with microelements are considered as an environmentally friendly and economically profitable way to increase the yield of cereals through

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accelerating germination and improving seedling growth (Narayanan *et al.*, 2017). That is one of the trends in sustainable agriculture that increases plant resistance to the effects of unfavorable environmental factors. Microelements are very essential and considered the most important physiologically active substances, without which plants cannot grow well and play a multifaceted role in plant, which participate in all physiological processes, the activity of enzymes, vitamins and hormones. These increase also the resistance of plants to pests, diseases and adverse environmental conditions (Wildfluh 2011).

MATERIALS AND METHODS

The two experiments were carried out in the laboratory of the Plant Production Department of the Agronomy and Biotechnology Faculty and field station at the State Agrarian University of Moscow Agricultural Academy named after KA Timiryazev in 2017 and 2018. With objectives to investigate

the effect of each of the pre-sowing seed treatments and fertilizing on the quality and productivity of spring barley.

Laboratory experiment

The experiment was conducted in 2017 and 2018 to study the effect of barley seed treatments pre-sowing on sowing properties by morpho-physiological evaluation of seedlings by measuring germination characteristics (Germination energy “%”, Laboratory germination “%” and Growth force), identified according to (Methods for determining the seed germination by State Standard of Russia). The germination energy was determined after 3 days of seed germination, as well as laboratory germination during the seventh day after seed treatment. In another experiment, germination strength was measured by root mass and length, as well as mass and length of shoots on the seventh day. The experiment was performed using complete random design using four treatments (Siliplant, Polaris, Siliplant + Polaris and distilled water “as control”) In 4 replications each one includes 100 seeds. The seed treatment rate was 15 ml and 0.6 ml/100 ml of water for both Polaris and Siliplant, respectively.

Field experiments

The experiments were carried out in (2017 and 2018) in four replications and the area of the accounting plot - 52 m². The experiment was carried out using two-row barley brewing varieties (Mikhailovsky), the seeding rate was 5.5 million seeds/ha (250 Kg).

Seed treatment

Seeds were treated 8 hours before seeding using Polaris at a rate of 1.5 l/t. and Siliplant was used at a rate of 60 ml/t with 10 liters of water/t.

Fertilizers

Nitrogen fertilization was carried out in two doses, the first - in tillage and the second - with the appearance of the third leaf with a dose of 50 kg/ha. Organic and Ecofus fertilizers were added at a rate of 2 kg/ha and 2 liters/ha, respectively, with 300 liters of water/ha.

Siliplant is a liquid micro fertilizer with a high content of silicon (7.5-7.8%) and microelements of potassium, Fe, Mg, Cu, Zn, Mn, Mo, Co, B in chelated form intended for pre sowing treatment of seeds.

Polaris is a fungicidal disinfectant intended for pre-sowing treatment of seeds. The preparative form in the form of a micro emulsion allows for maximum penetration of the active substances into the seed, powerful and prolonged protection during the growing season.

Ecofus is a new liquid organo-mineral fertilizer based on brown algae contains nitrogen (1.8%), phosphorus (1.0%), potassium (2.0%) and more than 40 trace elements, iron, magnesium, manganese, copper, boron, zinc, calcium, molybdenum, cobalt.

Organic

Organic fertilizer in the form of a powder containing many nutrients, enzymes, vitamins and minerals, strengthens the

organic strengthening of the soil and improves its structure, as well as enhances the growth and spread of the root, which increases and improves the development of the plant.

RESULTS AND DISCUSSION

Meteorological conditions of the growing seasons

Meteorological conditions in the years of research (2017 and 2018) are presented according to the data of the meteorological observatory named after V.A. Michelson RGAU- Moscow Agricultural Academy named after KA Timiryazev (Fig 1).

Data in Tables 1, 2 showed laboratory results of morpho-physiological evaluation of seedlings and effect of the seed treatments pre sowing on germination characteristics. Obtained data showed that the response of the barley to the different seed treatments was significant, with the germination data showing a clear difference between the different seed treatments. The best seed treatments were when mixture of Polaris and Siliplant was used, which recorded the best values for germination energy, laboratory germination and germination force during two years of study. The average differences of superiority were by 5%, 3.6% and 10.4%, respectively compared with control.

This result was clearly consistent with that of Borisova (2016) who indicated that treated spring wheat seeds with Siliplant, zircon and Epin-Extra together with a disinfectant reduce the duration period “sowing - germination”, increases the germination energy by 8 - 11% and seed germination by 5 - 7%. This may be due to Biopreparations play a role to increase germination energy and seeds germination, also reduce seeds fungal infection (Jankauskienė and Survilien 2009, Pekarskas *et al.*, 2007 and Gaurilčikienė *et al.*, 2008). The differences were significant between seed treatments on the weight of the 100 sprouts (g), weight 100 root (g), length of sprouts and roots (cm). Data revealed the presence of positive effect on weight 100 roots and sprouts (g), length of sprouts and roots (cm) by used of Polaris and Siliplant. It contributed to the improvement sprouts length from 12.55 cm by control to 15.8 cm, also roots length increased from 15.75 cm to 20.68 cm. Also there were significant differences when the seeds were treated with a mixture of Polaris with Siliplant compared with all treatments during two years of study. Where were increased weight of 100 roots and sprouts respectively, from 9.15 by control to 18.49 g when used Polaris and Siliplant mixed, also from 9.1 to 12.6 g during two years. The positive effect of Polaris + Siliplant seed treatment is probably related to silicon, which is one of the contents of Siliplant, which has the ability to improve the germination process. These results are consistent with that of Hameed *et al.* (2013). Just as the use of silicon increases germination percentage, germination, seedling length and force index. Silicon has a good effect on the physiological response of plants (Ghajari *et al.*, 2015).

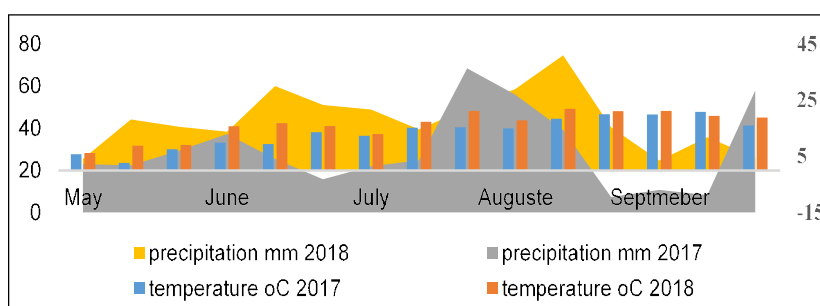
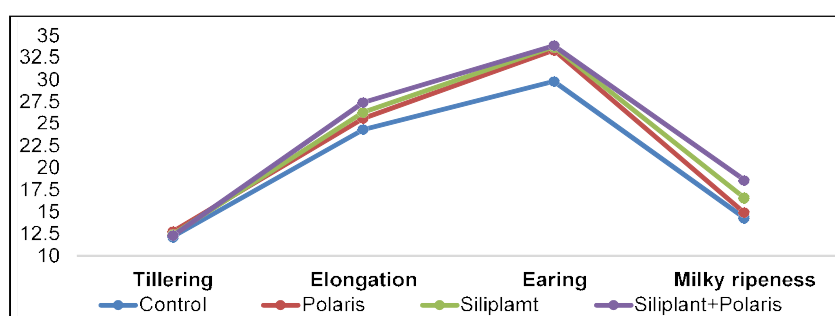
Fig 2 shows the positive effect of the seed treatments on the leaf area. The best surface area of the leaves was recorded during different plant growth phases when the

Table 1: Effect of seed treatments on germination energy (%), laboratory germination (%) and growth force (germination force % and weight 100 sprouts gr.).

Treatments	Germination energy (%)			Laboratory germination (%)			Growth power					
							Germination force (%)			Weight 100 sprouts (gr)		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
Control	89	96	92.5	92.3	96	94.2	82	84	83.0	6.8	11.4	9.1
Siliplant	96	97	96.5	97	98.2	97.6	92.7	100	96.4	8.6	12.8	10.7
Polaris	92	92	92.0	94.5	96.7	95.6	84.8	84	84.4	7.7	13.5	10.6
Polaris+Siliplant	97	98	97.5	97.5	98	97.8	92.8	94	93.4	8.6	16.7	12.7
LSD_{0.05}	2.54	1.23		2.13	1.65		5.63	2.46		0.85	0.48	

Table 2: Effect of seed treatments on weight 100 root gr., length sprouts (cm) and length roots (cm).

Treatments	Weight 100 root(gr)			Length sprouts(cm)			Length roots(cm)		
	2017	2018	Av.	2017	2018	Av.	2017	2018	Av.
Control	11.0	7.3	9.2	13.8	11.3	12.6	18.5	13.0	15.8
Siliplant	17.0	13.3	15.2	16.9	15.2	16.1	17.6	17.5	17.6
Polaris	12.6	12.5	12.6	14.0	13.7	13.9	20.3	13.5	16.9
Polaris+Siliplant	18.0	19.0	18.5	17.0	14.5	15.8	22.8	18.6	20.7
LSD_{0.05}	1.61	0.34		1.18	0.33		2.03	0.36	

**Fig 1:** Meteorological conditions of the two growing seasons.**Fig 2:** Effect of seed treatment on the dynamics of the formation barley leaf surface (2017-2018).

seeds were treated with a mixture of Polaris with Siliplant.

In the study of the effect of different fertilizers on leaf area (Fig 3), data showed superiority when were treated plant with Ecofus in general compared with the other fertilization treatments during the different phases of growth of barley plant, while superiority of spraying organic during the elongation and earing phases exceeded the treatment with Ecofus which reflected positively on the productivity as well as the characteristics and quality of the crop and the accumulation of dry matter.

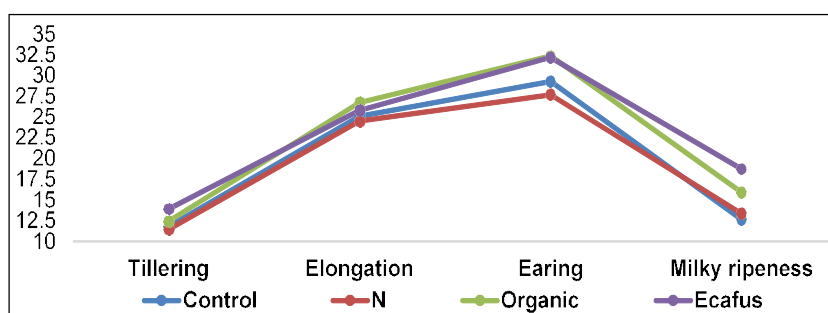
Data presented in Table 3 show the effect of seed treatments and fertilizer on barley grain yield, which increased significantly during 2017 and 2018 years. The obtained results are shown in (Table 3) effect of seed treatments and fertilizer on barley grain yield, were increased significantly during 2017 and 2018 years. Siliplant + Polaris increased grain yield (1.05 and 0.24 t/ha) in comparison with control in both seasons, respectively. The production by control were 4.29 and 3.39 t/ha in the first and second year, respectively. Also data revealed that grain yield was

Table 3: Effect of seed treatments and fertilizer on grain yield (T/ha) and their interaction during 2017 and 2018.

A) Seed treatments pre-sowing	B) Fertilizer				Average (A)	LSD _{0.05}		
	Control	N	Organic	Ecofus		A	B	A * B
The first season 2017								
Control	3.33	4.00	4.18	5.65	4.29	0.22	0.19	0.27
Siliplant	3.86	4.32	5.20	5.92	4.83			
Polaris	4.90	4.91	5.01	5.62	5.11			
Siliplant + Polaris	4.37	4.59	6.03	6.36	5.34			
Average (B)	4.12	4.46	5.11	5.89				
The second season 2018								
Control	2.86	4.08	3.62	3.01	3.39	0.17	0.19	0.22
Siliplant	3.00	3.52	3.97	3.38	3.47			
Polaris	3.13	4.34	3.37	3.24	3.52			
Siliplant + Polaris	2.95	4.24	3.87	3.45	3.63			
Average (B)	2.99	4.05	3.71	3.27				

Table 4: Effect of seed treatments and fertilizer on 1000 seeds (g) and their interaction during 2017 and 2018.

A) Seed treatments pre-sowing	B) Fertilizer				Average (A)	LSD _{0.05}		
	Control	N	Organic	Ecofus		A	B	A * B
The first season 2017								
Control	51.25	51.40	53.70	53.60	52.49	0.68	0.63	0.64
Siliplant	51.10	51.46	52.92	53.55	52.26			
Polaris	53.45	53.85	54.00	54.15	53.86			
Siliplant + Polaris	54.90	55.15	55.10	54.85	55.00			
Average (B)	52.68	52.97	53.93	54.04				
The second season 2018								
Control	45.80	48.08	45.86	45.61	46.34	0.69	0.7	0.85
Siliplant	43.19	48.09	43.47	45.03	44.95			
Polaris	49.77	51.32	46.79	47.79	48.92			
Siliplant + Polaris	43.97	46.31	47.37	49.77	46.86			
Average (B)	45.68	48.45	45.87	47.05				

**Fig 3:** Effect of fertilization on the dynamics of the formation barley leaf surface (2017-2018).

increased with applying fertilization with Ecofus in the first year and Nitrogen in the second year. Where the increasing rate reached 1.77 t/ha when applied Ecofus in first year and 1.06 t/ha when fertilized with nitrogen in the second year in comparison with control.

The data in Table 3 shows that using of seed treatments and fertilization leads to an increase in barley yield from 3.33 t/ha to 6.36 t/ha when treated seed with a mixture of Polaris with Siliplant and fertilization by Ecofus in the first year. But in the second year the increase was with the use

Polaris and nitrogen fertilization which recorded 51.75% compared to control, while the increase was 20.63% when treated with a mixture of Polaris with Siliplant and Ecofus fertilizer compared to control. This results agreed with those mentioned by Semina (2016), Borisova (2016) and Alenin (2015). They stated that the use of Siliplant (1L / ha), Ecofus (2.0 L / ha) and cytavet (1.5 l / ha) on spring wheat in the tillering stage had a positive effect on the spring wheat yield.

Results illustrated in Table 4 indicate that, applying the seed treatments and organo-mineral fertilizer led to increase

Table 5: Effect of seed treatments and fertilizer on water use efficiency (kg grain/m³) and their interaction during 2017 and 2018.

A) Seed treatments pre sowing	B) Fertilizer				Average (A)	LSD _{0.05}		
	Control	N	Organic	Ecofus		A	B	A * B
The first season 2017								
Control	8.93	10.72	11.21	15.14	11.5	0.42	0.64	0.53
Siliplant	10.35	11.58	13.94	15.87	12.93			
Polaris	13.13	13.16	13.43	15.07	13.7			
Siliplant + Polaris	11.72	12.29	16.16	17.04	14.3			
Average (B)	11.03	11.94	13.69	15.78				
The second season 2018								
Control	10.66	15.19	13.48	11.23	12.64	0.58	0.67	0.59
Siliplant	11.16	13.13	11.05	11.48	11.71			
Polaris	9.44	16.18	11.43	12.06	12.28			
Siliplant + Polaris	10.62	15.81	10.70	12.86	12.49			
Average (B)	10.47	15.08	11.67	11.91				

Table 6: Effect of seed treatments and fertilizer on Harvest Index (%) and their interaction during 2017 and 2018.

A) Seed treatments pre sowing	B) Fertilizer				Average (A)	LSD _{0.05}		
	Control	N	Organic	Ecofus		A	B	A * B
The first season 2017								
Control	38.78	45.36	43.99	44.76	43.22	0.63	0.77	0.97
Siliplant	44.16	43.46	46.51	50.51	46.16			
Polaris	45.38	42.00	41.99	44.26	43.41			
Siliplant + Polaris	42.60	40.58	49.97	46.35	44.88			
Average (B)	42.73	42.85	45.62	46.47				
The second season 2018								
Control	46.42	63.68	60.03	47.65	54.45	0.69	1.27	0.63
Siliplant	50.47	45.15	54.80	47.21	49.41			
Polaris	45.96	63.5	55.44	43.64	52.13			
Siliplant + Polaris	37.05	54.05	62.57	60.28	53.49			
Average (B)	44.98	56.6	58.21	49.7				

weight of 1000 seeds (g). The highest average observations were obtained when seeds treated with mixture of Polaris+Siliplant and plant treatment by Ecofus in the first year which recorded 55 g and 54.04 g, respectively. There were significant differences among all treatments in the second year. But the best results recorded by treated seeds with Polaris alone 48.92 g and fertilized by N 48.45 g. While the study of the interaction between seed treatments and fertilization, there were significant differences with an increase of 3.9 g compared to the control when processing the seeds with a mixture of Siliplant with Polaris and nitrogen fertilization in the first year. In the second year, superiority were when treated seeds by Polaris and nitrogen fertilization, which recorded an increase of 5.52 g compared to control.

The results in Table 5 show the effect of seed and fertilizer treatments on water use efficiency. The positive effect of the study factors on water use efficiency where increased by 24.35% when treated seeds by Polaris + Siliplant compared with control in the first season, while there were no significant differences during the second season. On the other hand, the performance of the Ecofus fertilization exceeded the water use efficiency by 43.06% as compared

to the control during the first season while the superiority of nitrogen fertilization during the second season led to an increase of 44.03% as compared to control.

By studying the interaction effect, preference was obtained when barley seed treated pre-sowing using a combination of Polaris and Siliplant with Ecofus fertilization, which increased by 90.82% in the first season compared to control. In the second season, barley seeds processing by Polaris and nitrogen fertilization recorded highest water use efficiency with an increase of 51.78%, 71.4% compared to control and Polaris alone, respectively.

In regard to harvest index, results shown in Table 6 indicated that highest significant observations in the first year were obtained from Siliplant as seed treatment which recorded increase of 2.94% compared to control. The use of Ecofus as a plant treatment led to increase harvest index 3.74% compared to control. The interaction between seed treatments and fertilizer, the best harvest index was recorded by treated seeds with Siliplant and fertilization by Ecofus which reached 50.51%.

On the contrary in the second year, non-treated seeds

(control) recorded the best results which reached 54.45%. Fertilization by organic was found superior to the other fertilization coefficients recording 58.21%. In the study of the interaction, the superiority of nitrogen fertilization with non-treated seeds (control) then nitrogen fertilization with the seeds treated treatment with Polaris, which recorded 63.68% and 63.5% respectively, where there was no difference significantly.

CONCLUSION

Combined pre-sowing treatment of seeds with Polaris and Siliplant micro-fertilizer allows in favorable years against the background of organic-mineral fertilizer Ecofus allows to improve the quality of seeds, which enhanced germination energy, germination rate and the growth force of the seed and increased the spread of the root system, which reflected on barley productivity.

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