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AGROECOLOGICAL ASSESSMENT OF THE INFLUENCE OF MICROBIOLOGICAL FERTILIZER ON OIL FLAX VARIETIES

Yuri KORYAGIN[1], Evgenya KULIKOVA[1], Natalya KORYAGINA[1], Yulia BLINOKHVATOVA[1], Anton BLINOKHVATOV[2]

[1]Penza State Agrarian University, 30 Botanicheskaya Street, Penza, Russia
[2]Penza State Technological University, 1/1a Baydukova passage/Gagarin Street, Penza, Russia

Corresponding author email: kuleg@mail.ru

Abstract

In a field stationary experiment and laboratory conditions, an assessment was made of the varietal responsiveness of oil flax plants to the effect of the microbiological fertilizer "Baikal EM-1" in the soil and climatic conditions of the Penza region. It has been established that in the technology of growing varieties of oil flax plants, the microbiological fertilizer "Baikal EM-1" used for seed inoculation before sowing + foliar treatment of flax plants in the "Christmas tree" phase + foliar treatment of flax plants in the budding phase, contribute to an increase in germination energy, field germination, as well as increasing the length of the seedling and germinal root. This leads to an increase in plant height in the herringbone phase of 14.2 cm, in the control variant 11.4 cm, in the flowering phase 49.1 cm, which is 10 cm higher than the control variant. Leafiness in the "herringbone" phase was 75.8%, in the control variant 64.8%. The seed yield of the Lirina variety was 19.3 c/ha and straw was 38.63 c/ha, while in flax plants of the Kinelsky 2000 variety, the seed yield was 18.4 c/ha and the straw was 36.8 c/ha.

Key words*: oil flax, microbiological fertilizer "Baikal EM-1", grade, productivity and crop structure.*

INTRODUCTION

The processes of soil degradation that have been rapidly developing in recent years against the background of chemicalization of agriculture are forcing producers to switch to energy-saving production technologies. In addition, special attention was paid to the quality of products (Kulikova and Blinokhvatova, 2021; Chebotar et al., 2015).

Of particular importance is the biologization of agriculture both in open and closed ground. The use of microbiological fertilizers has shown high efficiency in many crops (Baldani, 2005; Chandra et al., 2019; Hogenhout et al., 2009; Koryagin et al., 2020).

Flax is a valuable oilseed crop suitable for cultivation in almost any agricultural zone. An important reserve for the growth of oilseed flax yield is intensive technology of its cultivation, including scientifically based application of microbiological fertilizers (Pukalova, 2016; Shaykova et al., 2018; Posypanov, 2007).

Obtaining environmentally friendly products is of great importance in flax growing. Therefore, the study of the use of a biological product in the technology of flax cultivation and its effect on the productivity of seeds and fiber is currently relevant and promising.

MATERIALS AND METHODS

The microbiological fertilizer "Baikal EM-1" used in our experiments is an aqueous solution containing a complex of beneficial microorganisms that actually live in the soil and their metabolic products. These microorganisms interact in the soil, while producing all kinds of enzymes, amino acids and other physiologically active substances that have both direct and indirect positive effects on the growth and development of plants. The main role in the preparation "Baikal EM-1" is played by photosynthetic and lactic acid strains of microorganisms. Photosynthetic strains of bacteria affect the direct growth of plants, and lactic acid strains of bacteria contribute to faster soil cleansing from harmful substances and pathogenic microorganisms.

The aim of the work is to study the responsiveness of varieties flax oil seed for microbiological fertilizer Baikal EM-1, on the

dynamics of its growth, development and productivity.

The varietal responsiveness of oil flax to the effect of the Baikal EM-1 microbiological fertilizer was studied in a small-plot experiment on light gray forest soil. The plot area is 1 m^2, the experiment is repeated four times. The width of the protective strips is 1 m. The placement of repetitions is sequential. With a solution of the drug "Baikal EM-1", at a concentration of 1:1000, seeds were inoculated directly on the day of sowing and subsequent foliar treatments of plants - in the phases of herringbone and budding.

Scheme of experience:

1. Inoculation of seeds with water before sowing (control);
2. Inoculation of seeds "Baikal EM-1" before sowing;
3. Inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the "herringbone" phase;
4. Inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the budding phase;
5. Inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the "herringbone" phase + in the budding phase.

Sowing was carried out with a row spacing of 15 cm to a depth of 3 cm, the seeding rate was 700 pcs/m^2.The crop was harvested in the phase of full ripeness.

The yield data obtained in the experiment were processed by the method of dispersion analysis. Variety Lirina -Deutsche Saatveredelung AG, variety Kinelsky 2000 -Patentee GNU Povolzhsky Research Institute of Breeding and Seed Production. P.N. Konstantinov of the Russian Agricultural Academy (Figure 1).

RESULTS AND DISCUSSIONS

The study of the effect of the drug on the sowing qualities of flax showed that the germination energy of the studied varieties was higher in the variants with seed treatment before sowing with the microbiological agent Baikal EM-1 than in the control variant (treatment of seeds before sowing with water) (Table 1).

Table 1. Influence of inoculation of flax seeds with a biological product on the sowing qualities of oil flax seeds

Indicators	Linen variety			
	Lirina		Kinelsky 2000	
	1	2	1	2
Germination energy, %	85.6	89.8	84.1	87.6
Laboratory germination, %	91.3	95.5	88.5	93.7
Field germination, %	79.3	84.4	75.7	83.1
Spine length on day 3, cm	1.13	1.37	1.1	1.2
Spine length on the 6th day, cm	6.1	6.8	4.8	5.1

1 - Inoculation of seeds with water before sowing (control);
2 - Inoculation of Baikal EM-1 seeds before sowing.

The same can be said about the laboratory and field germination of the studied plant varieties. The inoculation of flax seeds "Baikal EM-1" ensured laboratory germination of plants of the Lirina variety - 95.5%, plants of the Kinelsky 2000 variety - 93.7%. Whereas in the control variant it was 91.3% and 88.5%, respectively. Field germination of the flax variety Lirina was 4.2% higher compared to the control variant; in the flax variety Kinelsky 2000 - by 5.2%. The length of the seedlings also increased markedly compared to the control.

The highest height of flax plants in the field was observed in the Lirina variety in the “herringbone” and flowering phases during seed inoculation + foliar treatment in the “herringbone” and budding phases. Plant height reached 14.2 cm in the herringbone phase and 49.1 cm in the flowering phase, while in the variant with seed treatment before sowing with water (control) it reached 11.4 cm in the herringbone phase, and in the flowering - 39.1 cm. A similar pattern was observed in flax varieties Kinelsky 2000 (Table 2).

Table 2. The effect of microbiological fertilizer on the biometric parameters of plants of oil flax varieties

Indicator	Development phases	Option				
		1	2	3	4	5
Flax variety Lirina						
Plant height, cm	"herringbone"	11.4	12.0	12.5	12.8	14.2
	bloom	39.1	42.4	45.3	46.8	49.1
Leafiness of plants, %	"herringbone"	64.8	71.4	72.1	72.9	75.8
	bloom	48.1	51.2	52.3	53.1	56.1
Plant biomass, g/m²	"herringbone"	299	310	349	411	454
	bloom	880	940	1100	1400	1770
Flax variety Kinelsky 2000						
Plant height, cm	"herringbone"	10.9	11.7	15.1	16.3	17.4
	bloom	48.5	51.4	55.4	59.2	60.4
Leafiness of plants, %	"herringbone"	63.6	70.0	71.2	72.3	73.7
	bloom	47.5	50.8	52.3	52.8	61.3
Plant biomass, g/m²	"herringbone"	221	297	330	375	423
	bloom	814	895	981	1212	1541

1 - Inoculation of seeds with water before sowing (control);
2 - Inoculation of seeds "Baikal EM-1" before sowing;
3 - Inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the "herringbone" phase;
4 - Inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the budding phase;
5 - Inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the "herringbone" phase + foliar treatment in the budding phase

The highest percentage of foliage, both in the Lirina variety and in the Kinelsky 2000 variety, was observed in the variants where the seeds were inoculated together with the processing of the vegetative mass "Baikal EM-1" in the "herringbone" and budding phases. In the “herringbone” phase, the Lirina variety had 75.8% foliage, which is 11% more than in the variant with seed treatment with water before sowing (control variant). In plants of the variety Kinelsky 2000, respectively, 73.7%, which is 10.1% more than in the control.

The degree of foliage of plants affects the net productivity of photosynthesis, which allows plants to accumulate more dry matter, which means that the largest economic yield can be predicted.

The biomass of flax plants in the “herringbone” phase increased by 155 g/m² during the inoculation of Baikal EM-1 seeds before sowing + foliar treatment in the “herringbone” phase + foliar treatment in the budding phase in flax plants of the Lirina variety compared to the control; in flax plants of the Kinelsky 2000 variety - by 201.4 g/m². In the flowering phase, the biomass of the Lirina variety in the variant with the inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the "herringbone" phase + foliar treatment in the budding phase was 1770.2 g/m^2, which is 890.2 g. more than in the control variant. In the flax variety Kinelsky 2000, in the variant, inoculation of seeds together with the treatment of the vegetative mass "Baikal EM-1" in the phases of "herringbone" and budding, the biomass during flowering was 1540.5 g/m^2, which is 726.5 g/m^2 more,

The study of the influence of microbiological fertilizer "Baikal EM-1" on the elements of the structure of the crop in different varieties of oil flax showed that both varieties showed high responsiveness to the use of microbiological fertilizer "Baikal EM-1". Compared to the control variant, the following increased: plant height, the number of bolls per plant, as well as the weight of 1000 seeds (Table 3).

Table 3. The effect of seed inoculation with fertilizer on the elements of the crop structure in different varieties of oil flax

Indicator	Development phases	Option				
		1	2	3	4	5
Flax variety Lirina						
Plant height, cm	General	44.6	50.1	52.5	52.8	55.6
	Technical	35.5	37.5	39.1	39.4	41.3
Quantity per 1 plant, pcs	Branches	2	2	2	2	2
	Boxes	7.1	7.6	7.7	7.7	8.0
Weight of 1000 seeds, g		6.1	6.3	6.4	6.4	6.5
Flax variety Kinelsky 2000						
Plant height, cm	General	59.0	61.4	63.1	63.7	64.0
	Technical	39.1	42.0	42.5	42.9	43.8
Quantity per 1 plant, pcs	Branches	2	3	3	3	3
	Boxes	6.5	6.7	6.8	6.7	6.9
Weight of 1000 seeds, g		5.10	5.2	5.3	5.3	5.4

1 - Inoculation of seeds with water before sowing (control);
2 - Inoculation of seeds "Baikal EM-1" before sowing;
3 - Inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the "herringbone" phase;
4 - Inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the budding phase;
5 - Inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the "herringbone" phase + foliar treatment in the budding phase.

The inoculation of flax seeds and the subsequent foliar treatment of the vegetative mass in the "herringbone" and budding phases of "Baikal EM-1" had a positive effect on the yield of seeds and straw (Table 4).

Table 4. Effect of microbiological fertilizer on the yield of seeds and straws of oil flax

Indicator		Option				
		1	2	3	4	5
Flax variety Lirina						
Seed yield, c/ha		13.3	15.0	17.2	17.5	19.3
increase	c/ha	-	1.7	3.9	4.2	6.0
	%	-	12.8	29.3	31.6	45.1
HCP_{05}		0.44				
Straw yield, c/ha		26.6	29.5	30.9	34.6	38.6
increase	c/ha	-	2.9	4.3	8.0	12.0
	%	-	10.9	16.2	30.1	45.1
$LSD_{0.05}$		0.34				
Flax variety Kinelsky 2000						
Seed yield, centner/ha		12.8	14.4	16.4	16.8	18.4
increase	c/ha	-	1.6	3.6	4.0	5.6
	%	-	12.5	28.1	31.3	43.8
HCP_{05}		0.40				
Straw yield, c/ha		25.6	28.3	29.5	33.5	36.8
increase	c/ha	-	2.7	3.9	7.9	11.2
	%	-	10.5	15.2	30.9	43.8
$LSD_{0.05}$		1.90				

1 - Inoculation of seeds with water before sowing (control);
2 - Inoculation of seeds "Baikal EM-1" before sowing;
3 - Inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the "herringbone" phase;
4 - Inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the budding phase;
5 - Inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the "herringbone" phase + foliar treatment in the budding phase.

The best result was obtained in the variant with the use of seed inoculation from the seeds of "Baikal EM-1" before sowing + foliar treatment in the "Christmas tree" phase + foliar treatment in the budding phase. The seed yield of the Lirina variety was 19.3 q/ha. Other options for the use of the drug also significantly exceeded the control option: in the option of seed inoculation "Baikal EM-1" before sowing, the seed yield was 15.0 c/ha; on the variant with the use of inoculation of seeds "Baikal EM-1" before sowing + foliar treatment in the "herringbone" phase - 17.2 c/ha; on the variant with the use of seed inoculation "Baikal EM-1" before sowing + foliar treatment in the budding phase - 17.5 c/ha. A similar effect of the microbiological fertilizer "Baikal EM-1" on the yield of seeds of oil flax plants is also observed in the variety Kinelsky 2000.

The straw yield of the Lirina variety in the variant of seed inoculation with water before sowing was 26.6 c/ha, and for the Kinelsky 2000 variety it was 25.6 c/ha. The highest straw yield in oil flax plants Lirina and Kinelsky 2000 was obtained in the variant with the use of Baikal EM-1 seeds inoculation before sowing + foliar treatment in the "Christmas tree" phase + foliar treatment in the budding phase - 45.1 and 43.8 c/ha, respectively.

CONCLUSIONS

In a field stationary experiment and laboratory conditions, an assessment was made of the varietal responsiveness of oil flax plants to the effect of the microbiological fertilizer "Baikal EM-1" in the soil and climatic conditions of the Penza region. It has been established that in the technology of growing varieties of oil flax plants, the microbiological fertilizer "Baikal EM-1" used for seed inoculation before sowing + foliar treatment of flax plants in the "Christmas tree" phase + foliar treatment of flax plants in the budding phase, contribute to an increase in germination energy, field germination, as well as increasing the length of the seedling and germinal root. This leads to an increase in plant height in the herringbone phase of 14.2 cm, in the control variant 11.4 cm, in the flowering phase 49.1 cm, which is 10 cm higher than the control variant. Leafiness in the “herringbone” phase was 75.8%, in the control variant 64.8%. The seed yield of the Lirina variety was 19.3 c/ha and straw was 38.63 c/ha, while in flax plants of the Kinelsky 2000 variety, the seed yield was 18.4 c/ha and the straw was 36.8 c/ha.

The use of microbiological fertilizer on the crops of oil flax varieties Lirina and Kinelsky 2000 easily fit into the cultivation technology, contribute to an increase in plant productivity and the production of environmentally friendly products.

REFERENCES

Baldani, J. (2005). History on the biological nitrogen fixation research in graminaceous plants: special emphasis on the Brazilian experience. *Anais da Academia Brasileira de Ciencias*, *77*(3), 549–579.

Chandra, D., Srivastava, R., Gupta, V. (2019). Field performance of bacterial inoculants to alleviate water stress effects in wheat (*Triticum aestivum* L.). *Plant and Soil*, *441*(1-2), 261–281.

Chebotar, V.K., Laktionov, Yu.V., Yakhno, V.V. (2015). Microbiological preparations in the system of ecological agriculture. *Regional Ecology, 6*(41), 41–47.

Hogenhout, S.A., Van der Hoorn, R., Terauchi, R., Kamoun, S. (2009). Emerging Concepts in Effector Biology of Plant-Associated Organisms. *Molecular Plant-Microbe Interactions, 22*. 115–122.

Koryagin, Yu.V., Kulikova, E.G., Blinohvatov, A.A., Koryagina, N.V., Blinohvatova, Yu.V., Nadezhkina, E.V. (2020). Biologization of closed ground technology in obtaining environmentally friendly products. *Problems of Regional Ecology*, *1*. 106–110.

Koryagin, Y., Kulikova, E., Koryagina, N., Kuznetsov, A. (2020). Agroecological evaluation of application the microbiological fertilizers in lentil cultivation technology, *Scientific Papers. Series A. Agronomy*, *63*(1), 361–365.

Kulikova, E.G., Blinohvatova, Yu.V. (2021). Safety and quality of food products, food raw materials and feed under conditions of intensive production technologies. *Sursky Messenger*, *13*(1), 15–18.

Posypanov, G.A. (2007). *Plant growing*. Moscow, Colossus.

Pukalova, E.N. (2016) The effectiveness of the use of microfertilizers in the cultivation of oil flax on soddy-podzolic light loamy soil. *Soil Science and Agrochemistry, 2*(57), 99–106.

Shaykova, T.V., Stepin, A.D. (2018) Microbiological preparations and their role in increasing productivity and improving the health of fiber flax crops. *Proceedings of the Velikiye Luki State Agricultural Academy, 2*. 31–37.