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LENGTH OF GROWING SEASON AND HEIGHT OF SOYBEAN PLANTS DEPENDING ON PRE-SOWING TREATMENT OF SEEDS AND FERTILIZER

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The article presents the results of experimental studies of the effect of seed inoculation, fertilizer and varietal features on the processes of growth and development, the duration of vegetation and interphase periods and linear measurements of the height of soybean plants. The duration of the growing season in soybean plant varieties depended on the variety features, seed inoculation and fertilization. The longest duration of vegetation and interfacial periods was noted in the variant, where the application of Wonder Bor was carried out against the background of the application of mineral fertilizer with the norm $N_{20}P_{20}S_9$ and the treatment of seeds with Maxim XL etching agent and Wonder Mikro microelements and foliar fertilization with Wonder Yelow and amounted to 109 and 111 days in Betina soybean varieties, and 114 and 115 days in Vyshyvanka variety, respectively, which is 9 and 8 days more compared to the control variant. Duration of sowing seedlings – 14 and 13; 14 and 13 days, full shoots - the third ternary leaf – 21 and 20; 22 and 21 days, the third ternary leaf - the beginning of flowering – 21 and 20; 22 and 21 days, the beginning of flowering – the end of flowering – 24 and 25; 25 and 26 days, the end of flowering – full pouring of seeds – 30 and 32; 31 and 32 days, full pouring of seeds – full ripeness – 13 and 14; 14 and 15 days, respectively.

In this variant of the studies, the highest linear measurements of plant height were noted in the variant of the studies, where the application of Wonder Bor was carried out against the background of the application of mineral fertilizer with the norm $N_{20}P_{20}S_9$ and the treatment of seeds with Maxim XL etching agent and Wonder Mikro trace elements and Wonder Yelow foliar fertilizer and amounted to 82.0 and 85.4 cm in Betina soybean varieties, and 86.1 and 89.7 cm in Vyshyvanka variety, which is 16.6 and 15.9 and 17.1 and 15.9 cm, respectively.

The height of plants in the phase of the third ternary leaf is 39.3 and 43.4; 40.3 and 43.7 cm, the beginning of flowering is 62.5 and 65.9; 66.6 and 68.4 cm, the end of flowering is 78.1 and 79.8; 81.4 and 84.3 cm, complete pouring of seeds is 68.7 and 72.6; 73.5 and 77.2 cm.

Keywords: *variety, soybean, seed inoculation, fertilizer, seed treatment.*
Table. 3. Ref. 15.

Statement of the problem. One of the important conditions for the formation of high yields, including soybean, is the variety, it is possible to reveal the maximum genetic potential inherent in it by inoculating the seeds, treating it with a suspension of trace elements and performing foliar fertilizations with chelated micronutrient fertilizers during critical periods of plant growth and development. Optimization of such technological methods of growing crops will contribute to the formation of high and sustainable yields of varieties. Also, the study of these factors will optimize the processes of growth and development to form the maximum productivity of the culture.

Disclosure of the maximum genetic potential inherent in the varieties is possible due to inoculation of seeds, treatment with a suspension of trace elements and foliar fertilizers with chelated microfertilizers during critical periods of plant growth and development.

In recent years, the area under soybean crops in Ukraine has grown rapidly compared to the sown area over the past 10-20 years. This is due to the economic attractiveness of this leguminous crop. Every year, the number of varieties of this crop suitable for distribution in Ukraine grows in the State Register of Plant Varieties.

Analysis of recent researches and publications. This, in turn, requires research to study their adaptation to the appropriate soil and climatic conditions of cultivation, optimization of technological methods of cultivation, which will contribute to increasing yields and realizing the maximum genetic potential [1].

The duration of the growing season is an important feature when growing soybeans under appropriate edaphoclimatic conditions. To obtain the maximum stable yield of soybeans, several varieties belonging to different ripeness groups should be grown on the same farm [2].

The duration of the growing season of soybeans is influenced by various factors, including varietal features, sowing time, fertilizers, pre-sowing bacterialization of seeds, and others [3].

Thus, it is noted that the longest growing season was established under the combined influence of pre-sowing bacterization of seeds with phosphonitragin and application of nitrogen fertilizers by the norm N_{30}, against the background of the main fertilizer $P_{60}K_{60}$ and additional feeding in the budding phase N15 – 107 days in the Vilshanka variety and 117 days in the Suzirya variety [4].

The conducted phenological observations of the growth and development of plants of soybean varieties of different ripeness groups emphasize that the duration of the growing season and interfacial periods depended on both the hydrothermal conditions of the year and the technological methods of cultivation, namely the dose of mineral fertilizers and the introduction of trace elements [5].

However, varietal features affect the duration of the growing season the most [6].

According to the Broad Uniform Classifier of the genus Glycine max. (L.) Merr. [7], according to the duration of the growing season, soybean varieties were divided into four ripeness groups: ultra-rapid (less than 90–100 days), early-ripening (101–120 days), medium-ripening (121–140 days) and late-ripening (141–160 days).

The reaction of the variety to the technological methods of cultivation depends on the variety features, that is, the ratio of the variety to moisture supply, pre-sowing bacterization of seeds, application of mineral fertilizers, drought and heat resistance of the variety and other technological methods of growing crops [8]. With the help of technological methods of cultivation, it is necessary to influence the modification variability of plants, which will by determined by the corresponding adaptive

reactions of the variety to the stages of its organogenesis [9].

Such a trait as the height of soybean plants is associated with grain productivity, therefore, depending on the variability of this trait over the growing season, one can note the appropriate conditions for the growth and development of plants that provided an increase in this indicator in ontogenesis. This, in turn, makes it possible to establish favorable conditions for the formation of high-yield soybean crops [10].

In the ontogenesis of soybeans, the height of plants significantly depends on the influence of abiotic and biotic factors, therefore the results of a linear increase in this indicator allow us to indicate the influence of the studied factors, including the grain productivity of crops. The technology of the variety, along with the resistance of plants to lodging and the height of attachment of lower beans, which depend on the height of plants, so the study of this feature is relevant, since it takes into account the parameters of a possible harvest [11, 13-15].

The purpose of the research was to establish the effect of seed inoculation, fertilizer and varietal features on the duration of vegetation and interfacial periods and linear height measurements of soybean plants.

Table 1

Scheme of the experiment

Soybean variety (factor A)	Inoculation (factor B)	Fertilizers (factor C)
1. Betina 2. Vishivanka	1.without inoculation 2. Inoculation (HighCot Super)	1. No fertilizer (control) 2. $N_{20}P_{20}S_9$ + Seed treatment Maxim XL - (background); 3. Background+ Wonder Mikro; 4. Background + Wonder Mikro+ Wonder Yelow; 5. Background + Wonder Mikro+ Wonder Yelow + Wonder Bor.

Source: based on own research

Research methodology. The research was conducted in the conditions of the agricultural company with limited liability “Druzhba” in Vinnytsia district, Vinnytsia region.

The total area of the site is 40 m^2. The accounting area is 25 m^2. Repeatability of the experiment four times [12].

According to the research methodology, a three-factor field study was established: Factor A - varieties: 1.Betina; 2. Embroidery; Factor B - inoculation: 1. without inoculation; 2. HighCot Super. Factor C - Fertilizer: 1. Without fertilizers (control); 2. $N_{20}P_{20}S_9$ + seed treatment Maxim XL − (background); 3. Background + Wonder Mikro; 4. Background + Wonder Mikro+ Wonder Yelow; 5. Background + Wonder
Mikro+ Wonder Yelow +Wonder Bor.

Research results. The effect of seed inoculation and fertilizer on the duration of vegetation and interfacial periods of soybean plant varieties is shown in Table 2. It

should be noted that the shortest interfacial periods and the duration of the growing season were noted in the control variant of the experiment, this applies to both

Table 2

Influence of seed inoculation and fertilizer on the duration of vegetation and interfacial periods of soybean plant varieties, days

Variety	Fertilization	Growing seasons													
		Sowing-full stairs		Full staircase - 3rd ternary leaf		3rd ternary leaf – the beginning of flowering		Beginning of flowering - end of flowering		End of flowering - full pouring of seeds		Full seed pouring - full ripeness		Full staircase - full ripeness	
		pre-sowing inoculation*													
		b	i	b	i	b	i	b	i	b	i	b	i	b	i
Betina	1. Without fertilizers Control	14	13	22	21	19	18	21	22	26	28	12	13	100	102
	2. $N_{20}P_{20}S_9$ + seed treatment Maxim XL – (background)	14	13	22	21	20	19	22	23	27	29	13	14	104	106
	3. Background + Wonder Mikro	13	12	21	20	20	19	23	24	28	30	13	14	105	107
	4. Background + Wonder Mikro+ Wonder Yelow	13	12	21	20	21	20	24	25	29	31	13	14	108	110
	5. Background + Wonder Mikro+ Wonder Yelow + Wonder Bor	13	12	21	20	21	20	24	25	30	32	13	14	109	111
Vishivanka	1.Without fertilizers (control)	15	14	23	22	20	19	22	23	27	29	13	14	105	107
	2. $N_{20}R_{20}S_9$ + seed treatment Maxim XL – (background);	15	14	23	22	21	20	23	24	28	30	14	15	109	111
	3. Background + Wonder Mikro	14	13	22	21	21	20	24	25	29	31	14	15	110	112
	4. Background + Wonder Mikro+ Wonder Yelow	14	13	22	21	22	21	25	26	30	31	14	15	113	114
	5. Background + Wonder Mikro+ Wonder Yelow + Wonder Bor	14	13	22	21	22	21	25	26	31	32	14	15	114	115

Source: based on own research

soybean varieties Betina and Vyshyvanka, where inoculation and fertilization were not carried out, the duration of the growing season in this variant of the experiment was 100 and 105 days, respectively. Duration of sowing and germination – 14 and 15 days, full germination - the third ternary leaf – 22 and 23 days, the third ternary leaf - the beginning of flowering – 19 and 20 days, the beginning of flowering – the end of flowering – 21 and 22 days, the end of flowering – complete pouring of seeds – 26 and 27 days, complete pouring of seeds – complete ripeness – 12 and 13 days.

Seed inoculation provided an extension of the growing season in soybean varieties to 2 days, and it was 102 and 107 days, respectively. There was also an extension of the duration of the interfacial period, the beginning of flowering-end of flowering – 22 and 23 days, the end of flowering-complete pouring of seeds – 28 and 29 days, respectively.

The application of mineral fertilizer at the rate of $N_{20}P_{20}S_9$, as well as the treatment of seeds with Maxim XL, provided an extension of the growing season to 104 and 106 days in the Betina variety and to 109 and 111 days in the Vyshyvanka variety, which is 4 days longer compared to the control variant.

Treatment of seeds with Wonder Mikro trace elements against the background of mineral fertilization and seed treatment provided an increase in the duration of the growing season to 105 and 107 and 110 and 112 days, respectively.

Conducting foliar fertilizations of Wonder Yelow against the background of applying mineral fertilizer with a rate of $N_{20}P_{20}S_9$ and treating seeds with Maxim XL fertilizer and Wonder Mikro trace elements helped to extend the duration of the growing season in Betina and Vyshivanka soybean varieties to 108 and 110 and 113 and 114 days, which is 8 and 7 days longer compared to the control variant.

The longest duration of vegetation and interfacial periods is noted in the variant where the application of Wonder Bor was carried out against the background of the application of mineral fertilizer with the norm $N_{20}P_{20}S_9$ and the treatment of seeds with Maxim XL seed dressing agent and Wonder Mikro trace elements and foliar top dressing Wonder Yelow was 109 and 111 days in Betina soybean varieties, and 114 and 115 days in Vyshyvanka variety, respectively. Duration of sowing seedlings – 14 and 13; 14 and 13 days, full shoots - the third ternary leaf – 21 and 20; 22 and 21 days, the third ternary leaf - the beginning of flowering – 21 and 20; 22 and 21 days, the beginning of flowering – the end of flowering – 24 and 25; 25 and 26 days, the end of flowering – full pouring of seeds – 30 and 32; 31 and 32 days, full pouring of seeds – full ripeness – 13 and 14; 14 and 15 days, respectively.

The effect of seed inoculation and fertilizer on the height of soybean plant varieties is shown in Table 3. The smallest linear measurements of plant height were noted on the control variant (without inoculation and fertilizer) in both Betina soybean varieties – 65.4 cm and Vyshyvanka – 69.0 cm, reaching its maximum in full ripeness. The height of plants in the phase of the third ternary leaf is 24.4 and 28.6 cm, the beginning of flowering is 45.6 and 50.1 cm, the end of flowering is 57.4 and 62.7 cm, the complete pouring of seeds is 63.7 and 67.2 cm.

Table 3

Influence of inoculation and fertilization on the height of plants of soybean varieties, cm

Copr	Fertilizer	Growth and development phase									
		3rd Ternary Leaf		Beginning of flowering		End of flowering		Full pouring of seeds		Full ripeness	
		pre-sowing inoculation*									
		b i	i	b i	i	b i	i	b i	i	b i	i
Betina	1. Without fertilizers Control	24,4	27,8	45,6	50,3	57,4	62,5	63,7	67,7	65,4	69,5
	2. $N_{20}P_{20}S_9$ + seed treatment Maxim XL – (background)	25,9	29,3	50,1	56,1	62,5	68,4	68,7	73,5	71,9	75,3
	3. Background + Wonder Mikro	27,8	35,5	57,3	61,5	69,2	73,4	74,8	78,6	76,2	80,8
	4. Background + Wonder Mikro+ Wonder Yelow	39,3	43,4	62,1	65,4	74,3	77,7	79,1	82,6	81,6	84,9
	5. Background + Wonder Mikro+ Wonder Yelow + Wonder Bor	40,1	45,3	62,5	65,9	74,9	78,1	79,8	83,3	82,0	85,4
Vishivanka	1. Without fertilizers (control)	28,6	31,5	50,1	54,5	62,7	66,2	67,2	71,4	69,0	73,8
	2. $N_{20}R_{20}S_9$ + seed treatment Maxim XL – (background);	33,6	35,8	55,2	60,1	67,3	72,4	72,6	77,2	74,5	78,9
	3. Background + Wonder Mikro	35,9	37,9	60,1	64,3	72,4	76,4	77,5	81,9	79,8	83,5
	4. Background + Wonder Mikro+ Wonder Yelow	39,8	42,3	65,4	67,5	77,5	79,6	81,6	85,8	83,4	87,6
	5. Background + Wonder Mikro+ Wonder Yelow + Wonder Bor	40,3	43,7	66,6	68,4	78,7	81,4	84,3	88,3	86,1	89,7

Source: based on own research

Seed inoculation provided an increase in plant height in soybean varieties to 69.5 and 73.8 cm, which is 4.1 and 4.8 cm more. The height of plants in the phase of the third ternary leaf is 27.8 and 31.5 cm, the beginning of flowering is 50.3 and 54.5 cm, the end of flowering is 62.5 and 66.2 cm, complete pouring of seeds is 67.7 and 71.4 cm.

The application of mineral fertilizer at the rate of $N_{20}P_{20}S_9$, as well as the treatment of seeds with Maxim XL, provided an increase in the height of plants to 71.9 and 75.3 cm in the Betina variety and to 69.0 and 73.8 cm in the Vyshyvanka variety, which is 6.5 and 5.8; 5.5 and 5.1 more compared to the control variant.

The height of plants in the phase of the third ternary leaf is 25.9 and 33.6; 29.3 and 35.8 cm, the beginning of flowering is 50.1 and 55.2; 56.1 and 60.1 cm, the end of flowering is 62.5 and 67.3; 68.4 and 72.4 cm, complete pouring of seeds is 68.7 and 72.6; 73.5 and 77.2 cm, respectively.

Treatment of seeds with Wonder Mikro trace elements against the background of mineral fertilization and seed treatment provided an increase in plant height to 76.2 and 80.8 and 79.8 and 83.5 cm, which is 10.8 and 11.3; 10.8 and 9.7 cm more compared to the control variant.

Conducting foliar fertilizers Wonder Yelow against the background of applying mineral fertilizer norm $N_{20}P_{20}S_9$ and treating seeds with Maxim XL etching agent and Wonder Mikro trace elements contributed to an increase in plant height in Betina and Vyshyvanka soybean varieties to 81.6 and 84.9 and 83.4 and 87.6 cm, which is 16.2 and 15.4; 14.4 and 13.8 cm more compared to the control variant.

The highest linear measurements of plant height were noted in the variant of studies, where the application of Wonder Bor was carried out against the background of the application of mineral fertilizer with the norm $N_{20}P_{20}S_9$ and the treatment of seeds with Maxim XL etching agent and Wonder Mikro trace elements and Wonder Yelow foliar fertilizer and amounted to 82.0 and 85.4 cm in Betina soybean varieties, and 86.1 and 89.7 cm in Vyshyvanka variety, which is 16.6 and 15.9 and 17.1 and 15.9 cm, respectively.

The height of plants in the phase of the third ternary leaf is 39.3 and 43.4; 40.3 and 43.7 cm, the beginning of flowering is 62.5 and 65.9; 66.6 and 68.4 cm, the end of flowering is 78.1 and 79.8; 81.4 and 84.3 cm, complete pouring of seeds is 68.7 and 72.6; 73.5 and 77.2 cm.

Conclusions and prospects for further research. The duration of the growing season in soybean plant varieties depended on the variety features, seed inoculation and fertilization. The longest duration of vegetation and interfacial periods was noted in the variant, where the application of Wonder Bor was carried out against the background of the application of mineral fertilizer with the norm $N_{20}P_{20}S_9$ and the treatment of seeds with Maxim XL etching agent and Wonder Mikro microelements and foliar fertilization with Wonder Yelow and amounted to 109 and 111 days in Betina soybean varieties, and 114 and 115 days in Vyshyvanka variety, respectively, which is 9 and 8 days more compared to the control variant.

In this variant of the studies, the highest linear measurements of plant height were noted in the variant of the studies, where the application of Wonder Bor was carried out against the background of the application of mineral fertilizer with the norm $N_{20}P_{20}S_9$ and the treatment of seeds with Maxim XL etching agent and Wonder Mikro trace elements and Wonder Yelow foliar fertilizer and amounted to 82.0 and 85.4 cm in Betina soybean varieties, and 86.1 and 89.7 cm in Vyshyvanka variety, which is 16.6 and 15.9 and 17.1 and 15.9 cm, respectively.

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АНОТАЦІЯ

ТРИВАЛІСТЬ ВЕГЕТАЦІЙНОГО ПЕРІОДУ І ВИСОТИ РОСЛИН СОЇ ЗАЛЕЖНО ВІД ПЕРЕДПОСІВНОЇ ОБРОБКИ НАСІННЯ ТА УДОБРЕННЯ

У статті представлено результати експериментальних досліджень впливу інокуляції насіння, удобрення та сортових особливостей на процеси росту й розвитку, тривалість вегетаційного та міжфазних періодів і лінійних промірів висоти рослин сої. Тривалість вегетаційного періоду у сортів рослин сої залежала від сортових особливостей, інокуляції насіння та внесення добрив. Найдовша тривалість вегетаційного та міжфазних періодів простежена у варіанті, де було проведено внесення Wonder Bor на фоні внесення мінерального добрива нормою $N_{20}P_{20}S_9$ та обробки насіння протруювачем Максим XL і мікроелементами Wonder Mikro й позакореневого підживлення Wonder Yelow і складала у сортів сої Бетіна – 109 і 111 діб, а в сорту Вишиванка – 114 і 115 діб відповідно, а це на 9 і 8 діб більше порівняно із контрольним варіантом. Тривалість сівба-сходи – 14 і 13; 14 і 13 діб, повні сходи-третій трійчастий листок – 21 і 20; 22 і 21 добу, третій трійчастий листок-початок цвітіння – 21 і 20; 22 і 21 добу, початок цвітіння-кінець цвітіння – 24 та 25; 25 та 26 діб, кінець цвітіння-повне наливання насіння – 30 і 32; 31 та 32 доби, повне наливання насіння-повна стиглість – 13 і 14; 14 і 15 діб, відповідно.

Визначено найвищі лінійні проміри висоти рослин відмічено у варіанті досліджень, де було проведено внесення Wonder Bor на фоні внесення мінерального добрива нормою $N_{20}P_{20}S_9$ та обробки насіння протруювачем Максим XL і мікроелементами Wonder Mikro та позакореневого підживлення Wonder Yelow і складала у сортів сої Бетіна – 82,0 і 85,4 см, а в сорту Вишиванка – 86,1 і 89,7 см, а це на 16,6 і 15,9 та 17,1 і 15,9 см, відповідно. Висота рослин у фазу третій трійчастий листок – 39,3 і 43,4; 40,3 та 43,7 см, початок цвітіння – 62,5 і 65,9; 66,6 і 68,4 см, кінець цвітіння – 78,1 і 79,8; 81,4 та 84,3 см, повне наливання насіння – 68,7 та 72,6; 73,5 і 77,2 см.

Ключові слова: *сорт, соя, інокуляція насіння, удобрення, протруювання насіння.*

Табл. 3. Літ. 15.

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