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INFLUENCE OF MINERAL FERTILIZERS AND METHODS OF USING THE COMPLEX OF MICROELEMENTS ON THE HEIGHT OF SOYBEAN PLANTS

Tsyhanska O.
Cand. of agricultural sciences, Senior Lecturer
Vinnytsia National Agrarian University

Abstract

It is established that depending on weather conditions in the years of research and growing conditions, both the height of plants of different soybean varieties and the dynamics of the average daily linear growth of the stem of soybean plant varieties change. The results of the study and analysis of the regularity of the average daily linear growth depending on different growing conditions are presented. It was found that soybean plants of Gorlytsia and Vinnychanka varieties in the process of ontogenesis had slightly different stem height, which is due to genetics, and the intensity of the average daily linear growth. On the basis of the performed researches it is noted that in the conditions of the Forest-Steppe of the Right Bank both height of plants of grades of soybeans, and its dynamics during the vegetation period as a whole, to a large extent depended on hydrothermal conditions in years of researches.

Based on the calculations, it was found that there is a significant correlation between the applied doses of fertilizers and the height of soybean plants. The dependence of the height of soybean plants on the doses of mineral fertilizers is given by linear regression equations. It was found that the intensity of the average daily linear growth of plants of soybean varieties, along with hydrothermal conditions, was significantly influenced by organized factors, in particular the background of mineral nutrition and methods of treatment with a complex of trace elements. It is established that a comprehensive approach to the soybean fertilization system provides the best conditions for growth, development and preservation of the largest number of plants in crops, under these growing conditions, the largest average daily linear growth was observed.

Keywords: height, fertilizer system, linear growth, phenological phases, soybean varieties.

The problem formulation. Soybeans are the main high-protein crop in the world, they are one of the most common legumes and oilseeds, play a crucial role in agriculture, engineering and processing industry and medicine. This is a valuable legume, which is especially important in the formation of the domestic market of high-protein feeds, balanced in nutrients and amino acids. Soybean seeds contain an average of 36 - 45% protein, 19 - 22% - fat, 23 - 28% carbohydrates, a significant content of vitamins, enzymes, minerals and other substances [6, 7].

Throughout the growing season, plants undergo two interconnected, but at the same time, different processes: growth and development. The study of the growth and development of soybean plants in ontogenesis makes it possible to reveal the most important dependences of the formation process of this crop high productivity. One of the main features that characterize the rate of growth and development of plants is the height of the central stem [1-5].

The height of plants is influenced by soil and climatic conditions and technological methods of cultivation, as a result of which it changes in time and space, which, in turn, determines the yield of the crop. Active growth of soybean plants begins in 2 - 3 weeks after full germination, so the growth of plants in height during the growing season is an important morphobiological indicator that characterizes the reaction of plants to changes in environmental conditions [8-10].

Soybean plants are negatively affected by biotic and climatic environmental factors during growth and development. Excessive moisture and prolonged droughts in critical periods of the growing season can lead to their loss, both from the negative impact of these factors and from the development of diseases that are the result of their impact [12-17].

When growing soybeans in the North-Eastern Forest-Steppe of Ukraine, it is advisable to give preference to varieties with high plasticity and stability, which is an important factor in realizing the genetic potential of the variety and obtaining a guaranteed high soybean yield [11].

Thus, based on an in-depth analysis of literature

sources, we can conclude that soybeans are a very flexible crop with great potential and significant sown areas not only in Ukraine but also in the world. Unique in its composition, it combines a significant number of economically valuable features, and plays a leading role in solving the problem of vegetable protein, while ensuring high quality food. In addition, soybeans, as a nitrogen-fixing legume, are an indispensable component of organic farming, increasing soil fertility, making it one of the best precursors for subsequent crop rotations.

Conditions and methods of research. Experimental studies were carried out during 2013 - 2015. in the research field of Vinnytsia National Agrarian University. Researched and analyzed the action and interaction of three factors: A - varieties; B - doses of mineral fertilizers; C - method of processing a complex of trace elements. Pre-sowing seed treatment and foliar feeding were carried out according to the experimental scheme. The system of tillage and its preparation for soybean sowing corresponded to the generally accepted for the soil-climatic zone of the Forest-Steppe. The primary task of such tillage is the complete removal and destruction of weeds, prevention of moisture loss and leveling of the soil surface. As a result, favorable soil and climatic conditions for plant growth and development are formed.

The previous culture is winter wheat. After harvesting the previous culture, the main tillage was carried out, which involved disking to a depth of 8 - 10 cm and application of phosphorus and potassium fertilizers at the rate of $P_{60}K_{60}$ kg / ha a.s. in the form of simple phosphate (P_2O_5 - 16%) and potassium salt (K_2O - 40%) with subsequent plowing to a depth of 22 - 25 cm. Pre-sowing tillage was carried out in the spring. It provided cultivation to a depth of 6 - 8 cm with rolling to ensure optimal sowing conditions to a given depth. Nitrogen fertilizers were applied to the respective options at the rate of 30 kg / ha a.s. in the form of ammonium nitrate (N - 34.6%) for pre-sowing cultivation according to the experimental scheme. About 4 - 5 days before sowing, soybean seeds were treated with Vitavax 200 FF (a.s. Carboxin 200 g / l + thiram 200 g / l) at the rate of 2.5 l / t of seeds. On the day of sowing, soybean seeds were inoculated with rhizobophyte (Bradyrhizobium japonicum) on the basis of active strains of nodule bacteria, manufactured at the Institute of Agricultural Microbiology and Agroindustrial Production of NAAS, and on the variants provided by the experimental scheme treatment with microfertilizer based on chelate Microfol Combi (Mg - 9.0%, Fe - 4.0, Zn - 1.5, Cu - 1.5, Mn - 4.0, B - 0.5, Mo - 0.1%) at a dose of 150 g / t of seeds. In the field experiment, soybean varieties of different maturity groups - Vinnychanka and Horlytsia - zoned for the Forest-Steppe zone were sown. Studies were conducted according to generally accepted guidelines [18].To reliably assess the data of field studies, the following phenological observations, measurements and laboratory analyzes were performed:

- phenological observations were carried out according to the "Methods of the State Variety Testing of Crops" and the "Methods of Research in Forage Production". The phases of plant growth and development were noted. The beginning of the phase was established when it occurred in 10% of plants, the complete phase in 75% of plants;

- plant height was determined by measuring on pegged 25 plants in the main phases of growth and development of soybean plants in two non-contiguous repetitions.

Research results. According to the results of our research, it was found that the stem height of soybean plants largely depended on the hydrothermal conditions of the year and the factors that were put to the study (variety, doses of mineral fertilizers and methods of treatment with a complex of trace elements). In the course of research it was noted that in the initial period soybean plants grow very slowly. With the appearance of the first - third true leaf begins branching of the stem. From this time the vegetative stage of development begins, the stem grows intensively until flowering, after which comes the generative stage, while the growth of the stem almost stops, and the formation of leaves ends. It was found that soybean plants of Gorlytsia and Vinnychanka cultivars had slightly different stem heights during ontogenesis, which is due to genetics and the intensity of the average daily linear growth. This is primarily due to the biological characteristics of the variety, which have a different genotype, and their relationship to different maturity groups.

Based on studies, it was found that during the period of intensive growth from the phase of the third trifoliate leaf to the beginning of flowering soybean height did not vary significantly depending on the variety, but from the beginning of flowering the difference in height between varieties increased and in subsequent phases was quite significant (tab.1.).

Table 1

Influence of fertilizer level and microelement treatment on soybean plant height, on average for 2013–2015, cm

M ± m *

Variety	Fertilizer level	Treatment with a complex of microelements	The third trifoliate leaf	The beginning of flowering	End of flowering	Full maturity
Gorlytsia	without fertilizers	1	10,7±0,8	27,8±1,9	57,0±7,8	73,4±6,2
		2	12,4±0,6	29,3±1,7	57,7±7,2	75,5±6,0
		3	10,8±0,7	32,9±1,2	58,8±6,6	76,9±6,3
		4	12,6±0,9	33,6±1,5	59,7±7,2	77,8±6,1
	$P_{60}K_{60}$	1	12,5±1,1	33,1±3,0	65,1±7,0	82,3±4,7
		2	14,1±1,6	35,2±3,1	66,2±7,5	84,3±5,1
		3	12,5±1,0	38,9±2,6	66,9±7,7	84,6±4,5
		4	14,3±1,6	39,4±2,5	67,8±7,3	86,4±5,0
	$N_{30}P_{60}K_{60}$	1	12,9±1,2	37,7±3,2	68,1±6,4	86,1±4,8
		2	14,5±1,1	38,9±3,7	68,9±6,2	88,9±4,7
		3	12,4±1,4	41,7±3,9	70,2±6,7	89,9±5,2
		4	14,9±1,4	42,5±4,4	71,3±6,5	92,5±4,9

Vinnychanka	without fertilizers	1	11,6±0,6	30,2±1,2	67,5±3,9	87,7±3,6
		2	13,5±0,7	32,0±0,6	69,1±4,3	89,6±3,9
		3	11,6±0,5	35,3±1,4	71,5±4,0	91,8±3,8
		4	13,4±0,6	36,0±1,2	73,4±4,5	93,4±3,7
	$P_{60}K_{60}$	1	12,9±1,5	34,6±1,9	77,8±4,2	98,6±2,8
		2	14,6±1,2	37,2±1,5	80,2±4,0	100,9±3,2
		3	13,1±1,3	38,9±1,9	82,0±3,9	103,4±2,4
		4	15,2±1,3	40,7±1,2	83,5±3,8	104,6±3,1
	$N_{30}P_{60}K_{60}$	1	13,9±1,4	39,2±2,0	82,0±4,6	104,0±3,6
		2	16,0±1,1	42,2±3,1	85,4±4,1	106,1±3,3
		3	13,4±1,7	44,7±2,4	87,4±4,9	109,0±3,1
		4	15,7±1,3	45,9±1,9	88,8±3,8	112,1±2,9
Coefficient of variation V, %			10,7	12,9	13,2	12,1
Relative error Sx%			2,2	2,6	2,7	2,5

Note: * M ± m is the confidence interval of the arithmetic mean at the 5% level of significance. 1. Without processing; 2. Seed treatment with Microfol Combi; 3. Foliar feeding with Microfol Combi; 4. Seed treatment + foliar feeding with Microfol Combi.

According to the results of determining the height of plants, it was found that the highest stem height of soybean varieties was observed in 2014 with fluctuations from 80.5 to 115.2 cm, and the lowest in 2012 from 68.8 to 109.5 cm.

On average, over the years of research (2013 - 2015) the maximum height of soybean plants in the phase of full maturity 92.5 cm in the variety Gorlytsya and 112.1 cm in the variety Vinnychanka was formed on the variants of the experiment, where mineral fertilizers were applied at a dose of $N_{30}P_{60}K_{60}$ and treated seeds with a complex of microelements Microfol Combi (150 g / t) in combination with foliar feeding in the budding phase with the same drug at the rate of 0.5 kg / ha, which is 19.1 and 24.4 cm more than the control (without mineral Fertilizers and Microfol Combi). Analysis of the dynamics of the height of the stem of soybean plants by phases of growth and development shows that the use of intensification factors contributed to a significant increase. Thus, in particular, the application of mineral fertilizers and the use of a complex of trace elements contributed to more intensive plant growth and increased stem height from the beginning of plant vegetation.

Optimization of mineral nutrition of soybean plants due to the introduction of $P_{60}K_{60}$ contributes to the growth of their height in the variety Gorlytsya up to 82.3 cm, which is 8.9 cm more than the control (without fertilizers) and up to 98.6 cm, which is 10.9 cm more compared with the control in the Vinnychanka variety.

A significant positive effect on the height of plants of soybean varieties was observed with the introduction of the "starting" dose of nitrogen (N_{30}). At the same time, compared to the control variant, the increase in plant height was 12.7 cm in the variety Gorlytsia and 16.3 cm in the variety Vinnychanka.

Based on the calculations, it was found that there is a significant correlation between the applied fertilizer doses and plant height of soybean varieties, with the correlation coefficient for the variety Gorlytsia r = 0.754 (1) and for the variety Vinnychanka r = 0.873 (2). The dependence of the height of soybean plants on the doses of mineral fertilizers is given by linear regression equations:

$$Y = -605.6833 + 6.7541 * x \quad (1)$$

$$Y = -776.6861 + 8.5958 * x \quad (2)$$

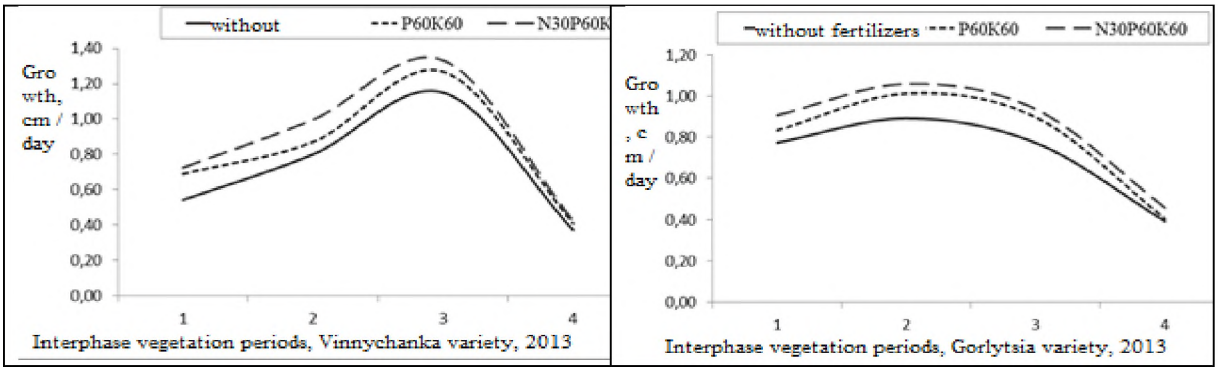
where:

Y - plant height, cm;

X - doses of mineral fertilizers.

On the basis of the conducted researches the positive influence on formation of height of plants, processing of seeds and foliar feeding by Mikrofol Kombi is revealed. Thus, at the time of full maturity on the variants of the experiment, where pre-sowing treatment of seeds with a complex of microelements was carried out, the height of soybean plants was higher by 2.0 - 2.8 cm in the variety Gorlytsia, and by 1.9 - 2.3 cm in the variety Vinnychanka. One of the important indicators that characterizes the features and rates of growth and development of soybean plants at different stages of the growing season is the average daily linear growth of the stem.

During the years of research (2013 - 2015), the dynamics of the average daily linear growth of the stem of soybean varieties had a similar character, but different intensity (fig. 1).



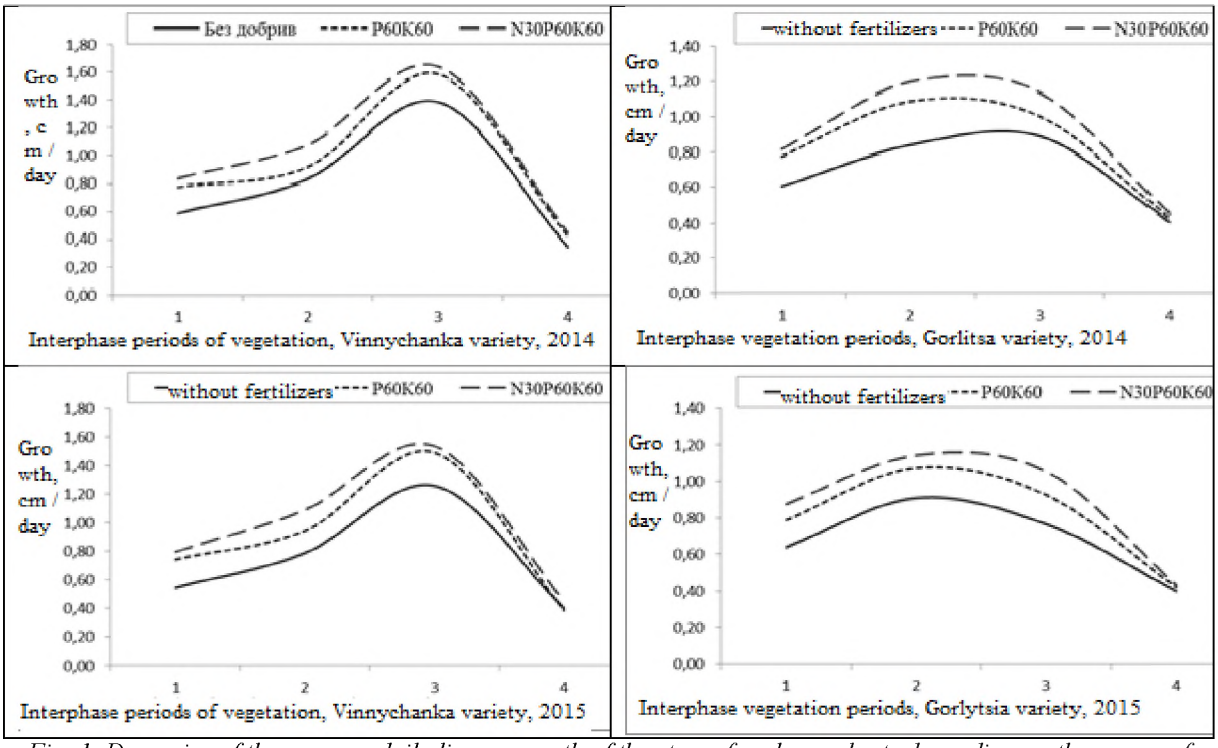


Fig. 1. Dynamics of the average daily linear growth of the stem of soybean plants depending on the norms of mineral fertilizers, 2013 - 2015, cm / day

Note: 1. Stairs - the third triple leaf; 2. The third trifoliate leaf - the beginning of flowering; 3. The beginning of flowering - the end of flowering; 4. The end of flowering - full maturity.

Thus, in the variety Vinnychanka the highest rates of average daily linear growth of the stem (1.15 - 1.39 cm / day) by years of research were observed in the period from the beginning of flowering to the end of flowering, and in the variety Gorlytsia - for the period from the third trifoliate leaf to the beginning flowering (0.89 - 0.91 cm / day). This can be explained by the fact that these varieties belong to different maturity groups. Thus, in the middle-early variety Gorlytsia intensive stem growth begins from the phase of the third trifoliate leaf, and in the variety Vinnychanka from the beginning of flowering. The lowest average daily linear growth of the stem was observed in both the variety Gorlytsia and the variety Vinnychanka in the period from the end of flowering to full maturity and in terms of years was 0.39 - 0.41 and 0.35 - 0.40 cm / day, respectively. This dynamics of the intensity of linear growth of the stem of soybean varieties is primarily due to the physiological features of their development. Thus, during the vegetative growth phases from full germination to the end of flowering, nutrients synthesized as a result of photosynthesis and assimilated from the soil are used by plants to form vegetative mass, then during the generative growth phases they are mainly used to form grain productivity and yield quality.

It was found that the intensity of the average daily linear growth of soybean plants was significantly influenced by the doses of mineral fertilizers. Thus, both in the variety Gorlytsia and Vinnychanka the plants grew most intensively in height on the variants of the experiment, where mineral fertilizers were applied in the dose of $N_{30}P_{60}K_{60}$. In this case, the growth of the stem from the phase of the beginning of flowering to the end of flowering was according to the years of research, respectively, 0.94 - 1.14 and 1.33 - 1.64 cm / day, which is 0.17 - 0.28 and 0.18 - 0.29 cm / day more compared to options without mineral fertilizers.

Conclusions. Based on research and phenological observations of plant growth and development of soybean varieties of different maturity groups, there is a tendency to significantly influence both hydrothermal conditions and organized factors that were studied, on the duration of periods between individual phases of growth and development and the growing season in general.

Therefore, on the basis of the conducted researches it is possible to draw a conclusion that the maximum height of a plant of a soybean of 92,5 cm of the Gorlytsia variety and 112,1 cm of the Vinnychanka variety is reached at carrying out presowing processing of seeds by a complex of microfolium Mikrofol Kombi (150 g / t) in combination with foliar feeding the same drug (0.5 kg / ha) against the background of mineral fertilizers at a dose of $N_{30}P_{60}K_{60}$, in addition, under these growing conditions, the largest average daily linear increase was observed.

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