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Influence of agricultural practices and sowing dates under different weather conditions on soybean yield

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The article is devoted to determining the optimal sowing time for soybeans with stable warming of the soil, considers the processing with a stratifier PRSM-5 and chisel processing against the background of pre-sowing rolling. Using soil-cultivating units of three types, an analysis was made of the effectiveness of various methods of basic cultivation against the background of various agricultural practices. The optimal timing of soybean sowing was determined with stable heating of the soil to 8–10 °C when treated with a stratifier PRSM-5 and up to 10–12 °C during chisel cultivation against the background of pre-sowing rolling. The obtained results of the research showed that the soil density depends primarily on the method of basic cultivation. The analysis of soil density indicators as a whole showed that after treatment with the stratifier PRSM-5 it was somewhat less and averaged 1.04 g/cm^3, and after chisel treatment – 1.09 g/cm^3. The analysis of the structural composition of the soil showed that the best structural structure of the soil was noted when processing with a stratifier PRSM-5 due to the removal of the most agronomically valuable soil lumps from the lower layers to the surface, here the structural coefficient was high and reached 2.36, and with chisel processing – 2.08. An analysis of the reserves of productive moisture at the end of the growing season showed that during chisel processing they were used more rationally, and significantly decreased in the phase of full ripeness after processing with a stratifier PRSM-5 – they amounted to 57 mm, and after chisel processing – 69 mm. The experimental data obtained indicate that under dry weather conditions, the best yield was formed when treated with a stratifier PRSM-5 at the second sowing date, and when chisel loosening - during the first and pre-sowing rolling.

Key words: soybean, tillage, stratifier PRSM-5, density, structure, yield.

Problem statement and analysis of recent research. In conditions of insufficient moisture in the Forest-Steppe of Ukraine, the improvement of the elements of the technology of growing all agricultural crops is of particular importance, since quite often in the spring there are difficult weather conditions, in particular, a rapid increase in the average daily air temperature with insignificant moisture reserves in the sowing layer. Therefore, during the optimal sowing time for soybeans with a soil temperature regime of 12–14 °C at a depth of 10 cm, with traditional methods of basic cultivation, it is not always possible to maintain the necessary moisture reserves in the seed layer. The agrotechnical methods developed and improved by us significantly reduce energy costs, increase the accumulation and rational use of moisture [1, 2], create favorable conditions for the growth and development of soybean plants [3, 4].

The accumulation of the main reserves of productive moisture in the soil falls on the autumn-winter period, so the main tillage plays an important role in this process [5]. However, little attention is paid to this issue when growing soybeans, in particular, the biological characteristics of the crop, its requirements for the agrophysical properties of the soil and moisture are not taken into account, which leads to a simplification of the elements of growing technology and a decrease in plant productivity. Soybeans, like other legumes, require very significant reserves of productive moisture for seed germination and crop formation [6]. The sowing time in growing technology is of decisive importance and largely determines the conditions for the growth and development of soybean plants [7, 8]. Excessively loosened soil after plowing, especially in dry conditions, requires additional compaction by rolling [9, 10]. Without this agricultural practice, the soil quickly loses moisture, as a result, soybean plants form a low productivity as a result of a decrease in grass stand density. Under such conditions, rolling becomes an important and necessary agricultural technique in the main tillage system [11].

The conducted phenological observations indicate that under different weather conditions, the duration of the growing season of soybean plants can change. Under favorable weather conditions, soybean plants developed well, and the duration of the growing season corresponded to the ripeness group, however, in dry conditions, its duration somewhat decreased [12, 13]. Optimization of growth and development conditions is determined not only by hydrothermal factors, but also by the main technological factors that significantly affect the formation of the crop [14, 15].

In the arid conditions of the forest-steppe zone, where almost during the entire growing season there is a constant moisture deficit, the development and improvement of agricultural practices aimed at maximizing the accumulation of moisture in the soil and its rational use is of particular importance. Indicators of productive moisture reserves at the beginning of the growing season mainly depend on the weather conditions of the autumn-winter period and the agrophysical properties of the soil [16, 17]. Favorable conditions for soybean plants are available only when the density of the soil corresponds to the optimal parameters and a sufficient amount of moisture accumulates in the seed layer of the soil [18, 19, 20].

Based on experimental studies, it is expected to get an answer to the following questions: how does the main tillage, the timing of sowing and rolling the soil before and after sowing on its agrophysical properties, the conditions under which the growth and development of soybean plants continues, the accumulation and rational use of moisture by them.

The aim of the research. To identify the optimal timing of soybean sowing with stable soil warming up to 8–10 °C when treated with a stratifier PRSM-5 and up to 10–12 °C during chisel cultivation against the background of pre-sowing rolling in the conditions of the north-eastern part of Ukraine.

Material and methods of research. In the course of the research, soil-cultivating aggregates of three types were used:

1. The stratifier tillage machine (Fig. 1) optimizes the physical and mechanical state of the cultivated soil layer to a depth of 18 cm [21], is a trailed universal tillage unit for pre-sowing and main surface tillage, in which weeds are carefully removed from the soil by combing together with whole root system and laid on the surface, where they are dried under the influence of climatic factors [22].

The machine (Fig. 1) consists of a chassis 1, with which, by means of a parallelogram lever mechanism 2, a frame 3 is fixed with the possibility of moving vertically. Working bodies are mounted on it: passive – racks 4 with ploughshares 5 and active – a rotor with rippers 6 in such a way that that the rotor is located above the shares and does not touch them. Shares are equipped with separating gratings [22].

2. Plow chisel subsoiler PCH-2.5 (Fig. 2).

Mounted chisel plow PCH-2.5 is designed for loosening the soil on moldboard and moldboardless backgrounds with deepening of the arable horizon, moldboardless tillage instead of autumn and spring plowing, deep loosening of soil on slopes [23, 24]. The main components of a general-purpose chisel plow are (Fig. 2): frame 1, working bodies 2, support wheels 3, hitch 4, travel depth adjustment mechanism 5 and supports6.

3. Ring-spur roller RSR for soil compaction before and after sowing (Fig. 3). When rolling the soil before sowing, the roller levels the field surface, breaks up clods and compacts soil that is too loose [25].

Pre-sowing rolling is carried out to retain moisture in the soil, crush large clods of earth and partially level the field surface, as well as to compact the settled, late-tilled soil, which is especially necessary before sowing crops. This operation reduces slippage and loading of the seeder support wheels, which increases the uniformity of sowing and stabilizes the seed placement depth [26, 27].

Post-sowing rolling is a necessary operation for moisture retention and ensuring seed-to-soil contact.Such contact creates favorable conditions for obtaining earlier and more friendly germination of seeds, which is essential in increasing the yield when sown in dry and wind-damaged areas [28, 29].

The skating rink is designed for use in all soil and climatic zones, except for the zone of mountain farming. The working bodies of the rink are cylinders made of steel. Overlapping of the working bodies allows for better rolling, which increases productivity.The design of the roller allows its safe transportation on public roads due to the possibility of its transfer to the position of long-distance transport using the hydraulic system of the tractor, controlled from the workplace of the tractor driver.The roller is aggregated with tractors of traction class 1.4-2.0 (MTZ-80 (82), MTZ-1221, etc.).

The effectiveness of various methods of the main treatment was evaluated against the background of agricultural practices-rolling before and after sowing, and chemical measures (Lancaster – 2.0 l/ha for pre-sowing cultivation).

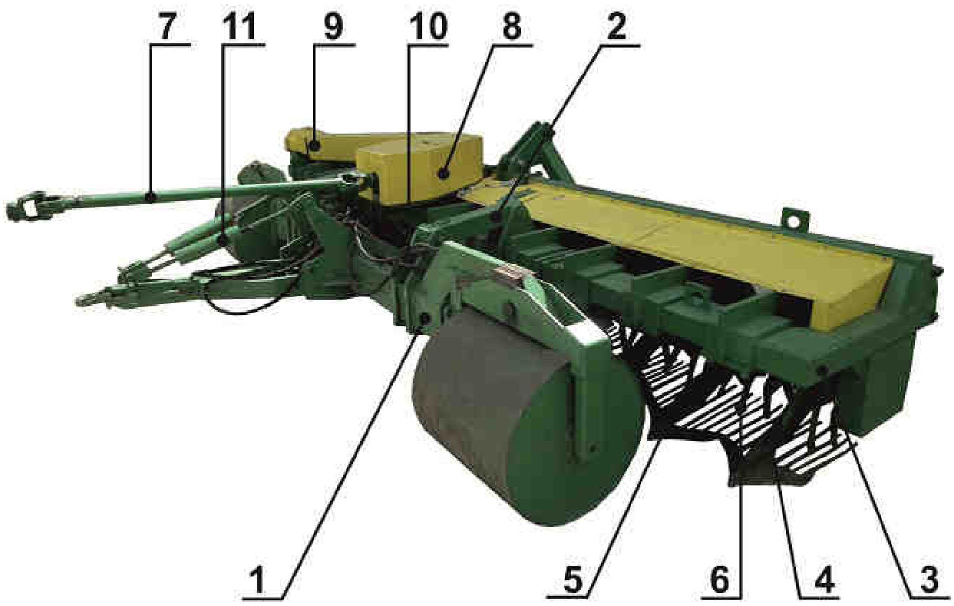

Fig. 1. **Soil-cultivating ripper-separating machine PRSM-5:**
1 – the chassis; 2 – the lever mechanism; 3 – frame; 4 – the rack; 5 – ploughshare with separating gratings; 6 – rotor with rippers; 7 – cardan gear; 8 – a gear transmission; 9 – chain transmission; 10 – mechanism for adjusting the depth of tillage; 11 – mechanism for adjusting the horizontal position of the frame [21].

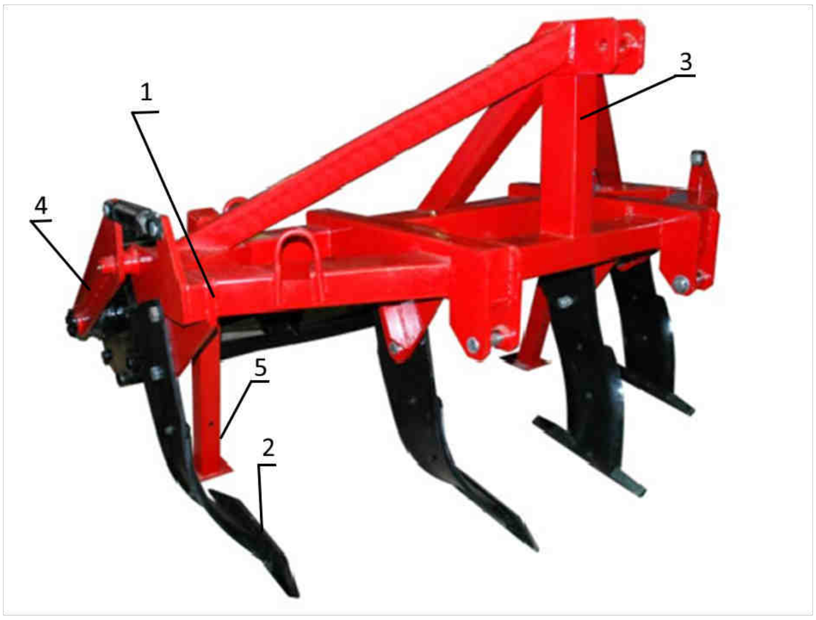

Fig. 2. **The main components of the chisel plow PCH-2.5 frame 1, working bodies 2, hitch 3, travel depth adjustment mechanism 4, supports 5.**

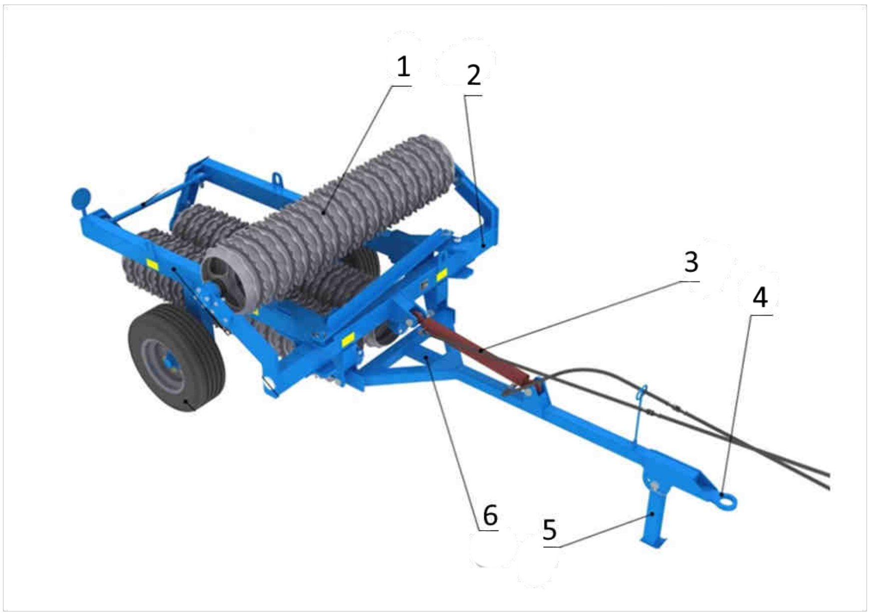

Fig. 3. **The main components of the ring-spur skating rink RSR-6 , ring section 1, frame 2, hydraulic cylinder 3, hook 4, support 5, drawbar 6.**

The studies were carried out in 2016–2018 on the experimental field of Kharkiv National Agrarian University in the crop rotation: soybean-winter wheat. In the experiment, non-moldboard processing with a stratifier PRSM-5 and non-moldboard processing (chisel) PCH-2.5 were studied. The area of the sowing plot is 128.8 m^2, the accounting area is 48.3 m^2. Repetition of experience – three times. Soybean seeds of the «Feya» variety were sown with stable heating of the soil to a depth of 10 cm in three periods: the first – at 8–10 ^oC, the second – at 10–12 ^oC, the third – at 12–14 ^oC in a wide row method with row spacing of 70 cm. Seeding rate 500 thousand viable seeds/ha.

The soil cover of the research plots is a typical slightly eroded (слабосмытый), low-humus, heavy loamy chernozem on carbonate lesse, which is characterized by the following agrochemical parameters: pH of the salt extract – 6.45–7.0, total humus content in the arable layer – 5.5 %, nitrate nitrogen 2–3 mg per 100 g of soil, mobile phosphorus (according to Chirikov) – 10.2 mg per 100 g of soil, exchangeable potassium 179 mg per 1 kg of soil (according to Surikov).

The main factor that significantly hinders the growth of seed productivity of this crop is moisture availability. The weather conditions during the years of the research were different, which made it possible to comprehensively characterize the effect of agrotechnical measures and sowing dates on the productivity of soybean plants. The growing season in terms of moisture in 2018 was favorable. The hydrothermal coefficient for the growing season (May–September) was 1.46 in 2016 (acutely dry) and in 2017 (dry) it was 0.66 and 0.87, respectively. The critical period for soybean plants is the flowering phase – the formation of beans. Difficult weather conditions are observed in our region in the second half of summer (July–August). In July and August, the air temperature rises significantly, and precipitation is often unproductive or several times less than the long-term average. Relative air humidity of less than 30 % is observed for 14–16 days per month. The hydrothermal coefficient in July and August 2016 was 0.13 and 0.56, and in 2017 it was 0.26 and 0.75, respectively. Difficult weather conditions negatively affected soybean potential.

Soybean assimilation surface area was determined by the cutting method. To do this, 10 plants were selected from the plot; the leaves were cut off and weighed. At the same time, 50 of them were cut with a metal tube. Knowing the mass and area of the cuts, as well as the total mass of the leaves, the area of the leaves of the entire sample was determined. Knowing the plant density or the area from which the samples were taken, the leaf area per 1 ha was calculated.

The yield of soybeans was determined by threshing the crops of experimental plots with a «Sampo-500» combine.

Research results and discussion. The obtained results of the research showed that the soil density depended primarily on the method of basic cultivation. Thus, before sowing, the density of the upper soil layer (0–10 cm) after treatment with the stratifier PRSM-5 was 0.95 g/cm^3, and after chisel treatment it was 1.04 g/cm^3. In a layer of 10–20 cm, after treatment with a stratifier PRSM-5, the density of the soil is 1.06, and after chisel treatment it is 1.09 g/cm^3. With an increase in the depth of the main processing, an increase in density was observed. So, after treatment with a stratifier PRSM-5, the density of the soil in a layer of 20–30 cm was 1.10 g/cm^3, and after chisel treatment it was 1.13 g/cm^3. The analysis of soil density indicators as a whole showed that after treatment with the stratifier PRSM-5 it was somewhat less and averaged 1.04 g/cm^3, and after chisel treatment it was 1.09 g/cm^3 (Table 1).

It should also be noted that significant differences in the impact on the arable layer were observed after chisel processing, in which the working bodies of the unit acted on the soil only in the vertical plane. As a result of such processing, vertical narrow stripes are formed, alternating with more intense and insignificant soil grinding. At the same time, partially unloosened strips of soil in the form of closed ridges are formed between the working bodies.

An analysis of the structural composition of the soil showed that the largest amount of agronomically valuable fraction (7–0.25 mm) in the upper layer of 0–10 cm is created by treatment with a stratifier PRSM-5 due to the removal of the most agronomically valuable soil lumps from the lower layers to the surface. In the areas where this treatment was carried out, in the upper layer (0–10 cm) the agronomic valuable fraction was 71.8 %. At the same time, the smallest amount of lumpy fraction and dust was observed, the structural coefficient here was 2.56, while during chisel processing it was 2.21, respectively. In the soil layer of 10–20 cm, the agronomic valuable fraction was more when processed with the stratifier PRSM-5 – 69.7 %, and slightly less when processed with chisel – 67.5%. The coefficient of structure during chisel loosening in a layer of 20–30 cm was 2.06, while when processed with a stratifier PRSM-5 it was 2.21. Analyzing the arable layer as a whole, it should be noted that the best structural structure of the soil was noted when working with a stratifier PRSM-5, here the coefficient of structure was high and reached 2.36, and when chisel tillage was 2.08 (Table 2).

Table 1 – **Soil density before sowing soybean, depending on the methods of main processing,** g/cm^3

Basic tillage	Soil layer, cm	2016	2017	2018	Average
Processing with a stratifier PRSM-5 by 15–17 cm	0–10	0.94	0.96	0.96	0.95
	10–20	1.06	0.98	1.14	1.06
	20–30	1.15	1.01	1.15	1.10
	0–30	1.05	0.98	1.08	1.04
Plowing – PCH-2.5 by 25–27 cm	0–10	1.01	1.01	1.10	1.04
	10–20	1.11	1.02	1.15	1.09
	20–30	1.19	1.04	1.16	1.13
	0–30	1.10	1.02	1.14	1.09

Table 2 – **Indicators of the agronomically valuable fraction (7–0.25 mm) of soil, depending on the method of main processing**

Basic tillage	Soil layer, cm	2016	2017	2018	Average	The structure coefficient
Processing with a stratifier PRSM-5 by 15–17 cm	0–10	71.0	74.3	70.0	71.8	2.56
	10–20	67.9	72.0	69.1	69.7	2.31
	20–30	67.0	71.8	67.4	68.7	2.21
	0–30	68.7	72.7	68.8	70.1	2.36
Plowing – PCH-2.5 by 25–27 cm	0–10	68.4	70.3	68.3	69.0	2.21
	10–20	66.7	66.2	69.5	67.5	2.06
	20–30	65.9	64.5	68.8	66.4	1.98
	0–30	67.0	67.0	68.9	67.6	2.08

Various methods of basic tillage significantly influenced not only the agrophysical properties of the soil, but also had certain differences in the accumulation of moisture in it. Reserves of productive moisture in the upper (0–10 cm) soil layer before sowing in areas treated with a stratifier PRSM-5 13.6–14.0 mm, and with chisel – 11.3–12.0 mm. Differences in moisture reserves are associated with an increase in the porosity of this layer as a result of mixing crop residues with soil. Moisture reserves in a meter layer of soil after treatment with a stratifier PRSM-5 were 128–144 mm, and after chisel treatment, 123–142 mm. At the end of the growing season, the reserves of productive moisture decreased significantly and in the phase of full ripeness after treatment with the stratifier PRSM-5 they were 57 mm, and after chisel processing – 69 mm, that is, during chisel processing, the reserves of productive moisture were used more rationally.

Rolling the soil before sowing with ring-spur rollers ensured the accumulation of moisture due to capillary pulling of moisture from the lower layers of the soil in the zone of seed placement. This agrotechnical technique provides uniform placement of seeds during sowing and closer contact of seeds with the soil, better moisture supply, and, consequently, obtaining friendly seedlings. However, the use of such an agricultural method in the case of soil moisture after sowing led to a decrease in the density of soybean plants, although close contact of seeds with soil was observed. As you know, soybean plants during germination bring their cotyledons to the surface of the soil and quite often, at high soil density, the sprouts break and die. Rolling the soil on the plots before sowing provided the best results, and after sowing led to a decrease in the density and productivity of soybean plants.

The observations made during the "sowing-shooting" period showed that the methods of sowing did not affect the emergence of seedlings. At the same time, the main role was played by the amount of moisture in the seed layer and the thermal regime during this period.

The passage of development phases by soybean plants depended on the above factors and weather conditions during the growing season. In the presence of precipitation and a decrease in air temperature, the phases of plant development were lengthened, and, consequently, the duration of the growing season also increased. So, the onset of full ripeness was noted on the 125-th day of vegetation, and under dry conditions, due to the reduction of interphase periods - on the 115-th day.

The analysis of biometric indicators at the time of soybean flowering showed that the height of plants changed depending on agricultural practices. So, soybean plants of the first sowing period after treatment with a stratifier PRSM-5 (soil temperature 8–10 °C at a depth of 10 cm) without pre-sowing packing had a height of 1.2–1.7 cm more compared to the variant where pre- and post-sowing soil compaction. At the second sowing term (soil temperature 10–12 °C), in areas without pre-sowing packing, the height of soybean plants was 1.7–2.3 cm higher than in the variant with pre- and post-sowing packing. Determination of the height of soybean plants at the third sowing period (soil temperature 12–14 °C) showed that this indicator was 7.8–9.5 cm less compared to the above period without pre-sowing rolling, and in areas with pre- and post-sowing rolling had the lowest rates.

It should be noted that other conditions for the formation of plant density and height were observed during chisel cultivation, when more than 60 % of crop residues remained on the soil surface. The residues mixed with the soil, which led to an increase in the number of cracks and some loss of moisture. Therefore, rolling in this case is an expedient agricultural technique in preparing the soil. The use of pre-sowing rolling at the first sowing period ensured the formation of a similar plant density, as in the case of treatment with a stratifier PRSM-5, but seedlings appeared 3–4 days later. This in a certain way affected the height of plants, its indicators at the time of flowering were 4.2 cm less. Rolling before and after sowing ensured better soil compaction, so seedlings appeared in these areas at the same time as when treated with a stratifier PRSM-5; there was a trend towards an increase in plant density. With such agrotechnical practices, the height of the plants was somewhat higher than when treated with the stratifier PRSM-5. At the second sowing period, when the soil warmed up to 10–12 °C, there were no significant differences in seedling density between the variants with rolling, depending on the implementation of this agricultural method before and after sowing.

At the third sowing term and soil warming up to 12–14 °C, rolling contributed to a more friendly emergence of seedlings. The height of soybean plants in the variants with pre-sowing rolling was 1.4 cm less. Carrying out this agricultural method before and after sowing led to a decrease in plant height – by 1.9 cm.

The main quantitative indicator of the photosynthetic activity of sowing is the area of the assimilation leaf surface of the herbage [30]. Taking into account the area of the leaf surface showed that these indicators varied depending on weather conditions, methods of basic processing and the timing of rolling (Table 3). Under favorable moisture conditions in the first half of the growing season, at the first sowing date, soybean crops, when treated with a stratifier PRSM-5 without pre-sowing rolling, formed a leaf surface at the level of 42.2, and with chisel treatment – 38.3 thousand m^2/ha.

The results of taking into account the leaf surface area during the second sowing period and pre-sowing rolling, as well as without rolling against the background of treatment with the stratifier PRSM-5 and chisel processing, showed that soybean crops formed almost the same assimilation surface – 42.6 and 42.4 thousand m^2/ha, and in the third – 42.8–43.7 thousand m^2/ha. In the arid conditions of past years, in the areas where the treatment with the stratifier PRSM-5 was carried out without rolling before sowing, the photosynthetic apparatus of soybean agrocenosis amounted to 26.7–30.7 thousand m^2/ha, and in case of chisel treatment with rolling before sowing – 25.0–25.6 thousand m^2/ha. Against the background of post-sowing rolling during treatment with a stratifier PRSM-5, the area of the leaf surface of crops amounted to 27.4–30.4 thousand m^2/ha, and during chisel processing – 26.0–26.5 thousand m^2/ha.

It should also be noted that due to the high temperatures that occurred in dry years, the level of harmfulness of the acacia moth increased over the entire growing season of plants. So, in the crops of the first sowing period, the damaged seed was almost 8 %, and in the case of chisel processing – 11.7–13.0 %. In crops of the second and third sowing terms, seed damage increased to 16–21 %.

The analysis of the indicators of the yield structure showed that the «Feya» soybean crops created the best conditions for growth and development, therefore, a greater number of branches were formed on one plant, and, consequently, the number of beans and seeds per plant increased. Such an indicator as the weight of 1000 seeds significantly depended on the weather conditions of each year during the period of grain formation.

The experimental data obtained under favorable moisture conditions (hydrothermal coefficient 1.45) indicate that when using the herbicide Lancaster (2.0 l/ha), high productivity of soybean plants was formed after treatment with the stratifier PRSM-5 when sowing with stable warming of the soil up to 8–10 °C, but the highest after chisel tillage and sowing at a soil temperature of 10–12 °C against the background of pre-sowing rolling (Table 4). Under dry weather conditions, the best yield was formed when treated with a stratifier PRSM-5 at the second sowing date, and when chisel loosening – at the first and pre-sowing rolling.

Table 3 – **Soybean assimilation surface area depending on growing conditions,** thousand m^2/ha

Basic tillage method	Rolling	Dry conditions (2017)			Favorable conditions (2018)		
		sowing dates					
		first	second	third	first	second	third
Processing with a stratifier PRSM-5 per 15–17 cm	without rolling	26.7	30.7	28.6	42.2	42.6	41.6
	after sowing	30.4	29.8	27.4	43.1	42.9	43.2
Chisel per 25–27 cm	before sowing	25.9	25.6	25.0	38.3	42.4	42.8
	before and after sowing	26.3	26.5	26.0	39.7	41.9	43.7

Table 4 – **Soybean yield depending on the main treatment method, sowing dates and preand post-sowing packing,** t/ha

Basic tillage method	Rolling	Dry conditions (2017)			Favorable conditions (2018)		
		Sowing time depending on soil temperature at depth 10 cm					
		8–10 °C (factor A)	10–12 °C (factor B)	12–14 °C (factor C)	8–10 °C (factor A)	10–12 °C (factor B)	12–14 °C (factor C)
Processing with a stratifier PRSM-5 per 15–17 cm	without rolling	1.12	1.18	1.15	1.91	1.77	1.71
	after sowing	1.14	1.14	1.15	1.78	1.75	1.68
Chisel per 25–27 cm	before sowing	1.08	1.03	1.02	1.80	1.96	1.70
	before and after sowing	1.05	1.05	1.03	1.76	1.81	1.66

LSD_{095} t/ha A – 0.04–0.05; B – 0.03–0.04; C – 0.02–0.04; AB – 0.04–0.06; BC – 0.04–0.05; AC – 0.03–0.06; ABC – 0.06–0.09.

Conclusions. When using chemical weed killers, the highest seed productivity of soybean plants under favorable growing conditions (1.96 t/ha) was formed in areas with chisel cultivation when the soil warmed up from 10 to 12 °C, and when treated with a stratifier PRSM-5 when sowing with stable warming soil to a depth of 10 cm to 8–10 °C, against the background without rolling, it was 1.91 t/ha. Under arid growing conditions, the highest seed productivity of soybean plants was obtained (1.18 t/ha) against the background of treatment with a stratifier PRSM-5 and when sowing with stable heating of the soil to a depth of 10 cm to 10–12 °C without rolling. Against the background of chisel cultivation, the best sowing time was when the soil warmed up to a depth of 10 cm to 8–10 °C and pre-sowing rolling. Rolling the soil after sowing led to a decrease in yield both during chisel cultivation and when treated with a stratifier PRSM-5 – by 0.03–0.07 t/ha.

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Вплив агротехніки та строків сівби за різних погодних умов на врожайність сої

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Стаття присвячена визначенню оптимальних строків сівби сої за стійкого прогрівання ґрунту, розглянуто обробку стратифікатором ПРСМ-5 та чизельну обробку на фоні передпосівного коткування. З використанням ґрунтообробних агрегатів трьох типів проведено аналіз ефективності різних прийомів основного обробітку на фоні різних агротехнічних прийомів. Оптимальні строки сівби сої визначено за стабільного прогрівання ґрунту до 8–10 °С за обробки стратифікатором ПРСМ-5 та до 10–12 °С за чизельної культивації на фоні передпосівного коткування. Дослідження показали, що щільність ґрунту залежить насамперед від способу основного обробітку. Аналіз показників щільності ґрунту загалом показав, що після обробки стратифікатором ПРСМ-5 вона була дещо меншою і становила в середньому 1,04 г/см^3, а після чизельної обробки – 1,09 г/см^3. Аналіз структурного складу ґрунту показав, що найкраща структурна будова ґрунту спостерігалася за обробки стратифікатором ПРСМ-5 завдяки винесенню найбільш агрономічно цінних грудок ґрунту з нижніх шарів на поверхню, при цьому структурний коефіцієнт був високим і сягав 2,36, за чизельної обробки – 2,08. Аналіз запасів продуктивної вологи наприкінці вегетації показав, що під час чизельної обробки вони витрачалися більш раціонально, у фазу повної стиглості після обробки стратифікатором ПРСМ-5 – становили 57 мм, а після обробки чизелем – 69 мм. Отримані експериментальні дані свідчать про те, що за умов сухої погоди найкращий врожай формувався за обробки стратифікатором ПРСМ-5 у другий строк сівби, за чизельного розпушування – під час першого та передпосівного коткування.

Ключові слова: соя, обробіток ґрунту, стратифікатор ПРСМ-5, щільність, структура, урожайність.

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