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4.1.1. Общее земледелие и растениеводство (биологические науки, сельскохозяйственные науки)

ДИНАМИКА ПАРАМЕТРОВ АГРО-ФИЗИЧЕСКИХ ПОКАЗАТЕЛЕЙ ПОЧВЫ ПОД ПОСЕВАМИ СОИ

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В работе предложен обзор прогресса параметров агро-физических показателей почвы под посевами сои в зависимости от приема основной ее обработки. Данный двухфакторный опыт был проведен на стационаре кафедры общего и орошаемого земледелия в отделении учебно-опытного хозяйства «Кубань». Варианты – вспашка на 25-27 см и no-till (прямой посев культуры). Исследованиями установлено, что Более оптимальные агро-физические параметры почвы (1,15-1,27 г/см^3) по показателю ее плотности отмечены по обработке почвы, подразумевающей ее оборот с глубиной 25-27 см (вспашка). По системе no-till отмечено увеличение данных параметров до 1,30-1,35 г/см^3 (что характерно для всего вегетационного периода культуры). Также это характерно и для показателя структуры почвы, где параметры ее агрегатного состава по вспашке превалировали над системой no-till на 25,0-35,9 %. В течение всей вегетации было заметно неравномерное содержание продуктивной влаги в почве под посевами сои. Здесь определяющим был прием, которым обрабатывалась почва с осени, в чьем подчинении находились процессы влагонакопления и влагопотребления. В фазу всходов растений сои (начало вегетации) суммарный запас продуктивной влаги пиковым был по вспашке – 195 мм. По системе no-till он был ниже на 51 мм. Анализ данным в фазу цветения сои показал равенство параметров по изучаемым показателям, а в концу вегетации – преимущество системы no-till – 74 мм супротив 24 мм на варианте со вспашкой

Ключевые слова: СОЯ, СКВЕДА, ПОЧВА,

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4.1.1. General agriculture and crop production (biological sciences, agricultural sciences)

DYNAMICS OF PARAMETERS OF AGRO-PHYSICAL INDICATORS OF SOIL UNDER SOYBEAN CROPS

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The study provides an overview of the progress of parameters of agro-physical indicators of soil under soybean crops depending on the method of its primary processing. This two-factor experiment was conducted at the stationary facility of the Department of General and Irrigated Agriculture in the department of the educational and experimental farm "Kuban". The options are plowing to 25-27 cm and no-till (direct sowing of the crop). Research has established that more optimal agro-physical parameters of the soil (1.15-1.27 g / cm3) in terms of its density are noted for soil cultivation, implying its turnover with a depth of 25-27 cm (plowing). According to the no-till system, an increase in these parameters to 1.30-1.35 g / cm3 was noted (which is typical for the entire vegetation period of the crop). This is also typical for the soil structure indicator, where the parameters of its aggregate composition for plowing prevailed over the no-till system by 25.0-35.9%. Throughout the growing season, an uneven content of productive moisture in the soil under soybean crops was noticeable. Here the decisive factor was the method by which the soil was processed in the fall, which controlled the processes of moisture accumulation and consumption. In the phase of soybean plant emergence (beginning of vegetation), the total stock of productive moisture was peaked by plowing - 195 mm. According to the no-till system, it was lower by 51 mm. Analysis of data in the soybean flowering phase showed the equality of parameters for the studied indicators, and at the end of vegetation - the advantage of the no-till system - 74 mm against 24 mm in the variant with plowing

Keywords: SOYBEAN, SK VEDA, SOIL, DENSITY,

ПЛОТНОСТЬ, ТВЕРДОСТЬ, ВЛАЖНОСТЬ, АГРЕГАТНЫЙ СОСТАВ
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HARDNESS, MOISTURE, AGGREGATE COMPOSITION

Introduction

Soybeans are a very unique and important crop. More than 400 types of products for confectionery, food, dairy, medical, feed and other industries are made from soybeans. As early as 40 years ago, about 10 companies were engaged in the production of soy analogues (imitating meat) in the USA. At present, their number has increased dramatically. Soy meat products are, of course, much cheaper than meat, and sometimes even preferable - they do not contain bones or fat. Soybeans are a multifaceted crop of wide use, considered a good predecessor for other crops in crop rotation. In general, growing any agricultural crop is a process that has always helped to select a competent specialist. But even an experienced agronomist is powerless before such factors as temperature conditions or solar insolation. Other factors are regulated and provided by humans. Among them are: moisture retention in the soil, plant nutrition, intensive varieties, good seeds. Optimal parameters of nutrient and air-water soil conditions, as well as an optimal combination of nutrition systems, protection of field crops and soil cultivation contribute to the formation of optimal parameters of the growing conditions of cultivated plants. In farms, the actual level of intensification of agricultural production must be selected based on the resource capabilities of agricultural producers [2].

Soybean is a plant that can respond positively to the use of fertilizers, especially on leached chernozems. Phosphorus and potassium fertilizers added to the soil along with the main tillage, including deep moldboard plowing, are highly effective, but the constant use of moldboard tillage negatively affects the condition of the soil. So other methods must be considered. Different methods of tillage and dosages of mineral fertilizers affect the condition of the soil cover of

leached chernozems differently, and there is no general opinion on which agricultural technology is the best.[5-7].

The yield of soybeans was directly dependent on the technological methods of crop cultivation. The highest results were provided by the technology based on moldboard plowing. The yield was 1.40-1.49 t/ha, on average for 7 years of observations, but also regardless of the level of fertilizers and plant protection from weeds. No-moldboard tillage resulted in a reduction in the harvest of crop seeds by 0.09 t/ha. The minimum yield of soybeans was established in the variant with peeling at 10-12 cm in the fall - 1.34 t/ha. Such results were reflected in the article by Shabalkin A.V. together with colleagues. High soil density negatively affects the yield of the crop, as well as the efficiency of the root zone. Primary soil cultivation is aimed at clearing the field of various weeds, accumulating nutrients, a sufficient level of moisture, creating a compacted seed bed, and, most importantly, a fine-grained, leveled soil layer. Research conducted on heavy soils has shown that the most favorable density index for many agricultural crops is d= 1.10–1.30 g/cm3. Optimum soil density promotes good growth and development of the root system of cultivated plants, which is achieved by improving the availability of mineral salts and water-air supply of plants, as well as greater activity of the microbiological activity of the soil. Tillage with layer turnover loosens the soil better than other treatments, and thereby reduces the density of the arable layer (0-20 cm) by 0.06 g/cm3 and the subsoil layer by 0.03 g/cm3 (30-40 cm).[1, 2].

The works of VNIIMK showed that when growing soybeans on soil with a density of d = 1.51, a significant decrease in yield was observed, in contrast to the soil density of d = 1.26. On more compacted soil, the yield was only 70% of the yield, where the density of the arable layer was lower. And in the case where the soil density was d = 1.06, no increase in yield was observed. On the contrary, there was a decrease in yield by 8%.[8].

In the period from 2020 to 2021, a stationary field experiment was conducted on leached chernozem in the Krasnodar Territory. The experiment included various options for primary soil cultivation: traditional moldboard (control), no-moldboard, surface and combined. The effect of three levels of mineral nutrition on crop yields was also studied: without fertilizers, medium level (N20P80) and high level (N40 P80). The research revealed that the most favorable conditions for the accumulation of productive moisture in the soil were observed when using no-moldboard and shallow tillage. However, the use of these soil cultivation methods also led to an increase in the number of weeds in crops by 1.8 times compared to the moldboard cultivation system. In general, the efficiency of cultivating field crops in grain-row crop rotation can be increased by using no-moldboard soil cultivation systems in combination with fertilizers [3].

High soil density has a negative impact on crop yield, as well as on the efficiency of root zone use. Primary soil cultivation is aimed at clearing the field of various weeds, accumulating nutrients, sufficient moisture level, creating a compacted seedbed, and, most importantly, a fine-grained, leveled soil layer. In the period from 2021 to 2022, studies were conducted on the chernozem soil of the experimental field of the Kuban State Agrarian University to determine the effect of general physical properties on soybean yield. The most significant factors influencing the increase in yield were aeration porosity and total porosity, with correlation coefficients of 0.87 and 0.86, respectively. However, it was found that soil density has an inverse effect on yield, while the relationship between these indicators was average, with a correlation coefficient of -0.52. In addition, there was a moderate relationship between soil solid phase density and increased soybean grain yield, with a correlation coefficient of 0.42 [4].

Material and object of research

Field experiments were conducted in 2022-23 on the experimental field of KubSAU, which is included in the Kuban Delta area, represented by the Predkuban Plain, and also belongs to the forest-steppe and steppe zone of the Ciscaucasian forest-steppe province. The soil cover is mainly represented by chernozems (64.6%).

Options include plowing to 25-27 cm and no-till (direct sowing of crops).

The object of research is soybeans,early ripeningvariety SK Veda,being one of the newest varieties, it was bred by breeders using a non-transgenic method in 2017, and later included in the State Register for the North Caucasus region (2019).

Research results

The most favorable soils for soybean vegetation are structured, well-aerated soils with optimal density parameters of 1.15–1.25 g/cm3. According to our data, the no-till principle (without soil cultivation) entails cultivating crops against the background of its equilibrium density – 1.29–1.30 g/cm3 against the density of 1.13–1.16 g/cm3 formed by plowing (deep soil cultivation with layer turnover) by the beginning of soybean vegetation. This is higher than the control under the no-till system by 0.15–0.16 g/cm3 (Table 1).

Table 1 – Dynamics of density (d0, g/cm3) and moisture content (B0, %) of the soil

Primary tillage	Soil layer, cm							
	0 – 10		10 – 20		20 – 30		0 – 30	
	d0, g/cm3	B0, %	d0, g/cm3	B0, %	d0, g/cm3	B0, %	d0, g/cm3	B0, %
shoots								
Plowing (k)	1.13	27.7	1.15	27.9	1.16	27.7	1.15	27.8
No-till	1.29	25.5	1.30	25.7	1.31	25.0	1.30	25.4
technical maturity								
Plowing (k)	1.26	16.7	1.27	15.1	1.28	15.6	1.27	16.1
No-till	1.34	22.3	1.35	21.7	1.37	22.2	1.35	22.1

By the end of soybean growth and development, a 2-fold smoothing of such a soil parameter as density was observed. Plowing contributed to the establishment of soil density at the level of 1.26–1.28 g/cm³, which is lower than the parameters of the no-till soil treatment option (1.34–1.37 g/cm³) by 0.08–0.09 g/cm³.

Thus, more optimal agro-physical parameters of the soil in terms of its density are formed with deep moldboard tillage (plowing to 25-27 cm) - 1.15-1.27 g/cm3 versus 1.30-1.35 g/cm3 in the no-till option throughout the entire vegetation period of plants.

One of the factors that should be monitored when comparing different methods of cultivation is the soil structure. The size and number of soil aggregates affect the creation of favorable conditions for water, air and thermal regimes. Satisfaction with these requirements allows you to get a high and stable harvest. Structure is understood as the ability to disintegrate into soil aggregates. And the totality of soil aggregates, in turn, makes up the soil structure. Soil is

called structured if it includes more than 55% of mesoaggregates, and the higher the structure coefficient, the better the soil structure. Soil units from 0.25 to 10 mm in size have the greatest structure.

The experimental data are presented in Table 2. In the soybean germination phase, the percentage of agronomically valuable aggregates was maximum in the plowing variant. Here, their number was 66.1%, and the structural coefficient was 1.95.

In the no-till variant, a decrease in the number of agronomically valuable units by 10.6% was recorded against the background of a decrease in the structure coefficient compared to the plowing variant to 1.25.

By the end of the crop's growing season, before harvesting, a general decrease in soil structure was noted in the arable soil layer compared to the beginning of the growing season.

Table 2 – Dynamics of the aggregate composition of the arable soil layer under soybean crops

Primary tillage	Size of units, mm		Structural coefficient
	0.25–10	(< 0.25) + (> 10)	
	%	%	
At the beginning of the growing season			
Plowing (k)	66.1	33.9	1.95
No-till	55.5	44.5	1.25
Before cleaning			
Plowing (k)	59.8	40.2	1.48
No-till	52.7	47.3	1.11

The highest content of agronomically valuable aggregates was recorded in the variant with plowing. Here their number was 59.8%, and the structural coefficient was 1.48.

In the no-till variant, a decrease in the number of agronomically valuable units by 7.1% was recorded against the background of a decrease in the structure coefficient compared to the plowing variant to 1.11.

Thus, plowing (moldboard tillage) helps to optimize the aggregate composition of the soil by 25.0-35.9% compared to zero tillage using the no-till system.

During the entire growing season, the content of productive moisture in the soil under soybean crops was noticeably uneven. The decisive factor here was the method by which the soil was treated in the fall, which controlled the processes of moisture accumulation and consumption. (Figure 1).

During the soybean germination phase (beginning of vegetation), the total supply of productive moisture peaked under plowing – 195 mm. Under the no-till system, it was 51 mm lower.

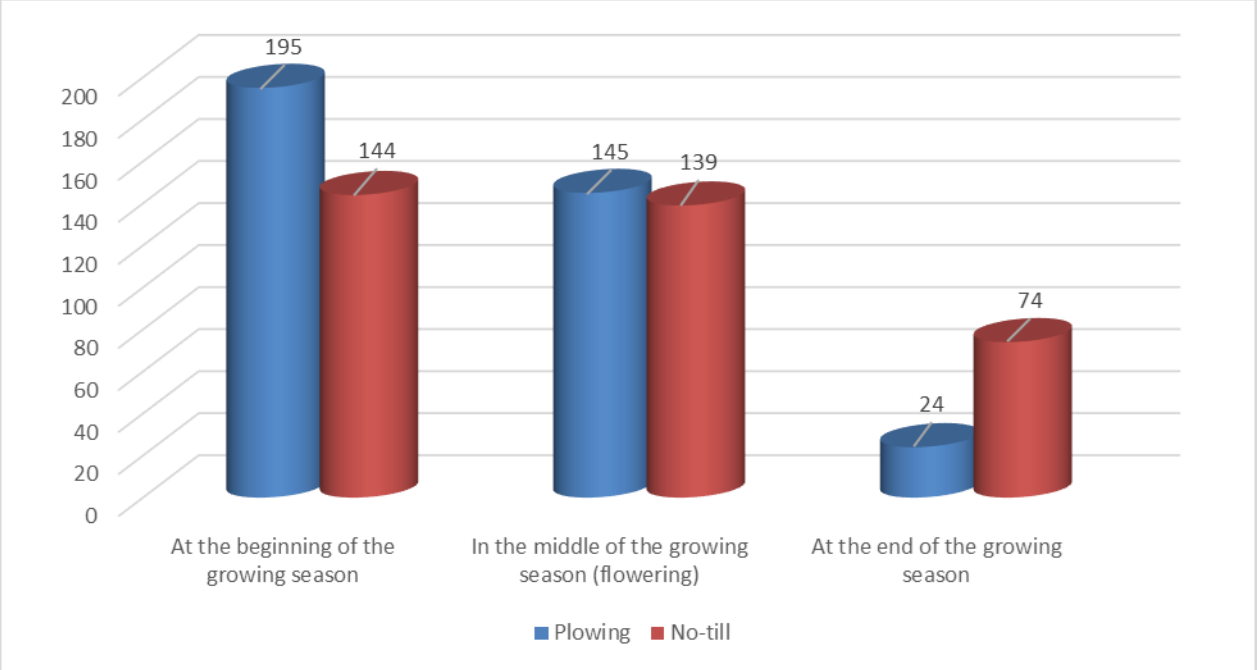

Figure 1 – Productive moisture reserves, mm

Analysis of data during the soybean flowering phase showed equality of parameters for the studied indicators, and at the end of the growing season, the no-till system had an advantage – 74 mm versus 24 mm in the plowing option.

Conclusion

More optimal agrophysical parameters of the soil (1.15-1.27 g/cm3) in terms of its density were noted for soil cultivation, which implies its turnover with a depth of 25-27 cm (plowing). According to the no-till system, an increase in these parameters to 1.30-1.35 g/cm3 was noted (which is typical for the entire vegetation period of the crop). This is also typical for the soil structure indicator, where the parameters of its aggregate composition for plowing prevailed over the no-till system by 25.0-35.9%. Throughout the vegetation, uneven content of productive moisture in the soil under soybean crops was noticeable. Here, the determining factor was the method by which the soil was cultivated in the fall, which controlled the processes of moisture accumulation and consumption. In the soybean germination phase (beginning of vegetation), the total productive moisture reserve was peaked by plowing – 195 mm. Under the no-till system, it was 51 mm lower. Analysis of data during the soybean flowering phase showed the equality of parameters for the studied indicators, and at the end of vegetation – the advantage of the no-till system – 74 mm versus 24 mm in the plowing variant.

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