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4.1.1. Общее земледелие и растениеводство (сельскохозяйственные науки)

ФОРМИРОВАНИЕ АГРОФИЗИЧЕСКИХ ПОКАЗАТЕЛЕЙ В ЗАВИСИМОСТИ ОТ МИНЕРАЛЬНЫХ УДОБРЕНИЙ НА ФОНЕ МИНИМИЗАЦИИ ОСНОВНОЙ ОБРАБОТКИ ПОЧВЫ

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Статья посвящена анализу формирования продукционного потенциала озимой пшеницы в зависимости от минеральных удобрений на фоне минимизации основной обработки почвы. Предмет исследований – озимая пшеница сорта, минеральные удобрения и чернозем выщелоченный. Исследованиями установлено, что к моменту всходов плотность почвы достигла 1,24 г/см^3 при дисковом лущении, что положительно повлияет на рост корневой системы пшеницы, а при вспашке плотность была ниже – 1,17 г/см^3. Постепенно плотность повышается на обоих вариантах, достигая 1,29 г/см^3 и 1,23 г/см^3 в фазу колошения. К концу вегетации в фазу полной спелости плотности достигла 1,30 г/см^3 для вспашки и находится в оптимальной норме для озимой и 1,34 г/см^3 для дискового лущения, показывая нам, что оптимальные показатели были на более глубокой обработке, а увеличение плотности связано с частыми движениями сельскохозяйственной техники. Переходя к динамике твердости почвы, стоит отметить, что в начале развития пшеницы данный показатель был на уровне в 11,9 кг/см^2 для первой обработки и в 2 раза меньше – 5,7 кг/см^2 для второй обработки. Но мере развития и доходя до фазы колошения, твердость почвы повышается на 12,2 кг/см^2 для обработки на 10-12 см и на 11,6 кг/см^2 для более глубокой обработки. Но уже при полной спелости зерна на лущении прирост был незначительный, всего 2,1 кг/см^2, увеличиваясь до 26,2 кг/см^2, но, что касаемо вспашки, то прирост был больше – 5,1 кг/см^2, вырастая до 22,4 кг/см^2. Данные показатели связаны с тем, что почва приходит к своему естественному сложению. Структура почвы

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4.1.1. General agriculture and crop production (agricultural sciences)

FORMATION OF AGROPHYSICAL INDICATORS DEPENDING ON MINERAL FERTILIZERS AGAINST THE BACKGROUND OF MINIMIZING PRIMARY SOIL CULTIVATION

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The article is devoted to the analysis of formation of the production potential of winter wheat depending on mineral fertilizers against the background of minimization of primary soil cultivation. The subject of the research is winter wheat varieties, mineral fertilizers and leached chernozem. The research has established that by the time of emergence the soil density reached 1.24 g/cm3 with disk stubble cultivation, which will have a positive effect on the growth of the root system of wheat, and with plowing the density was lower - 1.17 g/cm3. Gradually the density increases in both variants, reaching 1.29 g/cm3 and 1.23 g/cm3 in the heading phase. By the end of the growing season in the phase of full maturity the density reached 1.30 g/cm3 for plowing and is in the optimal norm for winter and 1.34 g/cm3 for disk stubble cultivation, showing us that the optimal indicators were with deeper cultivation, and the increase in density is associated with frequent movements of agricultural machinery. Moving on to the dynamics of soil hardness, it is worth noting that at the beginning of wheat development this indicator was at the level of 11.9 kg/cm2 for the first cultivation and 2 times less - 5.7 kg/cm2 for the second cultivation. As the crop develops and reaches the earing phase, the soil hardness increases by 12.2 kg/cm2 for 10-12 cm cultivation and by 11.6 kg/cm2 for deeper cultivation. But already at full grain maturity during peeling, the increase was insignificant, only 2.1 kg/cm2, increasing to 26.2 kg/cm2, but with plowing, the increase was greater - 5.1 kg/cm2, growing to 22.4 kg/cm2. These indicators are due to the fact that the soil comes to its natural composition. The soil structure characterizes the presence of agronomically valuable aggregates in the soil profile and if their number is greater than характеризует наличие агрономически ценных агрегатов в почвенном профиле и если их количество больше, чем бесструктурных, то это положительно скажется на развитие корней растения и культуры в целом. Поэтому, с появления всходов наибольшее количество ценных агрегатов было при дисковом лущении с удобрениями в двойной дозе, составляя 64,2 %. По мере развития озимой пшеницы, количество необходимых агрегатов снизилось, но самое количество осталось уже на другом варианте – на вспашке с двойной дозой удобрений и показывало цифры в 51,9 %

structureless ones, this will have a positive effect on the development of plant roots and the crop as a whole. Therefore, from the emergence of shoots, the greatest number of valuable aggregates was with disc peeling with fertilizers in a double dose, amounting to 64.2%. As winter wheat developed, the number of necessary units decreased, but the largest number remained on the other option - on plowing with a double dose of fertilizers and showed figures of 51.9%

Ключевые слова: ОЗИМАЯ ПШЕНИЦА, ОБРАБОТКА ПОЧВЫ, ТВЕРДОСТЬ, ПЛОТНОСТЬ И СТРУКТУРА ПОЧВЫ

Keywords: WINTER WHEAT, SOIL TILLAGE, SOIL HARDNESS, DENSITY AND STRUCTURE

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Introduction

Increasing the yield of crops used in agriculture is the driving force for the development of this sector of the Russian Federation. Among all crops, a special place is given to winter wheat, which ranks first in terms of total gross yield and sowing area. However, it is impossible to increase the yield of this crop only by expanding the sowing area. In this regard, in order to create competitive products, it is worth taking into account promising varieties that are best suited to specific weather conditions and adapted, as well as improving the technologies for their cultivation [1-5].

The use of mineral fertilizers and the choice of the correct primary soil cultivation are of great importance in the formation of the yield of such a crop as winter wheat. In the modern world, this topic is becoming more and more relevant and this is due to the fact that with the increase in the cultivated area under the influence of anthropogenic and biological factors, there is a tendency to reduce humus in the soil profile and reduce its thickness. Rationally selected soil cultivation together with normalized doses of mineral fertilizers will contribute to the stabilization of humus in the soil, but with the introduction of green manure crops, perennial legumes, organic matter into the cultivation technology, there will be an increase in humus in the soil cover, it is also necessary to remember about anti-erosion measures, especially when growing winter wheat [6-11].

Material and object of research

The experiment we are laying out was carried out in 2021–22 on an experimental field located on the territory of the Kuban training farm. Leached chernozem is the main part of the soil cover on the site of which the experimental study was conducted.

The experiment studied the effect of mineral fertilizers on the productivity of winter wheat.

Experimental design.

Factor A. Basic soil cultivation technique.

1. Disc stubble cultivation (10-12 cm). 2. Plowing (20-22 cm).

Factor B. Fertilizer rate.

1. Without fertilizers (control). 2. Recommended. 3. Intensive.

After harvesting the preceding crop – sugar beet. Since this predecessor does not leave stubble residues, we immediately started one disc stubble cultivation, then ploughed and leveled the field. After winter, we carried out pre-sowing cultivation at 5-6 cm the day before sowing. Fertilizers were applied according to the experimental scheme. On October 9, sowing was carried out (5 million pcs./ha) to the depth required for sowing – 5 cm.

For comprehensive protection of wheat from harmful organisms, the following pesticides were used: Axial, KE at a dose of 0.6 l/ha, Elatus Ria, KE – 0.4 l/ha and Karate Zeon, MKS – 0.2 l/ha.

Winter wheat was harvested at the stage of full maturity.

Research results

One of the most important indicators of soil properties is its density, i.e. the density of the soil, which characterizes effective fertility. Soil density is of great importance in agriculture, but it is most significant in regulating the water regime. The state of soil looseness directly affects the water-permeability and water-absorption capacity.

Table 1 shows the change in soil density in relation to tillage techniques.

Table 1 – Dynamics of soil density in layer 0–30 cm depending on its main processing (d0, g/cm3)

Option	Soil layer, cm			
	0–10	10–20	20–30	0–30
shoots				
Disc peeling (k)	1.21	1.24	1.26	1.24
Plowing	1.15	1.16	1.22	1.17
earing				
Disc peeling (k)	1.24	1.29	1.33	1.29
Plowing	1.21	1.23	1.26	1.23
full ripeness				
Disc peeling (k)	1.32	1.34	1.35	1.34
Plowing	1.28	1.30	1.33	1.30

Analyzing the soil density table, we can note that in the 0-10 cm soil layer, with disk stubble cultivation in the germination phase, the density was 1.21 g/cm3, and with plowing, the density was lower by 0.06 g/cm3. However, already in the 10-20 cm layer, the indicators increased by 0.03 g/cm3 and by 0.01 g/cm3 with disk stubble cultivation and plowing, respectively.

Looking at the underlying layer, namely 20-30 cm, we see that the density indicator for disc peeling increased slightly and was 1.26 g/cm3, but already during plowing the same data showed themselves better compared to the previous layer and were equal to 1.22 g/cm3. Calculating the average for all studied layers, we can note that during disc peeling at 10-12 cm the density was 1.24 g/cm3, and during plowing there was a different figure - 1.17 g/cm3.

Continuing to analyze the table and reaching the earing phase, the data showed other figures. So, in the control variant, also known as disk stubble cultivation at 10-12 cm, the density was 1.24 g/cm3, and with plowing - 1.21 g/cm3 in the 0-10 cm layer. Further in the 10-20 cm layer with disk stubble cultivation there is a good dynamics of the indicators, since the data increased to 1.29 g/cm3, and with plowing in the same layer the result increased slightly to 1.23 g/cm3. The lowest layer we are considering gives the following results: in the control variant the density increased by 0.04 g/cm3, and in the treatment with a depth of 20-22 cm the same figure increased by 0.03 g/cm3, all this in relation to the previous layer, and the figures became equal to 1.33 g/cm3 and 1.29 g/cm3. Deriving the average from these data, we note that the density of the arable soil layer in the control variant and the variant where the treatment was carried out with a plow corresponds to 1.29 g/cm3 and 1.23 g/cm3, respectively.

The extreme of the studied phases is full maturity, where the density in the control variant was 1.32 g/cm3 and with plowing 1.28 g/cm3 in the first studied layer. When studying another layer – 10-20 cm – the result we needed slightly increased both with disk stubble cultivation and with plowing, where the data increased by 0.02 g/cm3 in both variants. Finishing with the data in Table 2, we can see that at a depth of 20-30 cm the density was 1.35 g/cm3 with disk stubble cultivation and 1.33 g/cm3 with plowing. Calculating the average data for all indicators in the phase of full ripeness of grain filling of winter wheat, we note that during the control the density was 1.34 g/cm3, and during plowing the same results were slightly lower and equal to 1.30 g/cm3.

Drawing a conclusion from the table of soil density dynamics in the 0-30 cm layer, the best indicators for the growth and development of winter wheat were 1.34 g/cm3 and 1.30 g/cm3. These data were for disc stubble cultivation and plowing.

For the growth and development of a plant such as winter wheat, hardness is important, since hardness is a property of the soil that characterizes the resistance of the soil to various mechanical treatments.

The dynamics of soil hardness are presented in Table 2.

Table 2 – Dynamics of soil hardness depending on the primary tillage in the 0–30 cm layer (kg/cm2)

Option	Soil layer, cm			
	0–10	10–20	20–30	0–30
shoots				
Disc peeling (k)	7.2	12.8	15.8	11.9
Plowing	3.8	5.9	7.4	5.7
earing				
Disc peeling (k)	19.3	23.8	29.2	24.1
Plowing	13.8	17.9	20.2	17.3
full ripeness				
Disc peeling (k)	20.3	25.9	32.4	26.2
Plowing	17.9	22.9	26.4	22.4

From the table of soil hardness dynamics, it can be seen that in the winter wheat germination phase, in the variant with disk stubble cultivation in the soil layer from 0 to 10 cm, the indicator is 7.2 kg/cm2, and with plowing, these same results were almost 2 times less and amounted to 3.8 kg/cm2. Already in the 10-20 cm layer, the hardness data increased by 5.6 kg/cm2 for the control and by 2.1 kg/cm2 for plowing. In the deepest layer, which we took for research, the figures were increased to 15.8 kg/cm2 and 5.7 kg/cm2 for disk stubble cultivation and plowing, respectively. If we consider the average data on soil hardness in the layer from 0 to 30 cm, then in the variant where there was disc cultivation, the indicator was 11.9 kg/cm2, and in the variant with plowing, this same indicator was 6.7 kg/cm2 lower and equaled 5.7 kg/cm2.

Considering such a phase of winter wheat vegetation as heading, we noticed that with disk stubble cultivation at 10-12 cm, the desired indicator in the uppermost layer was 19.3 kg / cm2, and in the case of plowing, these figures were 5.5 kg / cm2 less. Following further along the profile, one can notice that there is an increase in soil hardness by 4.5 kg / cm2 and by 4.1 kg / cm2 in relation to the previous layer for control and for processing more than 20 cm. But already in the 20-30 cm layer there is a difference in increase between the options, so with the 1st option this indicator increased by 5.4 kg / cm2 and became 29.2 kg / cm2, and with the 2nd option it increased by 2.3 kg / cm2 and also equaled 20.2 kg / cm2. Comparing all the data by layers and calculating the average, it is clear that the overall figures were 24.1 kg/cm2 and 17.3 kg/cm2 for disc stubble cultivation and plowing, respectively.

In the extreme phase of wheat growth, the required indicator capable of resisting mechanical impact in the 0-10 cm layer in the control variant is at the level of 20.3 kg/cm2 and in the plowing variant it was 17.9 kg/cm2. In the soil layer from 10 to 20 cm, the required results increased by 5.6 kg/cm2 and by 5 kg/cm2. But already in the next layer, a strong growth is observed with disc stubble cultivation from 25.9 kg/cm2 to 32.4 kg/cm2, but with plowing the growth is insignificant from 22.9 kg/cm2 to 26.4 kg/cm2. In this regard, the average indicators will differ: 26.2 kg/cm2 in the control variant and 22.4 kg/cm2 in the plowing variant.

Thus,For seed germination and root system growth in winter wheat, plowing is better, since if the seeds are very hard, it will be difficult for them to develop.

The soil structure is understood as the interconnected aggregates into which the soil is broken down, and they can be of different sizes. They can be either structural, having a shape and size, or structureless, connected into large aggregates and forming a continuous layer, due to which the seeds and root system cannot develop properly.

Analyzing the 3rd table of soil structure, it can be seen that in the emergence phase with disc stubble cultivation in the variant without fertilizers, agronomically valuable aggregates prevail over others and make up 62.7% as opposed to 37.3%, and the structure coefficient was 1.68.

Table 3 – Soil structure in layer 0–30 cm depending on the main treatment and the rate of mineral fertilizer

Option		Size of units, mm		Structural coefficient
soil cultivation	fertilizers	>0.25 + <10	<0.25 + >10	
shoots				
Disc peeling	B0 (k)	62.7	37.3	1.68
	B1	63.7	36.3	1.76
	B2	64.2	35.8	1.79
Plowing	B0	57.3	42.7	1.34
	B1	58.1	41.9	1.39
	B2	58.4	41.6	1.40
full ripeness				
Disc peeling	B0 (k)	49.8	50.2	0.99
	B1	50.7	49.3	1.03
	B2	51.2	48.8	1.05
Plowing	B0	50.4	49.6	1.02
	B1	51.3	48.7	1.05
	B2	51.9	48.1	1.08

B0 – without fertilizers.
B1 – recommended rate of mineral fertilizer.
B2 – intensive rate of mineral fertilizer.

In the variant with the recommended dose of fertilizers, the indicators almost did not change their figures and were equal to 63.7% and 36.3% with a coefficient of 1.76. And in the variant with an intensive dose, the indicators slightly increased by 0.5%, both options. And the coefficient increased by 0.3 units.

When plowing on an unfertilized background, the percentage of agronomically valuable aggregates decreased by 5.4%, and the percentage of aggregates larger than 10 mm and smaller than 0.25 mm, on the contrary, increased by 6.9% and the coefficient decreased by 0.34. The percentage of agronomically valuable aggregates on the background with the recommended dose slightly increased to 58.1%, and other aggregates decreased and equaled to 41.9% with a coefficient of 1.39. It is also worth mentioning the option with an intensive dose of fertilizers, that the percentage of these indicators almost did not change, but stands at the level of 58.4% and 41.6% and an increase in the coefficient by 0.1.

At the onset of the full maturity phase, the data of the indicators for disk peeling on an unfertilized background, aggregates with a size of less than 10 mm and more than 0.25 mm decreased to 49.8%, and others, on the contrary, increased to 50.2% and a decrease in the coefficient of as much as 0.99. Already in the variant with the recommended dose of mineral fertilizers, the first indicator increased to 50.7%, and the second decreased to 49.3%. But the coefficient of structure increased slightly to 1.03. The variant with an intensive dose of mineral fertilizers also increased to 51.2% of valuable aggregates and the percentage of variants with a different size decreased to 48.8% and the coefficient became 1.05.

When plowing, the indicators almost did not change their numbers, but it is worth noting that against the background where fertilizers were not applied, the necessary units increased by 0.6% in relation to the same option, but already on disk processing, but units with other sizes decreased by only 0.8% and the coefficient grew by only 0.3. Already in the option with the recommended doses, the percentage of valuable options increased to 51.3% and other units considered by us decreased to 48.7% and the coefficient increased by 0.3, becoming 1.05. The last considered option of the necessary units in this table also increased to 51.9%, and units less than necessary decreased to 48.1% and the structure coefficient has already become 1.08.

Summarizing all of the above, we conclude that for better growth and development of winter wheat plants, agronomically valuable aggregates are needed, which prevail in disc stubble cultivation, in contrast to plowing, and with an increase in the dose of mineral fertilizers, their percentage increases, but insignificantly. Therefore, based on the tabular data, it is better to use such soil treatment as disc stubble cultivation.

Conclusion

By the time of emergence, the soil density reached 1.24 g/cm3 with disc stubble cultivation, which will have a positive effect on the growth of the root system of wheat, and with plowing the density was lower - 1.17 g/cm3. Gradually, the density increases in both variants, reaching 1.29 g/cm3 and 1.23 g/cm3 in the earing phase. By the end of the growing season in the phase of full maturity, the density reached 1.30 g/cm3 for plowing and is in the optimal norm for winter and 1.34 g/cm3 for disc stubble cultivation, showing us that the optimal indicators were with deeper cultivation, and the increase in density is associated with frequent movements of agricultural machinery. Moving on to the dynamics of soil hardness, it is worth noting that at the beginning of wheat development, this indicator was at the level of 11.9 kg/cm2 for the first treatment and 2 times less - 5.7 kg/cm2 for the second treatment. As the crop develops and reaches the earing phase, the soil hardness increases by 12.2 kg/cm2 for 10-12 cm cultivation and by 11.6 kg/cm2 for deeper cultivation. But already at full grain maturity during peeling, the increase was insignificant, only

2.1 kg/cm2, increasing to 26.2 kg/cm2, but with plowing, the increase was greater - 5.1 kg/cm2, growing to 22.4 kg/cm2. These indicators are due to the fact that the soil comes to its natural composition. The soil structure characterizes the presence of agronomically valuable aggregates in the soil profile and if their number is greater than structureless ones, this will have a positive effect on the development of plant roots and the crop as a whole. Therefore, from the emergence of shoots, the greatest number of valuable aggregates was with disc peeling with fertilizers in a double dose, amounting to 64.2%. As winter wheat developed, the number of necessary units decreased, but the largest number remained on the other option - on plowing with a double dose of fertilizers and showed figures of 51.9%.

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