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# ВОЗДЕЛЫВАНИЕ ПШЕНИЦЫ В ЗАВИСИМОСТИ ОТ СПОСОБА ПОСЕВА И ВНЕСЕНИЯ АЗОТНЫХ УДОБРЕНИЙ

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Представлены преимущества и недостатки наиболее распространенных типов рабочих органов сеялок. Изучен сошник, позволяющий вносить минеральные удобрения ниже уровня посева семян зерновых культур с сохранением почвенной прослойки между ними. Двухфакторный полевой опыт проведен в четырехкратной повторности с постоянной нормой высева семян яровой мягкой пшеницы Омская 36 4,5 млн всхожих семян/га в 2021 г. Норма внесения минеральных удобрений с содержанием азота 34,4% составляла 0 (контроль), 100, 150, 200 кг/га на каждом типе исследуемых рабочих органов. Приведены результаты сравнительных исследований качества работы трех типов сошников на базе серийной сеялки СКП-2,1. В ходе полевого опыта определяли глубину заделки семян, полевую всхожесть, урожайность и качество зерна по вариантам. Лучшие показатели посева по глубине заделки семян яровой пшеницы обеспечили комбинированные и дисковые сошники. Наибольшая полевая всхожесть (72,7%) получена при посеве комбинированными сошниками с внесением аммиачной селитры в норме 150 кг/га, дисковыми сошниками при той же норме – 71,0%, с серийным лаповым сошником – 55,1%. Наибольшая урожайность (3,18 т/га) получена при посеве сеялкой СКП-2,1К с комбинированными сошниками при внесении 150 кг аммиачной селитры/га. При той же норме внесения удобрений урожайность при посеве дисковыми сошниками составила 3,16 т/га. Содержание сырой клейковины на контрольном варианте зарегистрировано 31,2%, при посеве комбинированным сошником – 34,1%, при посеве дисковым сошником с внесением аммиачной селитры в физическом весе 200 кг/га – 33,4%.

**Ключевые слова:** сеялка, сошник, способы посева зерновых, внесение удобрений, урожай зерна, качество зерна

# WHEAT CULTIVATION DEPENDING ON THE METHOD OF SEEDING AND NITROGEN FERTILIZER APPLICATION

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The advantages and disadvantages of the most common types of seed drills are presented. A coulter has been studied that makes it possible to introduce mineral fertilizers below the level of sowing cereal seeds with preservation of the soil layer between them. Two-factor field experiment was conducted in four replications with a constant seeding rate of spring soft wheat Omskaya 36 4.5 million germinated seeds/ha in 2021. The rate of mineral fertilizers with a nitrogen content of 34.4% was 0 (control), 100, 150, 200 kg / ha on each type of the studied work tools. The results of comparative studies of the quality of three types of coulters on the basis of a serial seeder SKP-2,1 are presented. During the field experiment, the depth of seed embedding, field germination, yield and grain quality were determined according to the variants. The best seeding depth of spring wheat seeds was provided by combined and disc coulters. The highest field germination (72.7%) was obtained when seeding with combined coulters with the introduction of ammonium nitrate at a rate of 150 kg / ha, disc coulters at the same rate - 71.0%, with a standard tine coulter - 55.1%. The highest yield (3.18 t/ha) was obtained when seeding with SKP-2,1K drill with combined coulters at the application of 150 kg/ha of ammonium nitrate. At the same rate of fertilizer application, the yield when seeding with disc coulters was 3.16 t/ha. The content of crude gluten in the control variant was 31.2%, when seeding with a combined coulter - 34.1%, when seeding with a disc coulter with the introduction of ammonium nitrate in the physical weight of 200 kg/ha - 33.4%.

**Keywords:** seeder, coulter, grain seeding methods, fertilization, grain yield, grain quality

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## INTRODUCTION

The main reason for the low efficiency of crop cultivation in the Western Siberia is the inconsistency of technological and biological cycles in different climatic zones. For efficient grain production it is recommended to actively develop adaptive-landscape farming system with a set of agro-technologies of different levels of intensification based on accurate (digital) management of natural resource potential [1].

On the basis of agrolandscape zoning, rational structure of the use of sown areas, and intensification of production, grain production growth is ensured [2, 3].

Machine technologies determine the level of plant productivity, product quality and ultimately form the social and environmental aspects of agricultural production. Technical means in conjunction with their supporting systems constitute the material and technical base of technology, the adaptation of which to the natural and climatic conditions and resource capabilities of the agricultural producer determines the level of intensity. In this case, the necessary condition is the stability of the agrolandscape and the reproduction of soil fertility [4].

In crop production 76% of agricultural organizations and 78% of private farms produce according to extensive technologies, which practically do not use the achievements of science, advanced domestic and foreign experience, do not involve means of intensification (mineral fertilizers, etc.), use old-generation machines. The size of the harvest depends mainly on the prevailing weather conditions and the natural fertility of soils.

Under intensive farming the system of fertilizers provides for the application of 60-85 kg of active agent of mineral fertilizers per one hectare of crop rotation area, including nitrogen 30 kg, phosphorus 30-45 kg, potassium 10 kg. Based on soil diagnosis, phosphorus and potassium fertilizers can be applied in reserve for crop rotation or annually for individual crops. Nitrogen fertilizers should be applied locally before sowing [5, 6].

In most of the existing designs of coulter groups, seeding of seeds and fertilizer application is carried out jointly in one row (in one horizon of depth). In this case there is a change in the direction of growth (chemotropism) of the root system under the influence of chemicals (fertilizers). The disadvantage of this method is the low efficiency of using starter fertilizers, especially if the moisture content of the seed layer of soil is low. Therefore, it is preferable to have a layer of soil between the seeds and fertilizers for active development of the root system of the plant and use the full potential of the applied mineral fertilizers. Also, when applying fertilizers to a certain depth, it is possible to regulate the location of the root system of plants in the space of the arable layer [7-9].

There are several types of coulter groups: disc, tine, tyne. In turn, each of the coulter types can work in combination with various additional working tools, based on the selected seeding technology [10-12].

The operation of disc coulters is only possible on soil that has been prepared in advance by pre-cultivation. For work on chemical fallows, where there is a large amount of crop residues on the surface of the field, it is recommended to use discs with different diameters or single disc coulters. The double disc coulter works without the additionally installed slotted disc at the front, not by cutting but by pressing the straw mass into the soil. The seeds are not fully incorporated into the soil, the crushing among the straw mass reduces their field germination. The use of disc coulters is not desirable in case of high soil moisture. The disadvantages of disc coulters include the inability to incorporate seeds over 4 cm in hard parched soils.

The most universal are tine coulters that perform several technological operations in one pass: cultivation, loosening, sowing and fertilizer application. If the seeding layer is dry, tine coulters can sow at a greater depth (4-8 cm), which allows to obtain seedlings even in the most unfavorable conditions.

The tyne coulters are able to penetrate even the densest soils and sow to almost any depth. They have less impact on the soil compared to the duckfoot tine, leaving narrow sowing strips. The soil is loosened less, more stubble and straw remain on its surface, and less moisture evaporates [13, 14].

Germination and plant development depend to a large extent on the method of sowing and fertilizing. Joint seeding is undesirable because contact of mineral fertilizers with the seeds affects the germination of the seeds. Therefore, the creation of working tools for a chisel planter with separate application of seeds and mineral fertilizers is an important task. In order to improve the efficiency of fertilizers and crop yields, we developed a combined coulter for separate application of seeds and fertilizers [15].

The purpose of the research is to carry out a comparative study of cultivation methods of spring soft wheat planters SKP-2,1K equipped with coulters for multilevel sowing and SDS-2,1 with disc coulters in comparison with the serial SKP-2,1 (control). Also, the aim of the research is to determine the effect of the seeding method, placement of fertilizers relative to the seeds and the rate of application of starting doses of nitrogen fertilizers on the yield and quality of grain.

Research objectives:

– to develop a scheme of field comparative experiment for the performance of sowing cereals by intensive technology;

– conduct laboratory and field comparative studies of chisel planter operation with combined coulters, disc coulters and serial coulters to assess the quality and yield of grain.

## MATERIAL AND METHODS

Setting of field experiment was carried out 20.05.2021 by MTZ-82 tractor in the unit with a basic chisel planter SKP-2, 1. In the course of research three kinds of coulters mounted on the frame of the basic planter SKP-2,1 were compared: combined coulters for multilevel sowing (SKP-2,1K) designed by the Omsk Agricultural Research Center, disc coulters (SDS-2.1), serially produced tine coulters (SKP-2,1 - control). At different methods and variants of fertilizer application (ammonium nitrate) the rate was 100, 150 and 200 kg/ha. Spring wheat was the forecrop at sowing. The main soil treatment in autumn was not carried out. Ammonium nitrate was used as a mineral fertilizer, which was introduced simultaneously with sowing. In the course of the field experiment the depth of seed embedding, field germination, yield and quality of grain by variants were determined. Experiments were laid according to the generally accepted method of B.A. Dospekhov.

Methodology and conditions of the field agro-technical experience are based on STO AIST (Standards of the Association of Agricultural Machinery and Technology Testers) 10 5.6-2003 Sowing machines. Program and test methods, GOST 31345-2007 Tractor seeders. Test methods.

## RESULTS AND DISCUSSION

All sowing passes were performed at the same seeding rate of spring wheat Omskaya 36 (4.5 million germinated seeds/ha). The entire amount of work was carried out during one work shift. The scheme shows variants of one repetition of the experiment (see Fig. 1). The experiment was two-factor, the repetition was four times. The forecrop was spring wheat. No main tillage was done in autumn. Fertilizer was applied simultaneously with sowing, the percentage of nutrients in the fertilizer was 34.4%. Sowing was carried out with spring wheat Omskaya 36. Qualitative indicators of seeds: weight of 1000 grains - 33 g, field germination - 92%, moisture - 14%. Seeding rate for all replications - 4.5 million germinated grains/ha. Seeding depth - 6 cm.

The total number of accounting plots was 48, the size of the experimental plot was 0.25 ha. In the course of the field experiment the following indicators were determined: field germination, uniformity of the sowing depth and yield by variants. Herbicide treatment of the crops was carried out on June 20. Plots were harvested on 06.09.2021 by Wintersteiger plot harvester.

The seedlings obtained in the plots with each type of coulter group are shown in Fig. 2.

Uniform seed placement at a given depth is the most important indicator for both the evaluation of sowing and the work of the coulter group. The sowing depth can vary widely depending on the moisture of the sowing layer and the weather conditions at the time of sowing. If the spring is wet, it is recommended to sow to a depth of 4-5 cm. In hot, dry and windy weather during the sowing season, the sowing depth can be as deep as 6-8 cm. It is not recommended to sow cereal crops to a depth of less than 4 cm, as the soil dries out quickly and the seed does not have time to give seedlings.

Table 1 shows the calculated figures for the depth of seeding (by the ethylated part of the plants) of each of the studied coulter groups.

Comparative field tests showed that the coefficient of variation of the seed drill SKP-2,1 with standard tine coulters was 20%, seed drills SKP-2,1K and SDS-2,1, equipped with a combination and disc coulters, respectively, - 13%, indicating a better stability of the stroke of these coulters on the depth of seeding.

Field germination of plants for each type of coulter groups was determined after the emergence of complete shoots in the plots with an area of 1 m$^2$. Fig. 3 shows a graph of the dependence of field germination on the type of coulter used and the rate of nitrogen fertilizer application.

The results show that field germination on the control when sowing without fertilizer on

| The width of the plot is 92,4 m | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Section length 50 m | Headland | Registration plots | | | | | | | | | | | Headland |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| | | Seeder SDS-2,1 without fertilisers | 200 kg/ha | 150 kg/ha | 100 kg/ha | Seeder SKP-2,1K without fertilisers | 200 kg/ha | 150 kg/ha | 100 kg/ha | Seeder SKP-2,1 (control) without fertilisers | 200 kg/ha | 150 kg/ha | 100 kg/ha | |

***Рис. 1.*** Схема закладки одной повторности опыта

***Fig. 1.*** The scheme of setting up one repetition of the experiment

*а*

*б*

*в*

***Рис. 2.*** Общий вид исследуемых сошниковых групп с результатами всходов:
*а* – двухдисковые сошники сеялки СДС-2,1; *б* – сошники для разноуровневого посева и внесения минеральных удобрений сеялки СКП-2,1К; *в* – серийные лаповые сошники сеялки СКП-2,1 – контроль

***Fig. 2.*** General view of the investigated coulter groups with the results of shoots:
*а* – double-disc coulters of the SDS-2.1 seeder; *б* – openers for multilevel seeding and application of mineral fertilizers of the SKP-2.1K seeder; *в* – serial tine coulters of the SKP-2.1 seeder – control

**Табл. 1.** Расчетные показатели сеялок по глубине заделки семян
**Table 1.** Estimated indicators of seeders by seed placement depth

| Indicator | SKP-2,1 | SKP-2,1K | SDS-2,1 |
|---|---|---|---|
| Average embedment depth, cm | 5,58 | 5,89 | 5,60 |
| Standard deviation, cm | 1,13 | 0,92 | 0,91 |
| Coefficient of variation, % | 20 | 13 | 13 |

serial tine coulters was 52.7%, combined coulters - 63.6%, disc coulters - 61.5%. The highest field germination (72.7%) was obtained when ammonium nitrate was added at a rate of 150 kg/ha in the variant with combined coulters. On disc coulters at the same rate - 71.0%.

Fig. 4 shows a general view of the experimental plot before harvesting and the process of harvesting of the registration plots with a Wintersteiger plot harvester.

Prior to harvesting, sheaves were harvested from each registration plot for subsequent structural analysis. Table 2 shows the values of the resulting grain yield of spring wheat during harvesting with a Wintersteiger plot combine as well as according to the results of threshing of the harvested sheaves in the laboratory on the plot threshing machine.

Fig. 5 shows a graph of the dependence of grain yield of spring wheat Omskaya 36 on the type of coulter and the rate of nitrogen fertilizer application after threshing of the registration plots by Wintersteiger plot harvester.

Analysis of the yield results shows that the increase in grain depends on the method of fertilizer application and their norm. The highest yield (3.18 t/ha) was obtained when seeding with a seeder SKP-2,1K with combined coulters at the application of 150 kg of ammonium nitrate /ha. When seeding with a disc coulter at the same rate the yield was 3.16 t/ha. Compared to the control at the same rate these values are higher by 3%.

After harvesting, the grain material from each of the variants was collected for grain quality evaluation in the grain quality laboratory of the Omsk Agricultural Research Center. Table 2 shows qualitative indices of soft spring wheat grain - gluten.

The content of crude gluten when sowing with SKP-2,1 (control) was 31,2%, when sowing with SKP-2,1K planter equipped with com-

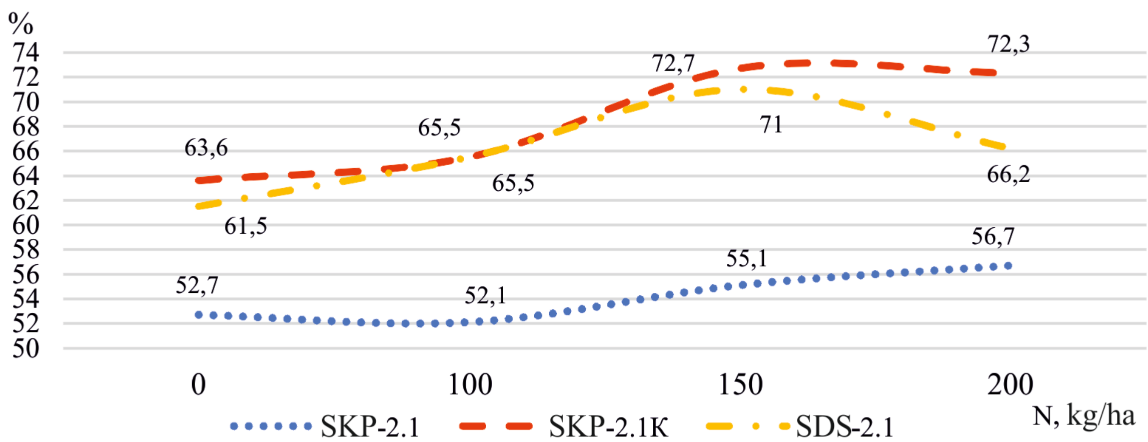


***Рис. 3.*** Полевая всхожесть семян яровой пшеницы в зависимости от типа сошника и нормы внесения удобрений, %

***Fig. 3.*** Field germination of spring wheat seeds depending on the coulter type and the fertilizer application rate, %

***Рис. 4.*** Общий вид опытного участка и процесс уборки учетных делянок

***Fig. 4.*** General view of the experimental plot and the process of harvesting of the registration plots

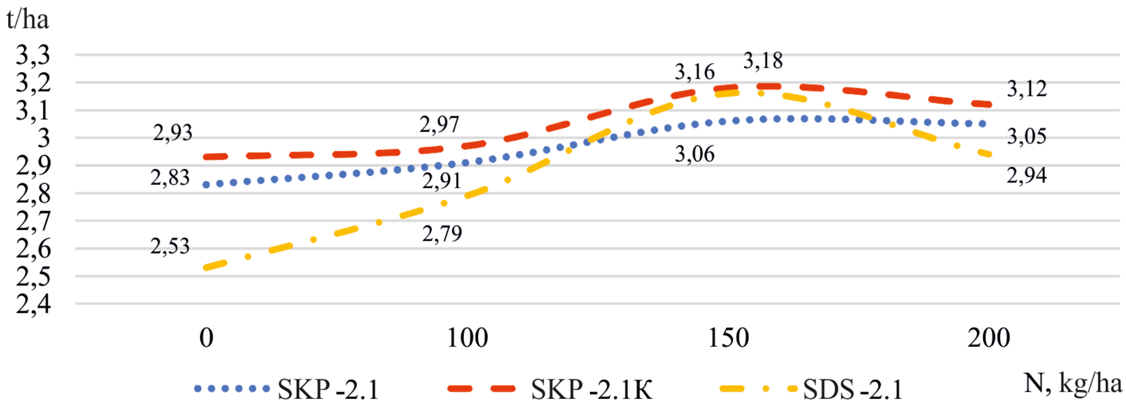


***Рис. 5.*** Урожайность зерна при уборке комбайном в зависимости от типа сошника и нормы внесения удобрений, т/га

***Fig. 5.*** Grain yield depending on the coulter type and the fertilizer application rate, t/ha

**Табл. 2.** Количество клейковины по каждому из вариантов, %

**Table. 2.** The amount of gluten for each of the options, %

| Option | The amount of gluten |
|---|---|
| SKP-2,1 (control) | 31,2 |
| SKP -2,1 + 100 kg/ha of fertilizer | 30,1 |
| SKP -2,1 + 150 kg/ha of fertilizer | 34,6 |
| SKP -2,1 + 200 kg/ha of fertilizer | 37,0 |
| SKP -2,1K | 31,2 |
| SKP -2,1K + 100 kg/ha of fertilizer | 31,0 |
| SKP -2,1K + 150 kg/ha of fertilizer | 36,1 |
| SKP -2,1K + 200 kg/ha of fertilizer | 38,0 |
| SDS -2.1 | 32,0 |
| SDS -2.1 + 100 kg/ha of fertilizer | 30,0 |
| SDS -2.1 + 150 kg/ha of fertilizer | 35,1 |
| SDS -2.1 + 200 kg/ha of fertilizer | 36,5 |

bined coulters for multilevel sowing and application of nitrogen fertilizers - 34,1%, when sowing with double disc coulters - 33,4% (see Table 2). The maximum values of the content of crude gluten were received for all the variants of sowing with the application of ammonium nitrate in the physical weight of 200 kg/ha and were 37,0% (control), 38,0 (shallow tillage) and 36,5% (seeding with disc working tools) accordingly depending on the type of coulter and method of application.

## CONCLUSION

Comparative tests of different types of coulters on the basis of a serial seeder SKP-2,1 according to the developed scheme of the experiment showed that the best performance for the depth of seeding spring wheat seeds provide combined and disc working tools.

The highest field germination (72.7%) was obtained when sowing with combined coulters at the rate of 150 kg ammonium nitrate/ha, when sowing with disc coulters at the same rate - 71.0%, standard tine coulter - 55.1%. The highest yield (3.18 t/ha) was obtained when seeding with a seeder SKP-2,1K with combined coulters at 150 kg ammonium nitrate/ha. At the same rate of fertilizer application the yield at seeding with disc coulters was 3.16 t/ha. The maximum content of raw gluten was obtained for all variants of sowing (control, combined, disc coulters) at the application of ammonium nitrate in physical weight 200 kg/ha and was 37,0; 38,0; 36,5% depending on the type of coulter and method of application.

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