Comparative evaluation of seeding spring wheat methods when using different types of coulters

A M Zaitsev¹, V I Solodun¹,² and M S Gorbunova¹

¹ Irkutsk State Agrarian University named after Ezhvevskiy, Molodezhny Settlement, Irkutsk district, Irkutsk region, 664038, Russian Federation
² Irkutsk Research Institute of Agriculture, 14, Dachnaya St., Pivovarikha, Irkutsk district, Irkutsk region, 664511, Russia

E-mail: zaycev38@mail.ru, gnu_iniish_@mail.ru, mari221158g@mail.ru

Abstract. The studies were carried out with the aim of identifying the most effective method for sowing spring wheat for the Pre-Baikal region through a comparative study of sowing machines of domestic and foreign production with different types of openers according to the backgrounds of dump, non-dump and zero tillage. The research was carried out on the basis of advanced farms in the Irkutsk region, widely using modern sowing units in 2016-2018 on typical gray forest loamy soils. In experiments, in comparison with the SZ-3.6 seeder, the Case IH Concord 2000, John Deere 1830, Morris Concept 2000, Tom-10 sowing complexes were studied, providing strip-spread, tape, single-line sowing with paw, anchor and disk coulters. As a result, it was found that the application of the band-spread method of sowing with the Concord 2000, John Deere 1830, Morris Concept 2000 sowing complexes increases the field germination of spring wheat seeds by 10-20%, plant standing density by 34-42%, and yield by 0.38-0.47 t/ha. An increase in the depth of seed placement to 5-6 cm led to an increase in the yield of wheat by 0.16 t/ha when sowing SZ-3.6; 0.26 t/ha when sowing John Deere 1830; 0.23 t/ha when sowing Concord 2000. In the Pre-Baikal agricultural sector, to increase the yield of grain crops, it is advisable instead of the ordinary method of sowing with the SZ-3.6 seeders to apply the tape and strip-spread methods of sowing with the paw and anchor coulters both for dump and for subsurface processing and for direct sowing. The most promising sowing machines are the sowing complexes Concord 2000, John Deere 1830, Morris Concept 2000 and their domestic counterparts Kuzbass-8.5.

1. Introduction

The solution to the problem of optimizing the nutritional area of grain crops for the conditions of Siberia is extremely important. This is due to the fact that with the recommended seeding rates used in the regions, with traditional ordinary sowing, it is not possible to achieve the optimum plant density of standing plants. So, in the Irkutsk region, the highest sowing rate of spring wheat, oats, and barley in the country and Siberia is 6-8 million germinating grains per hectare. In neighboring Buryatia - 4.5-6 million, in the Krasnoyarsk Territory - 4-6 million [1-3]. At the same time, the sowing machine fleet is standard for all regions and is represented by the SZ-3.6 (SZP-3.6) basic seeder with double-disc coulters and single-row sowing with 15 cm row spacing. With a spring wheat sowing rate of 7 million pcs. / ha, which is recommended for the conditions of the Prebaikalia, the distance between the seeds when sowing these seeders is reduced to 0.5-0.6 cm at a critical of 1 to 1.4 cm [4-5].
Due to this thickened distribution of seeds, plants find themselves in fierce competition from the earliest stages of development. This reduces the field germination of seeds, survival and productivity.

For normal tillering, the optimal distance between plants should be 3-4 cm [6, 7].

Reducing the distance between the grains leads to a thickening of crops in rows. As a result, field germination in some years is reduced to 60%, and with low productive bushiness of 1.1-1.2 pcs/m² by the time of harvesting per square meter, there are from 250 to 450 pieces of productive stems for a given 700 pcs/m² [8-10].

In recent years, in the region, new sowing units of domestic and foreign production with paw and anchor coulters, which carry out spread-spread, tape, tape-strip and other methods of sowing, have become widely used in the region. At the same time, sowing complexes are used not only for direct sowing on stubble, but also for heap and various subsurface treatments at different depths. In contrast to disk seeders of the SZ-3.6 type, which make it difficult to maneuver the sowing depth for non-sowing cultivation, and on heavy soils they cannot close seeds deeper than 4 cm, sowing complexes have advantages in achieving the specified parameters of the sowing depth and creating a more acceptable feeding area plants.

2. Research purpose, conditions, materials and methods

The purpose of the research was to conduct a comparative study of sowing machines with different types of openers and to identify the most effective ones that provide optimal seed placement according to feeding area and depth.

To achieve it, the following tasks were solved: establishing the effect of different types of openers on the distribution of seeds by feeding area and depth; determining the effect of sowing methods and seed placement depth on field germination, the number of productive stems and the yield of spring wheat; identification of the most efficient machines that provide optimal methods for sowing spring wheat on heap, non-heap and zero treatment backgrounds.

The studies were carried out on typical gray forest, heavy loamy soils in basic farms well equipped with modern sowing equipment in 2016-2018. In the agricultural public joint-stock company (SC PJSC) Belorechenskoye, three stationary seeders were studied in a stationary field experiment: SZ-3.6 (disc coulter); sowing complex (PC) John Deere 1830 (anchor opener); PC Concord 2000, (paw opener). Sowing was carried out at two depths of 4-5 and 5-6 cm. The sowing complexes were sown on the stubble, and before sowing the SZ-3.6 seeder, to create comparable conditions, pre-sowing cultivation was carried out by the KPE-3.8 cultivator to a depth of 6-8 cm.

Repeatability triple experience, the predecessor is a pea-oat mixture for grain fodder, a variety of spring wheat Iren. In the agricultural production cooperative (SPK) “Okinsky”, three seeders were studied: SZ-3.6 (disk coulter); PC Morris Concept 2000 (paw opener); PC Tom 3-10 (disk opener). The study was carried out according to the following treatment backgrounds: background A - plowing in autumn with a plow PLN-8-35 to a depth of 20-22 cm, cultivation of KPI-3.8 by 6-8 cm in spring before sowing SZ-3.6; background B - autumn disking of BDM-4 by 8-10 cm, cultivation of KPI-3.8 by 6-8 cm in spring before sowing of SZ-3.6; background B - stubble background - direct sowing by sowing complexes and preliminary cultivation of 6-8 cm KPE-3.8 before sowing SZ-3.6. After sowing with the SZ-3.6 seeder, the field was rolled in with rollers KZK-6-01.

The repetition is threefold, the precursor is wheat, the variety is Iren. The accounting area of the plots is 250 m². In the experiments, ammonium nitrate was introduced at a dose of N₄₅ kg ai. per ha at the same time as sowing. Observations, counts and analyzes, statistical processing were carried out according to generally accepted methods. Weather conditions were characterized by a lack of precipitation in May and June in all years of research, and in July - September more precipitation fell only in 2016 (table 1).
Table 1. The amount of precipitation by months of the growing season (Meteopost of Irkutsk Research Institute of Agriculture)

| Year  | May | June | July | August | Sept | Amount for May-June | Amount for July-Sept | Amount for May-Sept |
|-------|-----|------|------|--------|------|---------------------|---------------------|---------------------|
| 2016  | 28  | 37   | 86   | 177    | 99   | 65                  | 362                 | 427                 |
| 2017  | 67  | 13   | 105  | 55     | 37   | 80                  | 197                 | 277                 |
| 2018  | 16  | 27   | 77   | 100    | 56   | 43                  | 233                 | 276                 |
| Long-term average | 30 | 62 | 110 | 95 | 47 | 92 | 252 | 344 |

3. Results and discussion
Studies have shown that the set (set with the adjustments) seed placement depth for all units differed from the actual one by 1-2 cm both in the direction of increase and decrease (table 2). This may be due to the microrelief, the speed of the units, the method and quality of previous treatments. Using the SZ-3.6 seeder with double-disc coulters and 15-spacing rows for all indicators obtained was the least effective.

Table 2. The influence of methods for sowing spring wheat with different sowing units on seed placement, field germination, productive bushiness and yield (average for 2016-2018).

| Seeder brand (factor A) | Sowing method and type of coulter | Seed placement depth, cm (factor B) | Average A |
|------------------------|----------------------------------|-------------------------------------|-----------|
|                        |                                  | 4-5                                 | 5-6       |
|                        |                                  | 4-5                                 | 5-6       |
|                        |                                  | 4-5                                 | 5-6       |
|                        |                                  | 4-5                                 | 5-6       |
| SZ-3,6 control         | row, two-disk                    | 2-6                                 | 3-7       |
|                        |                                  | 47                                 | 53        |
|                        |                                  | 377                                | 395       |
|                        |                                  | 1.68                               | 1.84      |
|                        |                                  | 1.76                                | HCP by factor A 0.15 |
| John Deere 1830        | tape, anchor                     | 3-5                                 | 4-7       |
|                        |                                  | 63                                 | 67        |
|                        |                                  | 411                                | 438       |
|                        |                                  | 2.06                               | 2.32      |
|                        |                                  | 2.19                                |          |
| Concord 2000           | band-scatter, paw                | 3-6                                 | 4-7       |
|                        |                                  | 65                                 | 68        |
|                        |                                  | 429                                | 437       |
|                        |                                  | 2.08                               | 2.31      |
|                        |                                  | 2.20                                |          |

Field germination on average over three years averaged 47-53% - half of the sown norm, and yield 1.68-1.84 t/ha. The years were characterized by a lack of moisture during the sowing season and in the initial period of vegetation, which led to the drying of the seed layer, and, of course, influenced the starting indicators of germination and further development of plants, especially at a seed placement depth of 4-5 cm. The spread sowing of John Deere 1830 and Concord 2000 compared to SZ-3.6 contributed to an increase in field germination by 10-20%, plant stand density by 34-42 productive stems, and yields by 0.37-0.47 t/ha, and especially with a deeper seeding of 5-6 cm. At the same time, tape and strip-spread cultivation at the same seed placement depth, with a clear advantage over single-line ordinary, did not have significant differences. An increase in the depth of seed placement to 5-6 cm led to an increase in the yield of wheat by 0.16 t/ha when sowing with SZ-3.6; 0.26 t/ha for
sowing with John Deere 1830; by 0.23 t/ha when sowing with Concord 2000. The yield increase was obtained by increasing field germination and the number of productive stems for harvesting.

As a result of a comparative study of different sowing machines in the SEC “Okinskiy” when sowing spring wheat after wheat, it was found (table 3) that differences in yield depend on factor 38 (seeder grade), by 28% on the interaction of AB factors and on 25% of the treatment received - factor B.

**Table 3.** The yield of spring wheat, depending on the method of tillage and the seeder brand (average for 2016-2018).

| Seeder brand (factor A) | Processing method (factor B) | Average A |
|------------------------|-------------------------------|-----------|
|                        | plowing in the fall to a depth of 20-22 cm (control) | without processing |
|                        | autumn processing with a BDM-4 discator to a depth of 8-10 cm |   |
| SZ-3.6 control         | 3.20                          | 2.76      | 2.92 |
| Morris Concept 2000    | 3.15                          | 3.24      | 3.20 |
| Tom’-10                | 3.21                          | 2.96      | 3.05 |
| Average B              | 3.07                          | 2.98      | 3.09 |

HCP05 by factor A 0.10

HCP05 by factor B 0.09

For autumn plowing by 20-22 cm, differences in the use of different brands of sowing machines over the years of research have not been established. Wheat yield when sowing SZ-3.6; PC Morris Concept 2000 and PC Tom’-10 averaged over three years amounted to 3.20; 3.15 and 3.21 t/ha, respectively.

When sowing according to preliminary spring and autumn surface treatments, the SZ-3.6 double disc seeder did not provide a uniform seed placement depth due to microrelief, soil clumps and stubble residues, and the bulk of the seeds on heavy loamy soils was distributed in a periodically drying soil layer at a depth of 2-3 cm, which led to a decrease in field germination and the number of plants for harvesting. Morris Concept 2000 PCs with paw coulters and Tom’-10 PCs with double disc coulters for surface treatment and direct sowing work more steadily in terms of evenness of seed placement in depth, and packer rollers create high-quality contact of seeds with soil, provide compaction and good moisture rise to the seeds. The yield of wheat during sowing of Morris Concept 2000 and Tom’-10 was found to be significantly higher than when sowing SZ-3.6 both in autumn with a tillage of 8-10 cm by 0.41 and 0.18 t/ha, respectively, and with direct sowing, respectively, at 0.48 and 0.20 t/ha.

4. Conclusion

In the farming of the Prebaikal region with direct sowing of wheat, as well as with preliminary autumn cultivation with a tillage of 8-10 cm and an autumnal plowing of 20-22 cm to provide the specified parameters for the depth of seed placement, placing them over the area on the sowing bed, as well as for good contact with moist soil, it is effective to use the Concord 2000 and Morris Concept 2000 sowing units with paw openers, John Deere 1830 with anchor openers and Tom’-10 with double disc openers with a sowing depth of 5-6 cm.

The use of the SZ-3.6 seeder with double disc coulters for sowing is effective for autumn plowing by 20-22 cm with preliminary cultivation of KPI-3.8 by 6-8 cm, sowing to a depth of 5-6 cm and post-sowing rolling.

Sowing with SZ-3.6 by surface autumn and spring treatments leads to a significant decrease in wheat yield compared to sowing sowing complexes, which is associated with the failure of parameters for the depth of seed placement and, as a result, a decrease in field germination and number of plants at the time of harvesting.
References

[1] Batudaev A P and Tsydypov B S 2019 Agrotechnical methods and their impact on the yield and quality of grain of spring wheat Bulletin of the Buryat State Agricultural Academy named after V R Filippov 1(54) 6-13

[2] Ivchenko V K and Mikhailova Z I 2017 Influence of various tillages and intensification means on the productivity of grain crops Bulletin of the Krasnoyarsk State Agrarian University 4(127) 3-10

[3] Solodun V I 2015 Evaluation of methods for sowing grain crops using different types of openers Bulletin of the Krasnoyarsk Autonomous Okrug 4 37-40

[4] Demchuk E V, Golovanov D A and Yankovsky K A 2016 On the issues of improving the technology of sowing grain crops Tractors and agricultural machinery 6 45-8

[5] Matyushkov M I and Peshkov V N 1986 Modernized openers for grain seeders Agriculture 4 13-4

[6] Petrovets V R, Kurzenkov S V, Dudko N I and Grekov D V 2018 The results of the small-plot experiment on the preferred placement of grain seeds during sowing Bulletin of the Belarusian State Agricultural Academy 1 169-72

[7] Gabdrakhimov O B and Sultanov F S 2017 Cultivation of spring wheat in the Irkutsk region Bulletin of the Irkutsk State Agricultural Academy 81(2) 192-8

[8] Alferova P A 2013 Seed grain of East Transbaikalia (Chita)

[9] Safonov A F, Gataulín A M, Platonov I G et al. 2006 Agriculture systems ed A F Safonov (Moscow: KolosS)

[10] Khusnidinov Sh K and Dolgopolov A A 2000 Crop production of Prebaikalia (Irkutsk: IrSAA)