The coulter effect on the spring wheat yield at different row spacing and seeding rate

D N Radnaev*, A S Pekhutov, A A Abiduev, S V Petunov and D-C B Badmatsyrenov

FSBEI HE Buryat State Agricultural Academy named after V.R. Filippov, city of Ulan-Ude, Russia,

*E-mail:daba01@mail.ru

Abstract. Sowing is one of the key operations in the technology of cultivation of grain crops. Analysis of existing studies show that the most important reserve for sustainable grain production is the introduction of new methods of sowing, sowing machines and their working bodies. In modern conditions, resource-saving sowing technologies are widely used. In resource-saving technology, high-quality sowing characterizes the uniformity of seed distribution over the feeding area and the seeding depth, considering the soil and climatic conditions of Buryatia. In studies on the agronomic justification of sowing methods, the influence of row spacing, distribution uniformity and uneven sowing of seeds on the yield of spring wheat of the local variety "Buryatskaya-79" was studied. At the same time, comparative tests of serial and improved coulters of seeders of the SZ type were carried out. It was revealed that in the dry steppe, with a seeding rate of 4-5 million grains/ha, a row spacing of 7.5-15 cm is allowed, with 3 million grains/ha - 45 cm; with a row spacing width of 45 cm, there is an increase in separate harvesting losses; uniform seed placement during strip sowing has significant advantages compared to the usual row seeding method with the existing seeding rate.

1. Introduction

The cultivation of grain crops in the conditions of the use of promising resource-saving technologies, the development and introduction of new tillage, sowing machines and their working bodies leads to an increase in the efficiency of grain production [2, 7, 9, 11]. Today, the most popular are sowing machines and complexes that perform pre-sowing cultivation, sowing, fertilizing, rolling in compliance with agrotechnical requirements in one pass [1, 3, 4, 10].

In Buryatia, where grain crops are mainly cultivated, the soils are chestnut and light loamy chernozems. They are characterized by low humus and lightness of mechanical composition, as well as cold spring with the absence of soil moisture at the depth of sowing. This explains the low field germination of cereals and to obtain seedlings, they are forced to increase the seeding rate and the seeding depth to 6...8 cm, that is, to a wet layer [8].

In this regard, the work on substantiating agrotechnical requirements for sowing methods is relevant and important for the agriculture of the region.
2. Materials and methods

In the studies conducted on the fields of the Academy's training ground on the agronomic justification of sowing methods, the influence of row spacing, uniformity of distribution and unevenness of seed sowing on the yield of spring wheat was studied.

The research was carried out when sowing on spring wheat of the local variety "Buryatskaya-79". The plot area was 22.5 m², the accounting area was 10.0 m². The row spacing - 7.5; 15.0; 45.0 cm with a seeding rate of 3, 4 and 5 million grains/ha.

The value of the uniformity of seed distribution over the area was studied in two experiments. Row sowing was carried out with a serial narrow-row disc coulter with a row spacing of 7.5 cm, an experimental narrow-row disc coulter with a seeding strip of 6.5 cm in disk space, a row serial disc coulter with a row spacing of 15.0 cm and an experimental shovel coulter for subsurface sowing with a band width of 18 cm with a row spacing of 45.0 cm. In the first experiment, row sowing with row spacing of 7.5 and 15 cm was compared at the three specified seeding rates. In the second experiment, two variants of strip seeding were studied. The strip width is 6.5 and 18.0 cm, the space between strips is 7.5 and 45.0 cm, respectively, at the same seeding rates.

One of the most common methods of sowing is the narrow-row method, which has the disadvantage of excessive accumulation of seeds in rows, that is, the feeding area in the form of an elongated rectangle instead of a square or circle (Figure 1).

![Figure 1. Serial coulter of the seeder SZU-3,6: 1- left and right disks; 2- device for separating the flow of seeds from the seed tube.](image)

This disadvantage is eliminated by upgrading the serial coulter of the seeder SZU-3,6 (Figure 2). In the space between the disks, a pusher 3 is installed to form a seedbed, moving the soil to the disks at the seeding depth [6]. Instead of a device for separating the flow of seeds from the seed tube, a device 4 for dispersing seeds coming from the seed tube in the form of a strip 6-6.5 cm wide is mounted (Figure 2).
Figure 2. The scheme of the improved coulter of the seeder SZU-3,6.

Evaluation of the possibility of using combined machines and aggregates in the cultivation of grain crops is associated with the soil and climatic characteristics of the region, where there is a high probability of wind erosion and lack of soil moisture during the plant growing season.

By the staff of the Department of "Mechanization of Agricultural Processes" of the FSBEI HE Buryat State Agricultural Academy named after V.R. Filippov, an experimental sowing machine based on the SZP-3,6A-02B seeder was developed and manufactured [5] (Figure 3).

Figure 3. The scheme of experimental sowing machine on the base of the seeder SZP-3,6 A-02B: 1 – frame, 2 – self-castering wheel, 3 – seed tube, 4 – sowing machine, 5 – bunker, 6 – articulated rod, 7 – supporting press rollers, 8 – roller, 9 – cultivator shovel-coulter, 10 – pressure spring, 11 – parallel link mechanism.
Technical characteristics: Width – 3.6 m; row spacing – 45 cm; shovel-coulter width – 27 cm; seeding strip – 18±2 cm; number of shovel-coulters – 8; press rollers – 8; sowing machines – 16 (8+8); seeding depth - 6±1 cm.

The main seeder node is an experimental working organ - a shovel-coulter (Figure 4).

Figure 4. The scheme of the experimental working body: 1 - seed dispersing device; 2 - shovel-coulter; 3 -parallel link suspension mechanism of the coulter; 4 - press roller.

3. Results and discussion
The uneven distribution of seeds is 3, 6, 9, 12 and 15% with a seeding rate of 3 and 4 million grains/ha. Deviations alternated in even and odd rows (with an unevenness of 3%, 97% of seeds of a given thickening were sown in an even row for 1 year, and in an odd row – 103%).

The distribution uniformity increases with an increase in the seeding rate and row spacing of 7.5, 15.0 and 45 cm (Table 1).

Table 1. Yield of spring wheat depending on the width of row spacing and seeding rates, c/ha.

| Width of spacing, cm | Seeding rate, million grains/ha |
|---------------------|---------------------------------|
|                     | 3                              | 4        | 5        |
| 7.5                 | 16.4                            | 18.3     | 18.4     |
| 15.0                | 16.3                            | 18.1     | 18.4     |
| 45.0                | 16.4                            | 16.9     | 17.5     |

A significant decrease in yield was noted only in the wet and cold year. There was a benefit of increasing the seeding rate to 3-5 million grains/ha. Studies with more diverse values of row spacing confirm this conclusion (Table 2) on sowing up to 3-4 million grains/ha.

Table 2. Yield of spring wheat depending on the width of row spacing and seeding rates, c/ha.

| Width of spacing, cm | Seeding rate, million grains/ha |
|---------------------|---------------------------------|
|                     | 3                              | 4        | 5        |
| 7.5                 | 12.9                            | 15.5     | 15.9     |
| 15.0                | 13.5                            | 15.5     | 16.2     |
| 45.0                | 12.6                            | 13.4     | 14.6     |

In the years under review, the application of the seeding rate of 3 and 4 million grains/ha with a row spacing of 7.5 and 15.0 cm had a positive effect. Thickening in a row with a wide row spacing led to a decrease in yield.
It follows from the above that the optimal width of the row spacing of spring wheat is 15 cm with a seeding rate of 3-4 million grains/ha. It should be noted that increasing the row spacing width to 45 cm can lead to a decrease in yield in a heavily infested field. This width is acceptable in the dry steppe, where the best seeding rate is 3.0-4.0 million grains/ha.

Increasing the uniformity of seed distribution by varying the width of the sowing strip depending on the center-to-center distance of rows does not significantly affect the spring wheat yield (Table 3). This does not mean that the strip method of sowing has no prospects, because the yield is harvested with this method in the direction of sowing, and under the condition of separate harvesting, losses increase due to the failure of the roll. In addition, weeds are more shaded in infested fields with strip sowing than with row sowing.

**Table 3.** Yield of spring wheat when changing the width of seeding strip, c/ha.

| Width, cm of seeding strip | Seeding rate, million grains/ha of strip space | 3     | 4     | 5     |
|----------------------------|-----------------------------------------------|-------|-------|-------|
| 6.5                        |                                               | 16.8  | 16.7  | 16.9  |
| 18.0                       |                                               | 16.8  | 16.7  | 17.8  |

Theoretically, the greatest uniformity of seed placement is achieved with strip sowing, while with row sowing the feeding area is rectangular. The data of the structural analysis of the studies give grounds to conclude that the shape of the feeding area has a significant effect on the yield and an increase in the sowing area with a 6.5 cm strip.

The number of productive stems per 1 m² with row sowing was 5% less than with strip sowing. The number of grains in the ear (1000) and their weight is even smaller. Therefore, the increase in spring wheat yield is by an average of 15% because of the uniformity of seed distribution (Table 4).

**Table 4.** Yield of spring wheat depending on the method of seeding and seeding rates, c/ha.

| Seeding method | Seeding rate, million grains/ha | Average |
|----------------|--------------------------------|---------|
| Row            | 3                              | 16.1    |
|                | 4                              |         |
|                | 5                              |         |
| Strip          | 17.1                           | 18.5    |
|                | 18.7                           |         |
|                | 19.6                           |         |

The advantage of the strip method was revealed only at the seeding rate of 3 and 4 million grains/ha. It can be concluded that the most uniform distribution of seeds over the feeding area leads to a significant increase in the yield of spring wheat in these soil and climatic conditions.

As a result of studying the effect of uneven seeding on the yield, it was found that due to the unequal completeness of seedlings, the specified deviations of the sowing density

**4. Conclusions**
- in dry steppe, with a seeding rate of 4-5 million grains/ha, a row spacing of 7.5-15 cm is allowed, with 3 million grains/ha - 45 cm;
- with a row spacing of 45 cm, there is an increase in the loss of separate harvesting;
- uniform placement of seeds during strip sowing has significant advantages compared to the usual row sowing method with the existing seeding rate.

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