Influence of the predecessor and the seeding rates on the rape productivity

E A Cherkasova and V V Rzaeva

Northern Trans-Ural State Agricultural University, Tyumen, 625003, Russia
E-mail: evgeniyacherkasova92@mail.ru

Abstract. The aim of the research is to identify the optimal seeding rate of varieties and hybrids of spring rape for seeds in the conditions of Northern Kazakhstan. The subject of the research is varieties and hybrids of spring rape. On the experimental fields of the Esil state grain-feed variety seed-trial ground, located in the Republic of Kazakhstan, North Kazakhstan region, the Esil district, the village of Yavlenka, in 2019-2020, a competitive test of spring rape was carried out, represented by 5 varieties: Geros, Maikudyk, Hunter, Makhaon and 3 hybrids: Caliber, Builder, GEN0009. The study of varieties and hybrids was carried out against the background of the predecessor - pure fallow, according to several seeding rates, namely 2.0, 2.5 and 3 million viable seeds. The main counts and observations were carried out according to the approved methodology of state variety testing. The studies carried out made it possible to establish that the seed productivity of rape plants is closely related to the meteorological conditions of the growing season and the studied variants of the experiment. Having studied the seeding rates, we came to the conclusion that the highest productivity is provided by rapeseed with a seeding rate of 2.0 million and 2.5 million viable seeds, and with an increase in the seeding rate, the yield decreases.

Of the samples presented, over the years of testing, the variety Maikudyk and the hybrid Bilder distinguished themselves by a constant and full-fledged harvest for a number of selected characteristics.

1. Introduction
To fully provide the entire region with spring rape seeds, it is necessary to search, study, and evaluate valuable varieties of both local and foreign ecotypes, resistant to the main stress factors with a stable yield over the years and minimal expenditure of material resources [1, 10]. Taking into account the growing interest of commodity producers in new varieties of oilseeds, it is necessary to increase the set and testing of spring rapeseed. For this, it is necessary to intensify prospecting work to study the characteristics of varietal agricultural technology of such a valuable crop as rape [2].

With the diversification of agricultural production, the introduction of promising varieties of oilseeds, including spring rape, is cost-effective and relevant. One of the main factors in increasing the gross yield of spring rape is the selection of varieties. About 85% of rape are produced by the spring forms of this crop [3,6].

Over the past few decades, many positions in the technology of cultivation of spring rape have changed: every year there are innovations in the technology of sowing and caring for crops, the composition of pesticides has changed for the protection of crops, and the varietal composition has also...
changed, prompting the conduct of variety trials for further zoning in the changing sharply continental climate [8].

The aim of the research is to study the influence of the predecessor and the seeding rate on the productivity of varieties and hybrids of spring rapeseed.

2. Material and methods

On the experimental fields of the Esil state grain-feed variety testing site, a competitive test of spring rape was carried out, represented by eight samples, of which 5 varieties: Geros, Maikudyk, Hunter, Makhaon and 3 hybrids: Caliber, Bilder, GEN0009. The study of varieties and hybrids was carried out against the background of two predecessors: pure fallow and spring wheat, with a seeding rate of 2.0, 2.5, and 3.0 million germinating seeds / ha [8, 9].

The experiment was based on the type of seed plot for competitive variety testing, the area of the accounting plot was 25 m². Quadruple repetition with 2 tiers in the experiment. The options are placed randomly [7,5]. The agrotechnics in the experiment was as follows: after harvesting the preceding crop, the soil cultivation was carried out to a depth of 20-22 cm with KPG-5 + MTZ 1221. In spring, when the soil was physically ripe, self-harrowing was carried out to a depth of 5-6 cm ZIGZAG, pre-sowing soil cultivation with simultaneous application of ammophos fertilizer at a rate of 25-30 kg / ha - SZS 2.1, aggregated by the MTZ 1221 tractor [4]. The sowing of spring rape was carried out with a Wintersteiger sower. Seeding depth - 3 cm. 3-4 days after sowing - harrowing before seedling stage was carried out with a harrow - BZSS-1.0 in order to destroy weeds. Spraying of crops with the herbicide Nopasaran (0.8 l / ha) was carried out in the phase of 2-6 leaves of the crop. During the growing season, 2-fold dressing with systemic insecticides Biscay (0.3 l / ha) and Decis Profi (0.03 l / ha) was carried out to combat the complex of pests. Harvesting is carried out using Wintersteiger selection harvester. At the end of the harvesting, the necessary laboratory work was carried out. The main surveys and observations were carried out according to the approved methodology of state variety testing. The structure of the yield was determined by sheaves taken from plots with a size of 0.25 m² (4 on each plot) for all options [8].

3. Research results

The researchers have found that the yield of spring rapeseed had a trustworthy average relationship with the number of fruits per plant, the number of seeds in the pod (fruit). As a result of observations, it was found that the maximum number of pods per plant on average for 2 years was formed by hybrid Bilder and variety Maikudyk - 38.3 pcs / plant, which exceeded - 1.8 pcs / plant, in terms of pure fallow. The maximum number of seeds in a pod was formed by the Maikudyk variety (17.6 pcs.). Having the highest height - 110.1 cm, it showed the highest yield according to the predecessor, pure fallow (3.52 t / ha) (Table 1).

**Table 1. Influence of the preceding crop on the elements of the structure of the yield of varieties and hybrids of spring rape, 2019-2020.**

| Varieties/hybrids | Predecessor  
|-------------------|----------------|
|                   | Pure fallow  
|                   | (Seeding rate – 2 ml. viable seeds/ha)  
|                   | Spring wheat  
|                   |                   |                   |                   |                   |                   |                   |                   |
|                   | number of branches, pcs/plant | number of pods, pcs/plant | number of seeds, pcs/fruit | height of plant, cm | number of branches, pcs/plant | number of pods, pcs/plant | number of seeds, pcs/plant | height of plant, cm |
| Yubileiny st.     | 3.8 | 36.5 | 16.6 | 108.5 | 3.7 | 37.0 | 16.3 | 110.9 |
| Geros             | 3.8 | 36.7 | 16.4 | 109.8 | 3.7 | 36.4 | 15.7 | 110.5 |
| Maikudyk          | 3.8 | 38.3 | 17.6 | 110.1 | 3.8 | 38.3 | 17.2 | 109.6 |
| Hunter            | 3.8 | 35.6 | 16.6 | 109.9 | 3.5 | 36.6 | 16.2 | 109.2 |
| Makhaon           | 3.6 | 35.7 | 16.0 | 108.6 | 3.5 | 36.6 | 15.7 | 109.1 |
In terms of seeding rates, the varieties Yubileiny, Maykudyk and the Bilder hybrid showed good results. With seeding rates of 2-2.5 million viable seeds, they are leaders according to most indicators. The greatest number of branches per plant was formed by varieties and hybrids with a seeding rate of 2 million viable seeds. On average this indicator was 3.8 pcs / plant. 38.3 pcs / plant of pods were formed by varieties Yubileiny, Maykudyk and hybrid Bilder with a seeding rate of 2 million viable seeds. The largest number of seeds was observed in the varieties Yubileiny (24.9 pcs / fruit) and Maykudyk (17.6 pcs / fruit) (Table 2). Thus, according to the studied economically useful traits, the leading varieties are Maykudyk, Jubilee, and the Bilder hybrid.

Table 2. Influence of the seeding rate on the elements of the structure of the yield of varieties and hybrids of spring rape, 2019-2020.

| Varieties/ hybrids | Seeding rate (Predecessor – pure fallow) | 2 mlн. viable seeds(control) | 2.5 mlн. viable seeds | 3 mlн. viable seeds |
|-------------------|-------------------------------------------|------------------------------|-----------------------|---------------------|
|                   | | number of branches, pcs/plant | number of seeds, pcs/fruit | height of plant, cm | number of branches, pcs/plant | number of seeds, pcs/fruit | height of plant, cm | number of branches, pcs/plant | number of seeds, pcs/fruit | height of plant, cm |
| Yubileiny         | 3.8 | 36.5 | 16.6 | 108.5 | 3.6 | 36.7 | 24.9 | 109.5 | 3.4 | 34.1 | 15.8 | 106.6 |
| Geros             | 3.8 | 36.7 | 16.4 | 109.8 | 3.5 | 37.6 | 16.6 | 109.3 | 3.3 | 34.1 | 14.8 | 105.8 |
| Maikudyk          | 3.8 | 38.3 | 17.6 | 110.1 | 3.7 | 38.3 | 17.2 | 110.5 | 3.4 | 35.7 | 16.2 | 108.8 |
| Hunter            | 3.8 | 35.6 | 16.6 | 109.9 | 3.5 | 36.5 | 16.8 | 108.5 | 3.3 | 32.5 | 15.2 | 105.6 |
| Mekhano           | 3.6 | 35.7 | 16.0 | 108.6 | 3.5 | 36.8 | 16.3 | 109.4 | 3.2 | 32.9 | 14.8 | 102.8 |
| Bilder            | 3.7 | 38.2 | 16.0 | 109.6 | 3.5 | 37.7 | 15.8 | 108.2 | 3.1 | 34.5 | 14.1 | 103.9 |
| GEN0199           | 3.5 | 37.1 | 16.8 | 109.3 | 3.4 | 36.6 | 16.3 | 110.1 | 3.2 | 33.2 | 14.8 | 103.7 |

The yield of varieties and hybrids of spring rape was formed mainly because of quantitative traits - the number of fruits per plant and the number of seeds per fruit. According to the results of the experiments, the yield of seeds varied significantly from year to year, depending on the meteorological conditions, the variety or hybrid. In terms of seed productivity, the most adapted were the Maikudyk variety and the Bilder hybrid (Table 3).

Table 3. Influence of the predecessor on the yield of varieties and hybrids of spring rape, t / ha.

| Varieties/ hybrids | 2019 | 2020 | On average - 2019-2020 | Deviation from the standard, t/ha |
|-------------------|------|------|------------------------|----------------------------------|
|                   | pure fallow (control) | spring wheat | pure fallow (control) | spring wheat | pure fallow (control) | spring wheat | pure fallow (control) | spring wheat |
| Yubileiny         | 2.17 | 2.09 | 4.02                  | 3.83                 | 3.09                 | 2.96                  | -                  | -                  |
| standard          | 1.63 | 1.87 | 3.50                  | 3.48                 | 3.15                 | 3.13                  | -                  | -                  |
| Hunters           | 1.58 | 1.86 | 3.44                  | 3.62                 | 3.20                 | 3.45                  | -                  | -                  |
| Mekhano           | 1.48 | 1.85 | 3.33                  | 3.71                 | 3.14                 | 3.38                  | -                  | -                  |
| Bilder            | 1.42 | 1.86 | 3.28                  | 3.64                 | 3.12                 | 3.36                  | -                  | -                  |
| GEN0019           | 1.53 | 1.86 | 3.36                  | 3.72                 | 3.20                 | 3.46                  | -                  | -                  |
There is also a need to clarify the seeding rate of the tested varieties for the production conditions. The results of the research on the optimal seeding rate showed that the highest productivity is provided by rape with a seeding rate of 2.0 million viable seeds. With an increase in the rate, the yield decreases, in particular the Maikudyk variety has a yield of 4.28 t / ha at a seeding rate of 2 million viable seeds. With an increase in its seeding rate the yield decreased to 3.20 t / ha at a seeding rate of 3 million viable seeds (table 4).

**Table 4. Productivity of varieties and hybrids of spring rape depending on the seeding rate, t / ha.**

| Varieties | 2019 г. | 2020 г. | On average - 2019-2020 | Deviation from the standard, t/ha |
|-----------|---------|---------|------------------------|----------------------------------|
| | 2 млн. | 2.5 млн. | 3 млн. | 2.5 млн. | 3 млн. | 2.5 млн. | 3 млн. | 2 млн. | 2.5 млн. | 3 млн. |
| | viable | viable | viable | viable | viable | seeds(co | seeds | | seeds | seeds | seeds |
| Yubilei | 2.17 | 2.51 | 2.08 | 4.02 | 3.80 | 3.60 | 3.09 | 3.16 | 2.84 | - | - | - |
| ny | 1.98 | 2.61 | 1.77 | 3.81 | 3.70 | 3.50 | 2.88 | 3.16 | 2.64 | -0.18 | 0 | -0.20 |
| Geros | 2.84 | 2.66 | 2.59 | 4.20 | 4.01 | 3.81 | 3.52 | 3.34 | 3.20 | 0.49 | 0.18 | 0.36 |
| Maikud | 1.87 | 2.48 | 2.06 | 3.43 | 3.31 | 3.11 | 2.65 | 2.89 | 2.59 | -0.11 | -0.27 | -0.25 |
| yk | 1.82 | 2.30 | 1.81 | 3.43 | 3.32 | 3.15 | 2.63 | 2.81 | 2.48 | -0.25 | -0.35 | -0.36 |
| Hunter | 2.41 | 2.18 | 1.87 | 3.51 | 3.31 | 3.02 | 2.96 | 2.75 | 2.45 | -0.17 | -0.41 | -0.39 |
| Makhaon | 2.13 | 2.06 | 1.73 | 4.28 | 4.17 | 3.82 | 3.21 | 3.12 | 2.78 | -0.18 | -0.04 | -0.06 |
| Caliber | 1.98 | 2.34 | 1.91 | 3.42 | 3.23 | 3.01 | 2.70 | 2.79 | 2.46 | -0.33 | -0.37 | -0.38 |
| Bilder | 0.52 | | | | | | | | 0.04 | |
| GEN0009 | | | | | | | | | | |

Optimization of plant density is one of the most important conditions for the formation of highly productive crops of spring rape, and the planning of plant density per hectare of crops for harvesting is achieved by setting the correct seeding rate [6].
4. Conclusion
Thus, according to the complex of characteristics that determine the yield of spring rape after two years of the research, the variety Maikudyk and the hybrid Bilder were the most productive in the northern zone. The best ratio between the number of plants per area unit, as well as the structure of the harvest is formed at a seeding rate of 2.0 million viable seeds per hectare. It is also worth noting that at high seeding rates, the competition between rapes plants in crops increases, and the loss of plants increases. Analyzing the average yield in 2019-2020 the best predecessor was pure fallow for all tested varieties and hybrids.

References
[1] Abuova A B 2012 Selection of varieties of spring rape In the conditions of Northern Kazakhstan News of the Nizhnevolyzhsky agro-university complex: Science and higher professional education 2(26) 55-9
[2] Artemyev I V and Karpachev V V 2006 Rape - oil and fodder crops Agrarian science 4 142
[3] Golitsman S V, Rendov N A and Gorbacheva T V 2017 Economic efficiency of intensification of the technology of cultivation of spring rape for oilseeds in the southern forest-steppe of Western Siberia Bulletin of KrasGAU 6(129) 27-31
[4] Rzaeva V 2021 Productivity of crop rotation by the main tillage in the Tyumen region IOP Conference Series: Earth and Environmental Science 677 052079 DOI 10.1088/1755-1315/677/5/052079
[5] Dospekhov B A and Armor B A 1979 Field experiment technique (M.: Kolos)
[6] Cherkasova E A and Rzayeva V V 2019 Influence of the seeding rate on the yield of rapeseed in the North Kazakhstan region Bulletin of KrasGAU 12(153) 17-22
[7] Fedina M A 1985 Methodology of GSI of agricultural crops (M.: Kolos)
[8] Cherkasova E A and Rzayeva V V 2021 Comparative productivity of varieties and hybrids of spring rape in the North Kazakhstan region Agrarian scientific journal 4 34-6
[9] Cherkasova E A and Rzayeva V V 2020 Influence of elements of cultivation technology on the safety of spring rapeseed plants in the North Kazakhstan region Agri-food policy of Russia 3 32-5
[10] Loginov Y P, Kazak A A and Yakubysnina L I 2019 The Yield Rate and Quality of Tubers of Early Ripening Potato Varieties in the Conditions of Organic Agriculture of the Tyumen Region Annals of Agri Bio Research 24(1) 76-81 DOI: 2-s2.0-85071655469