RAPESEED YIELD FORMATION WITH DIFFERENT TECHNOLOGY OF CROP PRECURSOR CULTIVATION UNDER THE CONDITIONS OF THE SAP-ELEVATION ZONE IN AKMOLA REGION

ANNOTATION

The article examines the influence of the main elements of water-and resource-saving technology on the growth and development and yield of rapeseed plants. Based on the research conducted in 2015-2017, aimed at developing technological methods that ensure a high stable yield of rapeseed, the following results were obtained: the reserve of productive moisture before sowing spring rapeseed was 88.5-82.3 mm, the supply of nitrate nitrogen before sowing in the pure steam variants, the content of nitrate nitrogen is higher compared to other variants and amounted to 19.1 mg per 1000 g of soil; zero and minimum ploughing process of 17.2; 17.4 mg per 1000 g of soil, on the variants of occupied steam and legume culture, the figure was 11.8; 13.0 mg per 1000 g of soil. Over the years of research, rapeseed sown with the second crop in zero and minimum ploughing process allowed to get an increase in comparison with the control in 3.1 and 3.3 c/ha, respectively, with a yield of 14.0 c/ha in the control variant.

Key words: rapeseed, precursor, moisture supply, nutrients, crop.

Introduction. To organize a solid feed base, and increase the production of feed protein and vegetable oil, in addition to generally recognized feed crops, we need crops that are not demanding heat, are resistant to frost, with a short growing season, give a highly nutritious feed, maturing on seeds. These requirements are met by spring rapeseed, which belongs to high-protein crops. Rapeseed is rich in carotene, ascorbic acid, and minerals, grows well, develops everywhere, and produces high yields of green mass and seeds. Rapeseed is the most crucial source of cheap vegetable oil and high-protein feed. Its seeds contain 40-50% fat and 21% protein. It is widely used in the food and technical industries and occupies a special place in feed production [1-4].

Rapeseed is of considerable food, fodder, technical, agrotechnical, and ecological importance. For the region of Northern Kazakhstan, such ways of rapeseed use as receiving high-quality vegetable oil as well as use for forage purposes are especially important. Considering that spring rape is an important crop for diversification, i.e., changing the assortment of agricultural production, its areas are increasing, which requires the development of a high level of cultivation technology, and in connection with this a detailed study of its main elements.

Especially urgent in specific soil and climatic conditions of the steppe zone of Northern Kazakhstanis to consider the possibility of increasing the productivity of spring rape by improving the most mobile elements of technology: optimization of seeding rates and sowing dates, introducing different doses of mineral fertilizers and selection of varieties that provide the most complete realization of the climatic potential of the region. At the same time, on the basis of studying the peculiarities of culture biology in the relationship with the soil and climatic potential of the region, it is required to clarify the place of rape in a typical crop rotation of Northern Kazakhstan [5-8]. During the development of rapeseed passes 10 phases requiring different conditions for their optimal course: swelling and nucleation...
of seeds, germination, seedlings, rosette, stemming, budding, flowering, filling of seeds, wax maturity, and full ripeness. Rapeseed refers to plants with rapidly germinating seeds and rapidly developing seedlings. The larger the seeds, the more vigorous, faster, and stronger the seedlings appear. For rapeseed, however, seed size and germination do not correlate, although large seeds are more viable. The emergence of rape sprouts is observed on days 5-8, the appearance of which is significantly influenced by the depth of embedding the seeds. The seeding depth of rape seeds does not exceed 1-2 cm; increasing the depth leads to greater herbage thinning, and sometimes to the death of crops. Germination of seeds and appearance of shoots in rapeseed strongly depend on the various features and duration of seeds storage. As a rule, long-stored seeds germinate very late and incompletely. Seeds germinate at soil temperatures no lower than 2-4°C. However, at such low temperatures, the germination period for seeds is delayed to 10-14 days. The optimum temperature for fast and friendly emergence of seedlings is 15-18 °C, in which case the germination period is reduced to 4-5 days. The sum of active temperatures is 1600-1800°C [9-12].

During the period of 4-5 leaves, the root system of rape reaches 12-18 cm. Its development depends on soil type, agrotechnical, and variety. Varieties that produce seeds in the year of sowing form a root system more quickly and are less developed than plants that do not produce seeds. Rape flowering duration depends on variety, geographical origin, and climatic and agrotechnical conditions. The plant is moisture-loving, especially during fruit formation and flowering, with a transpiration factor of 550-620 units. In hot and dry weather, it is faster, in wet weather is longer. Under our conditions, rapeseed flowering varies from 20 to 40 days, with an average duration of one flower blossoming of 3 days. It is more demanding to the soil than other cabbage and oilseeds. It grows well on dark-chestnut soils. One of the main factors increasing gross yields of rape is variety. A proper selection of varieties is crucial. Not only knowledge of its biology and cultivation technology, but also highly plastic varieties for our region are necessary for the realization of rape productive potential [13-15].

Many researchers had studied the core issues of rapeseed cultivation technology. Nevertheless, this crop in Northern Kazakhstan is not widespread. One of the main reasons for unstable yields, as a rule, is a low level of agricultural technology, which is largely due to the lack of importance of biological characteristics and insufficient understanding of innovative technologies that help to reduce costs and energy intensity per unit of production. In the course of conducting scientific research, the following issues were studied:

- influence of the main elements of water- and resource-saving technologies on the growth and development of rapeseed plants;
- comprehensive assessment of rapeseed plants for yield, early ripeness, and crop structure.

In the subzone of common black soil of the Akmola region, the natural and climatic conditions fully correspond to the cultivation of this valuable crop. In connection with the above, the improvement of the elements of cultivation technology that ensure the growth of yields, and the stability of the ecological situation is very relevant.

The primary predecessor of rapeseed in our region is grain crops and fallow, prepared by different technologies. Sunflowers and legumes are bad predecessors for rapeseed, which are affected by the same diseases. The essential requirement when choosing a precursor for rape is clean fields of weeds. It is necessary to exclude its sowing on soils with low fertility, light texture, or soils, as well as on fields where herbicides of a long decay period may follow. In steppe farming, rape can be used to protect soils from water and wind erosion, for consideration, and to control weeds. It is a good precursor for most crops in crop rotation [16].

At the same time, rape can improve soil fertility. Leaving after crop residues (38-60 cwt/ha) and having a good degree of decomposition (72%), it stabilizes the content of organic matter in the soil. Thus, in crop rotations, the content of humus increases by 0.04 and 0.06%. rape in the crop rotation has protection value against weeds [17].

**Materials and methods of research.** For the implementation of this project in 2017, we borrowed research in the field experience, in accordance with the R&D program, which studied the adapted system and resource-saving technology of oilseed cultivation on ordinary chernozems in the conditions of the Akmola region.

Rapeseed sowing was carried out on May 17 with a seeding rate of 2.0 million tons, germinating seeds, disc planter SZP-3,6 to a depth of seed embedding 4-5 cm. Harvesting was carried out in the full ripeness phase by direct combining. Laboratory-field research method. The size of plots is 10 x 50 m in four replicates, and the placement of plots is randomized.

The soil of the experimental site is represented by ordinary medium-humus chernozem with a humus horizon depth of 25-27 cm and an average humus content of 4.01%. In the arable soil layer, nitrate nitrogen
– 17.9 mg, mobile phosphorus-8.6 mg, exchangeable potassium-350.0 mg per 1000 g of soil. Consequently, the nitrogen content is average, the phosphorus content is low, and the potassium content is high. The mechanical components of the soil are heavy loamy, the volume weight in the arable horizon is 1.19 g/cm³, and in the meter layer on average-1.30 g/cm³. The humidity of stable wilting is 12-13%.

The climate of the mountain-hill zone of the Akmola region is sharply continental, characterized by long cold winters and relatively short summers. Meteorological conditions during the years of research were different, and in general, the meteorological conditions 2015-2017 in 2015-2017 were favorable for the growth and development of spring rapeseed plants.

**Results and their discussion.** Conditions of moisture supply in plowing process. Considering that moisture is the limiting factor for the cultivation of agricultural crops in the conditions of our region, soil samples were selected to study the dynamics of the reserve of productive moisture depending on the ongoing agrotechnical measures. Before starting the experiment in the spring of 2014, the background content of productive moisture in the experimental area was 76.4 mm (Table 1).

Table 1 – Dynamics of productive moisture accumulation in the soil depending on various technologies of steam preparation for 2014-2016

<table>
<thead>
<tr>
<th>Predecessor</th>
<th>Years of research</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2014</td>
</tr>
<tr>
<td></td>
<td>at the beginning</td>
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<tr>
<td></td>
<td>- of steam</td>
</tr>
<tr>
<td>1. Clean ploughing process</td>
<td>76.4</td>
</tr>
<tr>
<td>2. Zero ploughing process</td>
<td>76.4</td>
</tr>
<tr>
<td>3. Minimum ploughing process</td>
<td>76.4</td>
</tr>
<tr>
<td>4. Occupied ploughing process</td>
<td>76.4</td>
</tr>
<tr>
<td>5. Legume culture</td>
<td>76.4</td>
</tr>
</tbody>
</table>

Due to the agrotechnical measures carried out, as well as atmospheric precipitation in the months of June-August (185.7 mm at the norm of 95.4 mm), in the fall, by the end of the 2014 fallow period, the accumulation of productive moisture occurred in the pure, zero and minimal vapor test variants and amounted to 105.6, 110.1 and 113.8 mm, respectively. In the experimental variants where plants (rapeseed, peas) of the 2014 crop were vegetated, the content of productive moisture by the end of the growing season was 74.5 and 72.3 mm, respectively. Heavy atmospheric precipitation during the spring period of 2015 and 2016 contributed to the accumulation of productive moisture reserves during the preparation of various predecessors and was at the level of good security, which led to the further emergence of friendly shoots of rapeseed plants.

It follows from the above that over the years of research in 2015-2017, the reserves of productive moisture in the soil played a decisive role in the formation of the yield of rapeseed plants.

**Nutritional adequacy in the soil**

The content of nitrate nitrogen in the upper 0-20 layer of the soil in 2014 for pure, zero, and minimum steam increased to 15.4-16.8 mg/1000 g. of soil by the end of steaming (Table 2).

Table 2 – Dynamics of nitrate nitrogen content in mg / 1000 g of soil depending on various steam treatment technologies for 2014-2016

<table>
<thead>
<tr>
<th>The predecessor</th>
<th>is 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At the beginning of steam, N-NO₃</td>
</tr>
<tr>
<td></td>
<td>0-20 cm</td>
</tr>
<tr>
<td>1. Clean ploughing process</td>
<td></td>
</tr>
<tr>
<td>2. Zero ploughing process</td>
<td></td>
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<tr>
<td>3. Minimum ploughing process</td>
<td></td>
</tr>
<tr>
<td>4. Occupied ploughing process</td>
<td></td>
</tr>
<tr>
<td>5. Legume culture</td>
<td></td>
</tr>
</tbody>
</table>
Due to the fact that plants (rapeseed, peas) were vegetated on variants 4,5, the content of nitrate nitrogen in the upper 0-20 layer of the soil by the end of the following is at the level of average availability and ranges from 7.4-6.2 mg /1000 g of soil, respectively. The content of nitrate nitrogen in the upper 0-20 layer of the soil in 2015 for pure steam reached the level of increased security by the end of steaming and amounted to 18.5 mg /1000 g. It is well known that the absence or limitation of mechanical treatments in a steaming field leads to some restrictions on the nitrification process in the soil.

As a result of the above factor, by the end of vaporization, the content of nitrate nitrogen in the zero and minimum vapors is lower than in the pure vapor and amounts to 15.2; 15.1 mg /1000 g of soil, respectively, according to the content of nitrate nitrogen in the upper 0-2; 20-40 soil layer in 2016, by the end of vaporization, a similar trend.

As is known, with a high content of total phosphorus (0.098-0.150 %) on ordinary chernozems, the available phosphorus for plants is at a minimum due to the alkalinity of the soil solution and the soil carbonate content. A positive phosphate mode favors root growth, enhances rape resistance to unfavorable growing conditions, and regulates yields. With the cumulative poor content of phosphorus in the soil and its insufficient application, the nutrition of rapeseed plants is provided solely by scarce soil reserves. Phosphorus application in the volume equal to the amount of its removal with the crop provides the highest stability of yield. With low phosphate content in the soil and insufficient fertilizer application, the coefficient of yield variation can reach 20% [18,19].

The content of mobile phosphorus does not depend on vaporization, the amount remains low at the level, decreasing with depth. Phosphorus is needed most by plants between stemming and flowering. The phosphorus supply of rapeseed plants comes mainly from soil reserves (70-80%). For more complete use of phosphorus by plants it should be at least 6-8 mg per 100 g of soil. Along with the regular application of phosphorus fertilizers, maintaining the optimal content of mobile phosphorus is possible through appropriate main soil tillage [20,21]. Over the years of research on experimental variants, the content of mobile phosphorus varies in the upper 0-20 cm layer of 8.1-9.8 mg /1000 g of soil.

**Conditions of crop moisture supply.**

The accumulation of moisture usually occurs partly in the autumn period and mainly in winter due to the use of winter precipitation. By the sowing of spring rapeseed plants in 2016, the reserves of productive moisture in pure, zero and minimum vapors ranged from 57.6 to 88.5 mm, and were at the level by the end of following in 2015 (Table 3).

Table 3 – Dynamics of productive moisture reserves in the soil by crops in the 0-100 cm layer 2015-2017, mm
Predecessor | First crop, wheat 2015 before sowing | First crop, wheat 2015 before harvesting | Second crop, rapeseed 2016 before sowing | Second crop, rapeseed 2016 before harvesting | Third crop, wheat 2017 before sowing | Third crop, wheat 2017 before harvesting
--- | --- | --- | --- | --- | --- | ---
St Clean ploughing process | 120.4 | 48.2 | 88.5 | 32.5 | 77.8 | 16.2
Zero ploughing process | 111.5 | 43.1 | 84.6 | 36.4 | 70.4 | 18.1
Minimum ploughing process | 113.6 | 46.4 | 82.3 | 37.2 | 71.6 | 17.8
Occupied ploughing process | 88.4 | 42.5 | 72.3 | 24.5 | 65.6 | 16.0
Legume crop | 80.9 | 35.2 | 57.6 | 23.2 | 61.5 | 15.2

These variants of the experiment practically only retain the accumulated moisture during this period, while all precipitation during the autumn-spring period is lost.

Crop yield. As noted above, the methods of preparing precursors had an impact on the content of productive moisture in the soil. Over the years of research, yield data indicate a positive effect of various methods of preparing precursors on the yield of spring wheat and rapeseed.

Table 4 – Yield of spring wheat and rapeseed in a four-field crop rotation, c/ha 2015-2017

<table>
<thead>
<tr>
<th>Predecessor</th>
<th>Yield, c/ha first crop, wheat 2015</th>
<th>Yield, c/ha second crop, rapeseed 2016</th>
<th>Yield, c/ha third crop, wheat 2017</th>
<th>Average</th>
<th>deviation from control for rotation, ±</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>St Clean ploughing process</td>
<td>14.4</td>
<td>14.0</td>
<td>12.5</td>
<td>13.6</td>
<td>-</td>
</tr>
<tr>
<td>Zero ploughing process</td>
<td>16.8</td>
<td>17.1</td>
<td>14.5</td>
<td>16.1</td>
<td>+2,5</td>
</tr>
<tr>
<td>Minimum ploughing process</td>
<td>16.7</td>
<td>17.3</td>
<td>14.7</td>
<td>16.2</td>
<td>+2,6</td>
</tr>
<tr>
<td>Occupied ploughing process</td>
<td>13.8</td>
<td>15.7</td>
<td>13.4</td>
<td>14.3</td>
<td>+0.7</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Legume culture</td>
<td>12.9</td>
<td>11.6</td>
<td>10.1</td>
<td>11.5</td>
<td>-2.1</td>
</tr>
<tr>
<td>NSR</td>
<td>1.23</td>
<td>1.45</td>
<td>1.39</td>
<td>1.38</td>
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<tr>
<td>S x%</td>
<td>3.49</td>
<td>3.59</td>
<td>3.42</td>
<td>3.55</td>
<td></td>
</tr>
</tbody>
</table>

Over the years of research, rapeseed sown by the second crop at zero and minimum plowing process allowed us to obtain a mathematically provable increase in comparison with the control and amounted to 3.1 and 3.3 c/ha, respectively (Table 4), with the control variant's yield of 14.0 c/ha, in weather and climatic conditions, option 5 "legume culture" reduced the yield by 2.4 c/ha compared to the control, which is due to the low content of productive moisture before sowing rapeseed compared to other predecessors, due to the low content of autumn-winter moisture charging 2015-2016 (table 4).

Conclusion. Based on the research conducted in 2015-2017, aimed at developing technological methods that ensure a high sustainable yield of spring wheat and rapeseed, the following conclusions are drawn:

It is established that over the years of research, the effect and aftereffect of various methods of preparing precursors on the accumulation and preservation of productive moisture reserves before sowing spring rapeseed was 88.5-82.3 mm.

Nitrate nitrogen content before sowing for rapeseed in the pure steam variants, the content of nitrate nitrogen is higher than in other variants and amounted to 19.1 mg per 1000 g of soil; zero and
minimum plowing process -17.2; 17.4 mg. per 1000 g of soil, in the occupied steam and legume culture variants- 11.8; 13.0 mg per 1000 г of soil.

Over the years of research, various methods of preparing precursors have had an effect and aftereffect on the yield of spring rapeseed. Over the years of research, rapeseed sown by the second crop in zero and minimum plowing process allowed us to obtain a mathematically provable increase in comparison with the control and amounted to 3.1 and 3.3 c/ha, respectively, with a yield of 14.0 c/ha from the control variant.

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ТУЙІН
Макалада ылғал және ресурстарды үнемдеу технологиясының негізінің элементтерінің рапс дакылының осуі мен дамуына және өнімділігіне асері зерттелген. Рапстың жоғары тұрақты шығымдылығын камтамасыз ететін технологиялық едістерді зерттеу үшін 2015-2017 жылы қарашынан 30-ге дейінгі саладықтарда зерттеу жылдарының өсімділігін 19,1 мг/1000 г топыраққа бірнеше нұсқалармен қамтамасыз етілген 17,2; 17,4 мг/1000 гр кур салады. Нәтижелер бойынша рапс өнімділігі 14,0 ц/га құрады.

РЕЗЮМЕ
В статье изучены влияние основных элементов по влаго- и ресурсосберегающей технологии на рост и развитие и урожайность растений рапса. На основании проведенных исследований за 2015-2017 гг., направленных на разработку технологических приемов, обеспечивающих получение высокой устойчивой урожайности рапса получены следующие результаты: запас продуктивной влаги перед посевом ярового рапса составил 88,5-82,3 мм, обеспеченность нитратным азотом перед посевом на вариантах чистый пар содержание нитратного азота выше по сравнению с другими вариантами и составила 19,1 мг на 1000 гр почвы; нулевой и минимальный пары 17,2; 17,4 мг на 1000 гр. почвы, на вариантах занятый пар и бобовая культура составила 11,8; 13,0 мг на 1000 гр. почвы. За годы исследований рапс, посевенный второй культурой по нулевому и минимальному парам, позволил получить прибавку по сравнению с контролем в 3,1; 3,3 ц/га соответственно, при урожайности на контрольном варианте 14,0 ц/га.