RESOURCE-SAVING TECHNOLOGIES OF WINTER WHEAT CULTIVATION IN WESTERN KAZAKHSTAN

ANNOTATION

The results of long-term studies of resource-saving technologies at the Ural Agricultural Experimental Station made it possible to form new directions in tillage systems, which became the basis for the development of energy-saving technologies for growing grain crops. The transition to new technologies is predetermined by world and domestic scientific and production experience, general trends in the development of agriculture. The technology of grain cultivation for non-moldboard and minimal tillage proposed by T.S. Maltsev and the soil-protecting farming system suggested by A.I. Barayev, it has a common theoretical basis – the possibility of efficient field farming in vast steppe and arid-steppe areas without extensive use of traditional plowing.

Winter wheat is of great practical interest for the conditions of Western Kazakhstan with insufficient moisture and lots of issues of agrotechnics of cultivation have not been studied enough. In this regard, there is required for a comprehensive study of the biological features of winter wheat and the development of agricultural technology, which allows to largely unleash potential opportunity of wheat. Interestingness of winter wheat is increasing due to a combination of a number of economic and biological features of this crop: high potential yield of grain and green mass, high winterhardiness, drought resistance, undemanding to the soil.

As a result of research, it was found that good fall soaking of soil for tillage, maintained options with deep basic tillage without turning the soil over. Over four years of research shown in a meter layer of soil before sowing, the highest content of productive moisture was available on the options: flat-cutting processing by 20-25 cm (KPG-250) -146.5 mm and slotting with a tool – Resource-saving Anti Zero Chisel Organ "RANCHO" by 35 cm-141.7 mm, the smallest on the minimum options (OPO-4.25) by 10-12 cm -133.9 mm and direct sowing (without treatment) -121.9 mm.

On average, over four years of studying the technology of tillage for winter wheat, the most productive options were: flat-cut tillage (KPG 250) and slotting "RANCHO".

Key words: mechanical tillage, productive soil moisture, yield productivity.

Introduction. The problem of creating crop and crop products in modern conditions can be solved only through the intensification of agricultural production. The steps for this are required to use all the possibilities: increasing the yield of winter wheat on arable land, cultivating the most productive and economically advantageous varieties under the given conditions, and improving productivity. While the problems are generally clear, the provision of approaches that ensure the formation of optimal crop rotations, there is lack of clear process maps for their creation in the west of the republic. The limits of the real possibility of productivity increases in them are also unknown. This is mainly due to the lack of knowledge accumulated in arid zones and the lack of clear integrated, optimized, economically sound developments. In this regard, based on the generalization of many years of research, an assessment is made of the role of individual measures of their combination in crop rotations [1, 2].

Winter wheat is a widely used grain varieties. The first samples of this plant were created by breeders at the end of the 19th century. The main feature of winter wheat is an increased protein content
from 13 to 18%, with a complete amino acid composition. The main use of grain is as a raw material for making flour. The yield under appropriate weather conditions reaches 50-60 centners per hectare of grain. Positive features, in addition to protein content, are immunity to many fungal diseases, high winter hardiness and undemanding soil fertility. Particularly large yields are obtained after fallow, tillage, both basic and pre-sowing, is fully consistent with regional agricultural practices. Winter wheat is very sensitive to the timing of sowing, they fall approximately in mid-August. Seed dressing has a good effect on the crop. Depending on local conditions, either separate cleaning or direct combination is used. Separate harvesting begins in the phase of wax ripeness of the grain, direct only when fully ripe [3].

A rational farming system is unthinkable without correct crop rotations. Against the background of crop rotation, all other agrotechnical measures, as the use of fertilizers, and progressive methods of tillage can be used with the greatest efficiency.

The novelty of the study lies in the fact that for the first time in the soil and climatic conditions of the dry steppe, complexes of agrotechnical measures were studied in the system of grain fallow crop rotation based on the principles of sustainable production of grain fodder crops and stabilization of soil fertility in the conditions of Western Kazakhstan. Research and observations are continued based on existing crop rotations deployed in time and space at the LLP "Uralsk ACS" [4, 5].

**Purpose and objectives.** To elaborate additional methods of cultivation for accumulation, conservation and rational use of soil moisture for cultivation of field crops in the structure of grain and fallow crop rotation on the principles of consistent overcoming the limiting factors of the environment.

**Material and methodology.** The research have been carried out at the station of the Department of nonirrigated farming in a cereal fallow rotation: fallow - winter wheat - millet - spring wheat - barley. Sowing has been carried out by SZS-2,1 seeder. Seeding rate has been 3.5 million germinated seeds per 1 hectare.

Analysis of the course of rainfall amounts in relation to the yield of major crops has been done according to published data of the Ural Hydrometeorological Station and data from the Department of Agriculture of Western Kazakhstan region.

Soil moisture is determined from selected samples from a 0-100 cm layer (after 10 cm) by the thermostatic weight method before sowing, during heading and before harvesting crops [Vodyunina A.F., Korchagina Z.A. Methods for studying the physical properties of soils, 1986].

Adjectives for volume weight of the soil has been carried out by using a cylinder with a volume of 98 cm³ in tillering and prior to harvesting crops in soil layers 0-10, 10-20, 20-30 cm [Vodyunina A.F., Korchagina Z.A. Methods for research the physical properties of soils, 1986].

Harvesting operations for the samples are performed plot-by-plot, small-scale harvester "Wenterhtaiger". Crop yield data are given for standard moisture content and 100% purity.

Static handling of the obtained data is carried out by the method of dispersion analysis [Dospekhov B.A. Methods of field experience, 1973].

The soil cover for experimental plot is represented by dark chestnut carbonate soil.

The content of physical clay along the profile varies from 54.10 to 61.06%. The soil layer of 0-23 cm contains minimum of fine particles.

Water-physical properties of the soil indicate its high moisture-accumulating capacity, with the upper arable layer (0-30 cm) has highest moisture capacity.

The properties of soil are characterized by a neutral environment, medium supply of mobile forms of phosphorus, nitrogen and high - potassium. The sums of absorbed bases in the upper layer is 30-34 mg eq/100 g of soil and in gradual mode decreases with depth. Calcium dominates among the exchange cations. The maximum of absorbed potassium is closer to the surface horizon, and that of sodium is at a depth of 95-100 cm.

In the extremely arid conditions of Western Kazakhstan, tillage makes of difference a huge role in increasing crop yields and gross yields of crops. Tillage of soil, as well as other agronomic techniques, shall be applied differentially, considering specific soil and meteorological conditions, based on the specific requirements of winter wheat [6,7].

The fallow fields had been cultivating at the beginning the fall. After spring crops harvesting, winter tillage of the fallow field was carrying out. Spring harrowing of fallows as the mellowas of soil. In summertime, all processing is aimed at keeping the field clean, to maintain on loose condition of topsoil.
by cultivation to a depth of 6-7 cm, as much as possible to accumulate and retain moisture in the soil. Accumulated in recent years, the experimental data of the Ural Agricultural Experimental Station allowed once again to raise the question of the prospects of resource-saving technologies of cultivation of grain crops based on a combination of tillage methods, up to the refusal in some cases from its use. Therefore, resource-saving technologies currently being developed and mastered to consider as an important stage in the implementation of ploughless farming in western Kazakhstan [8,9,10].

**Short content of the researched technologies:**
A. flat tillage at 20-25 cm (KPH-250) - (control)
B. minimum tillage at 10-12 cm (OPO-4.25)
C. direct seeding (no tillage)
D. slitting at 35 cm (RANCHO)

**Research results.**

Agroclimatic conditions of research. In April 2019 precipitation has been within the average annual data. Meteorological conditions in May differed significantly from typical long-time average annual. Air temperatures persisted high temperature until late June, and precipitation has been very low (only 3.3 mm in the period of 1-28 June). In general, the atmospheric drought continued for 51 days. Autumn has been long and dry in terms of weather conditions. There was a significant shortfall in precipitation, with 38% of the norm for the three months. Temperatures in September and October were 2.2°C and 3.1°C above the long-term average, appropriately. Average daily temperatures decreased since November (-2.5°C vs. -2.0°C as per the long-term average). Stable snow cover formed on 27 December, prior this date precipitation in the form of rain fell fractionally, and its amount was 9 mm less than normal [11,12].

In March 2020, a deviation of the average daily temperature of +8.5°C from the long-term data (+4.5°C against -4.0°C) at the continued lack of precipitation of 15.4 mm was also noted. Lack of essential precipitation in spring months essentially affected formation of vegetative mass.

The autumn period of 2020 has been anomalously warm and dry. Thermal cycle sharply differed from the traditional indicators in the region: in September below the norm by 2.2°C, in October and November - above the norm by 3.1 and 0.5°C appropriately [13, 14]. Thus, November ended with an average daily temperature of 2.3°C, December 2 already - 20.3°C, January 15 - 4.2°C; January 21 - 24.2°C, which affected in general condition of preserve winter triticale. The growth in the early-spring period has been from satisfactory to positive. Precipitation in September-November in total has been significantly lower than the average annual rate (96 mm) by 2.6 times, which in general favored the average long-term rate of moisture accumulation in the soil by type of cultivation prior to going out from winter [15,16]. The temperature mode in April, May and June has been maintained at the level of average annual data (Fig. 1).

Temperature mode 2021 for the first months of the growing season (May, June) exceeded the norm in May by 34%, in June by 17%. Average daily temperature in May was 21.5°C against the norm of 160°C, in June 24.50°C against 20.90°C according to long-term data.

The stress situation improved by many days of rains at the end of May. From 30 May to 4 June, 81 mm of precipitation fell in 6 days, indicating moisture reserves in the 0-100 cm layer of soil at 120 mm, which favored the formation of secondary roots of plants crop productivity. However, the following continuous air drought led to a loss of moisture in the soil. There have been 25 consecutive days of drought in June, with daytime temperatures ranging from 33.5 to 41.8°C and soil temperatures ranging from 50-55°C. The average daily air temperature was 28.8-31.90°C on 15-30 June. while the long-term average is 20.9°C. Precipitation haven't been observed at all during this period.
Thus, the accumulation (formation) of vegetative mass of winter triticale took place in extreme conditions of atmospheric and soil drought. In July, the situation hasn’t been changed much. The average daily temperature measured 25.10°C, while the norm was 22.90°C. Precipitation dropped only 17mm and the norm was 40mm. Precipitation hasn't been recorded in the end of July and the beginning of August, the average daily temperature was 28.2-29.50°C, while the long-term average was 22.9-21.20°C. Daytime temperatures reached 38-42°C. Deviation of average daily temperature in July have been +2.2 degrees, in August +4.9 degrees. Cooling down have begun only in September: the average daily temperature was 22.5 degrees Celsius. Precipitation within 20 days was 15 mm, while the monthly norm was 29 mm [17, 18].

In April 2022, the average daily air temperature has been +11.60C, which is higher than the long-term average by 3.50C (the norm is +8.10C). Maximum air temperature has been reached +20.9C and minimum measured +3.4C. Precipitation was 22.0 mm, which was normal for the average annual values (normal 22.0 mm). The average daily humidity for the month was 72%. The first two decades have been noted by precipitation, stable positive average daily temperatures and with gusty winds. Average daily temperatures increased by the end of the third decade period. The second decade have been noted good precipitation and with gusty winds, there was an increase in temperature compared with the first decade period.

The average daily air temperature in May reached +12.4 С, what exceeded the long-term average by 3.6 С (the norm is +16.0 С). Maximum air temperature reached +20.60С, minimum +8.10С. Precipitation observed 38.2 mm, which was 10.2 mm above normal (normal is 28.0 mm). Average daily humidity for the month was 64%.

Weather conditions during the first two decades of May have been characterized by gusty winds, temperature variations during the day and night, and particularly strong precipitation in the second decade period.

The third decade from the middle have been characterized by high daytime temperatures, which reached +20.60°C, and precipitation in the form of rain and hail. As compare with last year, the month of May has been cooler, with high precipitation.

Therefore, precipitation and weather conditions of May have been favorable for growth and growth of winter and spring crops.

The mean daily air temperature in June reached +20.9C, which is the same as the average long-term data (the norm is +20.9C). Maximum air temperature was +26.2C, minimum +17C. Precipitation was 8.0 mm, which was 25.0 mm below normal (33.0 mm was normal). The average daily humidity for the month was 55%.

In the first and third decades there was minor precipitation of a hollow character, high temperatures during the day and at night have been observed.

At the beginning of the third decade, high temperatures have been recorded, and by the end, there was a significant decrease in daytime and nighttime temperatures and no notable precipitation.

The average daily air temperature was +23.2°C in July, which was 0.30°C above the norm (the norm was +22.9°C). The maximum air temperature was +30.4°C, and the minimum was +17°C.
Precipitation was 15.0 mm below the long-term average. Precipitation was 15.0 mm, which was 25.0 mm below the long-term average (mean of 40.0 mm). Average daily humidity for the month was 55%.

Since the middle of the first decade have been observed by the lack and further weak manifestation of (mainly band) precipitation, gusty winds, high temperatures and the establishment of high temperatures in the day and night. In the fields there was observed oppression of crops from the strong heat in the form of wilting of leaves and in the areas of agricultural formations there was a drying of the soil [19].

Until the middle of the third decade, shallow draft has been recorded. Stable high daytime and night-time temperatures in July resulted in abnormal heat and worsened conditions for vegetation growth, but it was favorable for harvesting.

The average daily air temperature in August was 25.4°C, which is 4.3°C above the norm (the norm is +21.1°C). Maximum air temperature was +37.0°C, minimum air temperature was +10°C. Precipitation was 1.1 mm below the long-term average of 25.9 mm (normal - 27.0 mm). Average daily humidity for the month was 37%.

Weather conditions in August have been characterized by low precipitation, anomalous heat and noted differences in temperatures during the day and night. There was little precipitation during the second decade of the month.

In September, the average daily air temperature in September was +15.9°C, which is +1.4°C above the norm (the norm is 14.5°C). The maximum air temperature was +36.0°C, the minimum +0.0°C. Precipitation was 27 mm, which is 2 mm lower than the average annual data (the norm is 29 mm). The average daily air humidity for the month was 60% (Table A.1)

The average daily air temperature in August was 25.4°C, which is 4.3°C above the norm (the norm is +21.1°C). Maximum air temperature was +37.0°C, minimum air temperature was +10°C. Precipitation was 1.1 mm below the long-term average of 25.9 mm (normal - 27.0 mm). Average daily humidity for the month was 37%.

The weather conditions of two decades were marked by precipitation, gusty winds, significant differences in day and night temperatures. Precipitation in the first and second decades contributed to soil moisture in the fields, favored the growth and development of winter crops [20, 21].

The scientific basis of modern technologies based on minimal tillage and sowing is the established pattern that dark chestnut soils do not need constant plowing to regulate agrophysical properties.

Over four years of research, it has been established that the average content of productive moisture in a meter layer of soil before sowing was the largest in the following options: flat-cut tillage by 20-25 cm (KPG-250) - control -146.5 mm and slotting with a RANCHO tool by 35 cm -141.7 mm, the smallest on the variants minimum by 10-12 cm -133.9 mm and direct sowing (without treatment) - 121.9 mm table1.

<table>
<thead>
<tr>
<th>Soil Treatment Technologies</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>138,5</td>
<td>156,0</td>
<td>112,8</td>
<td>178,8</td>
<td>146,5±7,6</td>
</tr>
<tr>
<td>B</td>
<td>143,3</td>
<td>133,2</td>
<td>106,6</td>
<td>152,5</td>
<td>133,9±6,6</td>
</tr>
<tr>
<td>В</td>
<td>135,6</td>
<td>103,2</td>
<td>105,1</td>
<td>143,7</td>
<td>121,9±4,7</td>
</tr>
<tr>
<td>Г</td>
<td>147,1</td>
<td>146,6</td>
<td>115,7</td>
<td>157,2</td>
<td>141,7±7,3</td>
</tr>
</tbody>
</table>

The amount of productive moisture before harvesting in a meter layer of soil in a grain-fallow crop rotation for all variants of processing technology did not differ significantly, apparently soil and atmospheric drought affected table 2.

<table>
<thead>
<tr>
<th>Soil Treatment Technologies</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>38,0</td>
<td>67,4</td>
<td>40</td>
<td>29,6</td>
<td>43,8±2,3</td>
</tr>
<tr>
<td>Б</td>
<td>47,7</td>
<td>45,2</td>
<td>30,7</td>
<td>21,9</td>
<td>36,4±2,4</td>
</tr>
</tbody>
</table>
On average, over four years of studying the technology of processing winter wheat, the most productive options were shown in table 3: flat-cut processing -14.5 c/ha, and slotting by 35 cm, the minimum is -11.2 c/ha, the least on the options is the minimum by 10-12 cm -10.5 c/ha and direct sowing (without treatment) -8.3 c/ha table 3.

When transferring to such tillage systems, labor costs are reduced, resources are saved, labor productivity increases, and the danger of soil over-compaction is eliminated. In recent years, particular attention has been paid to mulching cultivation technologies that help preserve organic residues on the field surface and regulate the dynamics of soil organic matter.

Table 3 – Productivity (c/ha) of winter wheat, depending on the technology of their cultivation

<table>
<thead>
<tr>
<th>Treatment Technologies</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td>А - plow cutter on 20-25 cm (KPI-250) - (control)</td>
<td>13,3</td>
<td>12,7</td>
<td>10,7</td>
<td>21,3</td>
<td>14,5±2,3</td>
</tr>
<tr>
<td>Б - minimum on 10-12 cm (ОПО-4,25)</td>
<td>10,7</td>
<td>6,9</td>
<td>8,0</td>
<td>16,2</td>
<td>10,5±2,1</td>
</tr>
<tr>
<td>В – direct seeding (untreated)</td>
<td>7,9</td>
<td>8,0</td>
<td>6,9</td>
<td>10,2</td>
<td>8,3±1,4</td>
</tr>
<tr>
<td>Г - slotting on 35 cm (RANCHO)</td>
<td>11,0</td>
<td>10,3</td>
<td>8,3</td>
<td>15,1</td>
<td>11,2±2,2</td>
</tr>
</tbody>
</table>

Conclusion: As a result of the research, it was found that a good autumn soaking of the soil by tillage has been ensured the options with deep main tillage without turning of the soil layer over. On average over the four years of research in the meter layer of soil before sowing the highest content of productive moisture had been in the following options: flat tillage at 20-25 cm (KPH-250) -146.5 mm and slotting tool - Resource-saving Anti Zero Cheese Tool "RANCHO" at 35 cm-141.7mm, the lowest in the minimum (ОПО-4,25) at 10-12 cm-133.9mm and direct seading (untreated) -121.9mm.

On average, during the four years of research of tillage technology for winter wheat, the most productive had been the following techniques: shallow tillage (KPG 250) and slotting "RANCHO".

Research have been executed within funded by the Ministry of Agriculture of the Republic of Kazakhstan, Scientific and Technical Program "To elaborate a system of crops cultivation (cereals, legumes, oilseeds and industrial crops) applying elements of cultivation technology, differentiated nutrition, plant protection substances and machinery for cost-effective production on the basis of comparative research of different cultivation technologies for the regions of Kazakhstan".

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**ТҮЙІН**

Батыс Қазақстандың ауыл шаруашылығы ондірісінде таза тыңайған егістік ауыспалы егістер ресурс үнемдейтін технологиялардың табысты дамуын қамтамасыз етеді, тыңайтқыштар мен өсімдіктерді қорғау құралдарына аз шығынмен тиімді топырақ құнарлылығын жоғары деңгейде ұстауға қабілетті. Таза тыңайған жерлердегі топырақтың тұрақты қолайлы су режимі жыл сайын толыққанды көшетерді өндіруге және тыңайған егісте күздік дақылдардың қолайлысына әкінінен жақсы дамуына жағдай жасайды.

Зерттеу нәтижесінде топырақтың өндірісін өндеше әркек жақсы көктерге сүндірген қабтап айналымыныз қамтамасыз етеді, түнілгіштәр мен екімдіктерді көрінген құрылымды азықтық құрау құралдары аз қызмет атқарып жатат. Таза тыңайған жерлердегі топырақтың қолайлылығы және құрау құрылымының өзгерісі пайдаланылға әсер етеді.

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Ортша алғанда, күздік бидай-цу ушін топырақ өңдеу технологиясын зерттеген торт жыл ішінде нұсқалар ең өнімді болды: жалпақ кесу (КПГ-250) және "РАНЧО"саңылаулары.

РЕЗЮМЕ

В сельскохозяйственном производстве Западного Казахстана полевые севообороты с чистыми парами являются гарантом успешного освоения ресурсосберегающих технологий. Они обеспечивают устойчивое производство зерновых, способны поддерживать на высоком уровне эффективное плодородие почвы при минимальных затратах на удобрения и средства защиты растений. Стабильно благоприятный водный режим почвы на чистых парамах создает условия для ежегодного получения полноценных всходов и хорошего поледующего развития озимых в зерно поровом севообороте.

В результате изучения установлено, что хорошее осеннее промачивание почвы по обработкам почвы обеспечили варианты с глубокой основной обработкой почвы без оборота пласта. В среднем за четыре года исследований в метровом слое почвы перед посевом наибольшее содержание продуктивной влаги имелось на вариантах: плоскорезной обработки на 20-25 см (КПГ-250) -146,5мм и щелевание орудием -Ресурсосберегающий Анти Нулевой Чизельный Орган «РАНЧО» на 35 см-141,7мм, наименьшее на вариантах минимальная (ОПО-4,25) на 10-12 см - 133,9мм и прямого посева (без обработки) -121,9мм.

В среднем за четыре года изучения технологии обработки почвы под озимую пшеницу наиболее продуктивным показали себя варианты: плоскорезной обработки (КПГ 250) и щелевание «РАНЧО». 

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