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OPTIMIZATION OF NO-TILL TECHNOLOGY ELEMENTS FOR WINTER WHEAT GROWING IN DRY CONDITIONS

Elena DREPA, Yulya BEZGINA, Elena GOLOSNAYA, Anna GOLUB

Stavropol State Agrarian University, 12 Zootekhnichesky Lane, Stavropol, 355017, Russian Federation, Phone: 8(906)-478–09-72, E-mails: drepa-elena@mail.ru, juliya.bezgina@mail.ru, el_popova87@mail.ru, annagolub26rus@mail.ru

Corresponding author: drepa-elena@mail.ru

Abstract

Improvement of the technology for the cultivation of winter wheat in the arid zone of the Stavropol Territory based on the optimization and renewal of the varietal base of winter wheat grown using the No-Till technology. The work was carried out in 2019–2020 in the arid zone of the Stavropol Territory. In the experiment to study the assessment of varieties of winter wheat grown according to the predecessors of peas and sunflower, we studied 15 varieties. The economic variant, variety Yuka, was used as a control one. The total size of the experimental plot is 1.9 hectares. The yield of the predecessor peas was 23.92-39.44 q/ha, depending on the variety. The highest-yielding variety turned out to be Tanya (39.44 q/ha), which is 12.6% higher than the economic variant Yuka (35.04 q/ha). An increase of 4.8-7.1% in relation to the economic variant Yuka was given by the varieties Aksinya and Volny Don. All studied varieties showed a fairly high degree of resistance to the development of pathogens. The highest prevalence rate and intensity of development of pyrenophorosis in winter wheat plants sown after peas was noted in the Alekseich variety – 67% prevalence and 0.63% intensity, and the lowest in the Aist variety – 22% and 0.33%, respectively. The highest prevalence and development rate of pyrenophorosis in winter wheat plants sown after sunflower was observed in the Krasa Dona variety – 47% prevalence and 0.63% intensity, and the lowest in the Niva Stavropolya variety – 21% and 0.33%, respectively.

Key words**:** *winter wheat (Triticum), technology, predecessor, variety, economic effect, yield*

INTRODUCTION

Over the past fifty years, with a doubling of the world's population, grain production has tripled, but energy consumption has increased almost fourfold, therefore, all over the world, in order to save resources, it has become urgent to replace traditional grain cultivation technologies with technologies based on minimum and "zero" tillage [2][3].

In resolving this issue, Russia lags far behind such technically developed countries as Canada, USA, Australia, France, Germany, despite the fact that the need for innovative technologies in the country is felt much stronger [8].

Therefore, the development of resource-saving technologies for the cultivation of grain crops aimed at preserving and increasing soil fertility, stabilizing the productivity of agrocenoses of grain crops, and reducing costs is currently of great scientific and practical importance [7].

Wheat is a crop that belongs to one of the first plants cultivated by humans. More than seven thousand years ago, wheat was grown in Asia Minor. Its extensive development began about 145 years ago [5].

Winter wheat, being one of the main food crops in the North Caucasus, occupies 70% of all sown areas [10].

In modern conditions, the progressive development of agricultural production largely depends on the development of soil-protecting, resource-saving and energy-saving technologies. Agricultural technologies involving tillage are labor-intensive and energy-intensive. Today, the technology of direct sowing or No-Till is widely used in many countries of the world, which is implemented on an area of more than 100 million hectares. No-Till technology takes its rightful place in the fields of the Stavropol Territory. No-till is a crop cultivation technology that requires optimization of technology elements [12].

MATERIALS AND METHODS

The production experience was carried out on the fields of JSC Agroholding Energomera, LLC Khleborob in 2019 and 2020. Sowing of winter wheat was carried out using the No-Till technology at the time optimal for the zone. Technological techniques in technology are generally accepted for the zone. The seeding rate is 4.5 million viable seeds per hectare.

According to the scheme of agroclimatic zoning of the Stavropol Territory, the land use of LLC Khleborob belongs to the 2nd (arid) zone. Humidification is characterized by a hydrothermal coefficient, where HTC = 0.7-0.9. The willow zone in which the farm is located is characterized by an arid climate, rather mild winters with little snow, the seasons change relatively evenly, without sudden changes. The meteorological station for recording meteorological phenomena is located in the regional center of Svetlograd, where there is a base of long-term observations of climate changes. The arid zone is characterized by a large number of days with dry wind phenomena. The number of days with strong winds over 15 meters per second per year is more than 50 days. Strong winds contribute to the drift of snow cover from fields to low places. During the warm period, the presence of days with winds contributes to the development of wind erosion. This fact once again speaks of the advisability of using technology without tillage.

The soil of the experimental site is ordinary powerful medium loamy chernozem, which is characterized by a low humus content of 3.95%, a very low content of nitrate nitrogen (1.45 mg/kg), an average content of mobile phosphorus – 18.2 mg/kg (according to Machigin's method), and the average supply of exchangeable potassium – 222 mg/kg. The physical properties of chernozems are favorable for the cultivation of winter wheat.

In the arid zone, where the experiments were carried out, on average, according to long-term data, 400-450 mm of precipitation falls during the growing season. During the study period, 200 ... 225 mm fell, which is 145 ... 170 mm less than the average long-term. Unfavorable conditions for moistening were complicated by the uneven distribution of precipitation over the periods of development.

In the autumn period of the 2018/19 agricultural year, 78 mm fell, in 2019/20 – 59.4 mm, which is almost 2.5 times less than the average long-term norm (120 mm). The amount of precipitation in 2019/20 was not evenly distributed, which affected the duration of the germination period. But a long warm temperature regime (15 ... 17° C) allowed the winter wheat plants to leave in the winter in the phase of three or four shoots. In the sowing period of 2018/19, only 11.0 mm fell, which is 65 mm less than the average long-term norm, which negatively affected germination.

The winter of the study period was rather mild, but in the spring of 2020, in April, a return of spring frosts was observed, when the temperature dropped to -13° C, which adversely affected the development of plants. The fall of 30 mm of precipitation in three spring months led to the fact that the development of only one main shoot was noted on winter wheat plants, which was the reason for the low yield. In late May-early June, the average daily temperature was 4 ... 5° C higher than the multiyear temperature. High temperature conditions, lack of precipitation and dry wind phenomena affected the quantity and quality of the crop.

Before sowing winter wheat, weeds are treated with Tornado 500 herbicide at a rate of 2 l/ha using a John Deere 4730 self-propelled sprayer.

After tillage, sowing is carried out with simultaneous application of Ammophos fertilizer 12:52 (John Deere 8345 RT tractor + CASE PRD 500 sowing complex). The optimal seeding rate in the area of unstable moisture is 4.5-5.0 million germinating seeds per hectare. The optimum seeding depth is 3.5-4 cm. It is important that the seeds fall into the moist soil layer during sowing. The optimal sowing dates in the zone are in the third decade of September and the first decade of October.

RESULTS AND DISCUSSIONS

In the course of the research, counts and observations were carried out in the main growth phases of winter wheat plants – before going into winter, in the spring tilling phase, in the flag leaf phase and in the full ripeness phase. We noted full ripeness in the third decade of June, since the conditions during the period of plant growth and development were severely arid, and the lack of moisture contributed to the drying of winter wheat plants on the vine [6].

The experiment became necessary in connection with the emergence of new products on the market, the growing need for updating the varietal base, the need to find varieties that are resistant to various unfavorable conditions. It is especially important to note that at the moment, with the emerging dry periods when growing winter wheat, there is a need for varieties with a stable yield. Selection of a more productive variety according to the sunflower predecessor, since the share of this crop as a predecessor is more than 45% every year [4].

In this regard, the aim of the research is to improve the technology of growing winter wheat in the arid zone of the Stavropol Territory based on the optimization and renewal of the varietal base of winter wheat grown using the No-Till technology [9].

To solve this goal, the farm laid an experiment to study the assessment of varietal characteristics of winter wheat grown according to the predecessors of peas and sunflower, 15 varieties were studied in the experiment. The economic variant, variety Yuka, was used as a control. The total size of the experimental plot is 1.9 hectares.

The counts and observations were carried out in accordance with generally accepted methods:

phenological observations, determination of the structure and accounting of the yield were carried out according to the method of state variety testing;

registration of diseases by indicators: distribution, or the number of affected plants in crops, intensity or degree of development.

technological quality of grain - GOST R52554-2006;

grain glassiness,% - (GOST 10987);

protein content,% - (GOST 13586.1);

gluten content,% - (GOST 13586.1);

GDM readings, rel. units – (GOST 13586.1);

During the growing season, winter wheat goes through the corresponding phases of development associated with the formation of new organs. The passage of development phases, the intensity of growth and productivity of plants are in a certain dependence on the conditions of existence. Plants develop best with optimal provision of all the necessary processes of their life.

In the conditions of autumn, spring and summer, we carried out phenological observations for the onset of the main phases of growth and development of plants of new varieties of winter wheat.

In the autumn, during the research period, favorable conditions developed for obtaining friendly seedlings of winter wheat. All cultivars tested in the production experiment in the winter have gone bustling, all cultivars had from 3 to 5 shoots. The winter during the research period was rather mild. The stubble that remained on the surface had a positive effect on the retention of snow, which had a positive effect on the overwintering of winter wheat plants.

The resumption of spring vegetation began in the first ten days of March, and by the time the plant counts were carried out, the winter wheat plants had grown well.

When calculating the number of stems on average for 2 years, we obtained the following results 283-519 pcs/m^2 and 315-504 pcs/m^2, respectively, depending on the predecessor. There were no significant differences between the predecessors, and the differences between the varieties are due to the varietal characteristics.

The number of stems is directly related to the coefficient of bushiness.

In the spring, when examining winter wheat varieties according to the pea predecessor, the highest tillering coefficient was noted in the Aist variety – 5.7. The coefficient is somewhat lower for the varieties Steppe and

Niva Stavropolya. The lowest coefficient for the varieties Krasa Dona and Alekseich is 3.1.

According to the sunflower predecessor, the tillering coefficient was somewhat lower, since it is a rather tough predecessor for winter wheat. The highest tillering coefficient for winter wheat plants, according to the sunflower predecessor, was noted in the varieties Tanya and Stavka – 4.0, and the lowest in the variety Sila – 2.1.

The commercial variety Yuka had a similar situation. According to the predecessor sunflower, the tillering coefficient was 2.2, and according to the predecessor peas – 4.0.

But the further course of the growing season cooled with an acute shortage of soil moisture and high temperature conditions. The totality of external factors contributed to the fact that in plants of all varieties of winter wheat self-shedding of lateral shoots was observed, which subsequently led to the fact that one, maximum two productive stems remained on the plant. Basically, this was observed for the predecessor sunflower, the yield of which was in the range of 17-18 q/ha. According to the predecessor peas, which dries up the soil to a lesser extent and ensures its fertility, the yield was almost 100% higher.

During the period of the exit phase in the tube, the main elements of productivity are formed in cereals, such as the length of the ear, the height of the plants. Productivity elements are varietal traits. The predecessor, varietal characteristics and prevailing weather conditions had a significant influence on the formation of productivity elements [11].

In general, when evaluating the length of the ear, it should be said that according to the predecessor sunflower it was within 4-6 cm, while according to the predecessor peas this figure was 7-8 cm. Such indicators are natural.

The shortest spike according to its predecessor, sunflower, was noted in the varieties Steppe, Ksenia, Volny Don – 4 cm, and in the varieties Alekseich, Nador and Karolina 5 as the longest – 8 cm.

According to the pea predecessor, in almost all cultivars the spike length was 8 cm, with the exception of Krasa Dona and Volny Don cultivars, which is characterized either by varietal characteristics or belonging to a certain ripeness group, and during the period of ear length formation these cultivars were influenced by external factors.

As for the height of plants, it should be said that according to their characteristics, all studied varieties belong to the group of short-stemmed and medium height.

The highest prevalence rate and intensity of development of pyrenophorosis in winter wheat plants sown after peas was noted in the Alekseich variety – 67% prevalence and 0.63% intensity, and the lowest in the Aist variety – 22% and 0.33%, respectively. The highest prevalence rate and intensity of development of pyrenophorosis in winter wheat plants sown after sunflower was noted in the Krasa Dona variety – 47% prevalence and 0.63% intensity, and the lowest in the Niva Stavropolya variety – 21% and 0.33%, respectively. It is worth noting that on the varieties Aist, Stavka, Ksenia, Niva Stavropolya, MV Nador, there are plants infected with the wheat striped mosaic virus, the prevalence is 5-7%. Leaves and stems are damaged by powdery mildew on the following varieties Karolina 5, MV Nador, Aist: prevalence – 6-8%. On the MV Nador cultivar, we note single spots of basal wheat bacteriosis on the leaves and stem: the prevalence is 3%.

The priority of a variety in the formation of the yield of any agricultural crop is determined by the level of its genetic potential for productivity, which is the primary and leading factor [4, 6]. Cultivation technologies, despite their great influence on productivity, only contribute to a greater or lesser extent to the realization of the genetic potential of the variety.

At the same time, the efficiency of growing winter wheat is largely determined by soil and climatic factors, agrotechnical methods, the direction to reduce costs [1, 2, 3], as well as the use of chemicals and mineral fertilizers.

An important condition for growing this crop is to obtain high quality grain, which is determined by both agrotechnical factors and varietal characteristics. There are a number of different opinions about the role of the variety. The contribution of the winter wheat

variety to the yield increase is on average 50%, the remaining 50% are fertilizers, remedies, a predecessor, and a method of basic soil cultivation.

The share of the variety in the yield of this crop is 20-27%, fertilizers – 20-25%, plant protection products – 15-18%, mechanization and tillage – 12-15%. The magnitude of the factors noted may vary from year to year depending on weather conditions, farming culture, placement in crop rotation, organizational, economic and material resources invested in production.

The studies carried out under the conditions of production experience for the study of winter wheat varieties allowed us to obtain data on yield depending on the predecessor (Table 1).

Analyzing the data obtained, we can say that the yield for the predecessor of peas was 23.92-39.44 q/ha, depending on the variety. The highest-yielding variety was Tanya (39.44 q/ha), which is 12.6% higher than the economic variant Yuka (35.04 q/ha).

An increase of 4.8-7.1% in relation to the economic option was given by the varieties Aksinya and Volny Don.

Table 1. Productivity of winter wheat varieties grown according to the predecessor sunflower (on average for 2 years)

№	Variety	Costs, rub/ha	Yielding ability, q/ha	Increasing, q/ha	Increasing, %	Economic effect, rub/ha
1	Yuka (k)	3,857.00	17.43		-	0
2	Tanya	3,724.00	17,86	0.43	2.5	541.52
3	Sila	3,534.00	12.24	-5.19	-29.8	-4,612.10
4	MV Nador	4,256.00	16.11	-1.32	-7.6	-1,651.52
5	Steppe	3,610.00	17.45	0.02	0.1	265.36
6	Aist	4,142.00	11.53	-5.90	-33.9	-5,894.71
7	Karolina 5	3,211.00	17.66	0.22	1.3	859.55
8	Stavka	2,926.00	15.27	-2.16	-12.4	-1,121.57
9	Ksenia	3,534.00	17.04	-0.39	-2.3	-49.71
10	Niva Stavropolya	3,344.00	14.69	-2.74	-15.7	-2,087.59
11	Bagira	3,344.00	18.09	0.66	3.8	1,136.88
12	Volny Don	3,610.00	16.20	-1.23	-7.1	-920.57
13	Krasa Dona	4,085.00	14.33	-3.10	-17.8	-3,177.02
14	Lydia	3,952.00	15.75	-1.68	-9.6	-1,689.44
15	Aksinya	3,812.00	16.63	-0.80	-4.6	-719.68
16	Alekseich	3,534.00	16.50	-0.93	-5.4	-564.34

Source: Own calculation

But the yield is not the main indicator, since the yield is also assessed by economic effect, which consists of production costs.

Evaluating the economic effect, it should be said that it turned out to be quite low, since the seeds of these varieties have a high cost, which affected production costs.

Varieties Lydia (35.79 q/ha), Bagira (33.44 q/ha), Ksenia (33.88 q/ha) and Karolina 5 (32.61 q/ha) by 3.3-6.8% had a lower yield relative to the Yuka variety, but economic effect had a positive effect, which allows them to be recommended for further production testing. According to the sunflower predecessor, the average yield for 2 years was formed quite low for all varieties. The economic option was exceeded by the varieties Steppe (17.46 q/ha), Karolina 5 (17.66 q/ha), Tanya (17.86 q/ha) and Bagira (18.09 q/ha). The excess was 1.0-3.8% (Table 2).

The cultivar also plays a major role in the formation of grains with a high protein and gluten content. However, under the same conditions, their genetic properties are not always realized.

During the research period, the protein and gluten content was subject to large changes depending on the cultivation techniques, such as the predecessor.

The highest protein content in the winter wheat grain for both predecessors was noted for the Aist variety (17.8 and 19.3%, respectively).

Table 2. Productivity of winter wheat varieties grown according to the predecessor peas (on average for 2 years)

№	Variety	Costs, rub/ha	Yielding ability, q/ha	Increasing, q/ha	Increasing, %	Economic effect, rub/ha
1	Yuka (k)	3,857.00	35.04		-	
2	Tanya	3,724.00	39.44	4.40	12.6	-30.20
3	Sila	3,534.00	23.92	-11.11	-31.7	29.06
4	MV Nador	4,256.00	34.76	-0.28	-0.8	-1,420.28
5	Steppe	3,610.00	35.73	0.69	2.0	-357.84
6	Aist	4,142.00	27.54	-7.50	-21.4	-37.99
7	Karolina 5	3,211.00	32.65	-2.39	-6.8	270.63
8	Stavka	2,926.00	31.96	-3.08	-8.8	301.99
9	Ksenia	3,534.00	33.88	-1.16	-3.3	279.13
10	Niva Stavropolya	3,344.00	29.85	-5.19	-14.8	98.78
11	Bagira	3,344.00	33.44	-1.60	-4.6	320.16
12	Volny Don	3,610.00	37.52	2.48	7.1	-99.42
13	Krasa Dona	4,085.00	34.40	-0.64	-1.8	-357.00
14	Lydia	3,952.00	35.70	0.66	1.9	143.32
15	Aksinya	3,812.00	36.71	1.67	4.8	-26.95
16	Alekseich	3,534.00	35.45	0.41	1.2	-789.93

Source: Own calculation.

We observe a clear pattern in the protein content depending on the precursor; in most cases, the protein content of peas is higher than that of sunflower. The increase is insignificant, but, nevertheless, it amounted to approximately 3.0-5.0%, depending on the variety.

CONCLUSIONS

In the course of the studies carried out, the following conclusions should be drawn that in the arid zone of the Stavropol Territory, using the No-Till technology when growing winter wheat according to the predecessor sunflower. It is recommended to sow winter wheat varieties Tanya, Steppe, Bagira, Karolina 5, giving an increase in yield of 1.0-4.0% in relation to the economic option with an economic effect of 235.36-1136.88 rub/ha; sowing winter wheat varieties Tanya, Volny Don and Aksinya according to the predecessor of peas, giving an increase in yield of 4.8-12.6% in relation to the economic option.

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