The effectiveness of technologies without autumn tillage

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Abstract. The article shows the yield of spring soft wheat in different technologies in the absence of autumn tillage. Technologies differ in the place of wheat in crop rotation and the use of fertilizers. Soil tillage in experiment No. 1 in a four-field grain-fallow crop rotation and on permanent wheat is zero. In experiment No. 2, stubble was left in autumn on long (24 yields) repeated wheat crops, where the soil loosens only when sown with a seeder SKP-2,1 with a cultivator-type coulter. With zero tillage with the removal of crops from fallow, the yield from 1,7 t/ha in the 1st field in the following crops decreased by 1,31-1,44 times, against the background of fertilizer in 1,08-1,12. Permanent sowing of wheat on stubble, compared with the yield of fallow, reduced grain harvest on backgrounds N0 and N40 by 1,60 and 1,42 times. Yield of 2,5 t/ha were obtained in the 1st field after fallow only in a favorable year, as in the following field. Due to fertilizer N40 in such a year, grain harvest increased in three crops of the crop rotation to 2,7-3,0-3,3 t/ha in up to 2,9 t/ha of permanent wheat. The formation of a high yield of wheat by fallow was facilitated by the preservation of the number of productive stems at an average level of 291 pieces per 1 m^2, whereas on other backgrounds there were 274-265 and 243 with permanent cultivation. The number of grains in the ear was of great importance, which reached 18,1-20,2 pieces in fallow with 14-15 in other technologies.

1 Introduction

All important elements of the technology have an impact on the yield of spring wheat with different strengths in favorable and dry years. In one of the generalizations of the data from the experiments of the Kurgan Research Institute for 2010-2020, the variability of wheat yield under three types of weather is shown. Even in the 1st wheat by st fallow eam in dry years, grain harvest fell to 1 t/ha, increasing in the best conditions of moisture availability to 1,8 and 2,4 without fertilizers, and against their background, yields for three types of weather in order to improve growth conditions amounted to 1,1-1,9-2,7 t/ha [1]. Fertilizers increase the content of nitrate nitrogen in the soil to control, which persists until the end of the exit phase into the tube [2]. The distribution of wheat seeds during sowing with the

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UPC-2.1 seeder with a cultivator-type coulter and a chisel-shaped one was compared [3], which shows their close effect on yield in experiments for 2008-2011. The effect of the type of tillage on wheat yield differs by zone. For example, in the Central Experimental Field of the Kurgan Research Institute, plowing had an advantage over minimal and zero treatments, both in grain- fallow crop rotation and permanent wheat. In the north-west of the region, according to research at the experimental field in the village of Maltsevo in 2014-2018, grain harvesting on the 2nd wheat after fallow was similar in terms of types of tillage, but in the 1st crop, the elimination of plowing by fallow led to a decrease in yield by 4 kg/ha [4]. A strong loss of zero processing was shown in experiments for 2013-2015 on ordinary medium loamy chernozem of the Krasnoyarsk forest-steppe, where, when testing plowing and direct sowing, the latter reduced wheat yield by 0,6-0,7 t/ha [5]. A 2-3 c/ha reduction in grain harvest without plowing is described in [6] based on experiments at the A.I. Baraev Grain Processing Center. In the experiments of N.G. Vlasenko et al. [7] in the first year of mastering zero tillage without fertilizer, this option gave wheat yields in the first year of development of zero tillage without fertilizer, this option gave a wheat yield 0,2 t/ha higher than during plowing, where 1,4 t/ha was obtained. With complex chemicalization, direct sowing won by 0,3 t/ha. In wetter years (2009 and 2010), against the background of chemicals, the gain of zero treatment reached 0,5 t/ha with a plowing yield of 3,6 t/ha. The replacement of plowing by leaving a stubble background in the experiments of V.I. Volynkin and E.V. Kirillova in a 4-full grain- fallow crop rotation reduced the yield of the 1st and 2nd crops after fallow by 5-7 kg/ha [8]. The level of wheat yield depends on the preservation of the number of productive stems for harvesting, the number of grains in the ear and the grain size. According to [9] in experiments in the Samara region in the middle arid years, the yield was determined by the grain weight of one ear and the weight of 1000 grains, and in wet years the number of productive stems became particularly important.

2 Research methodology and methods

A stationary experiment with zero tillage has been conducted since 2007 at the Central Experimental Field of the Kurgan Research Institute of Agricultural Sciences within the framework of the state task on the topic No.0531-2021-0002. This experience is located on the basis of the hospital, founded in 1968 year by V.I. Ovsyannikov. Currently, the performers are V.P. Efremov and E.I. Lopareva. Experiment No. 2 with permanent wheat on stubble is conducted by a leading researcher O.V. Volynkina. This experiment was started in 2000, it was a replacement for the V.I. Volynkin hospital with a grain crop rotation, opened in 1971. The soil is medium loamy leached chernozem with the following agrochemical properties: in experiment No. 1, pH_{KCl} 5,2-5,3, humus content 4,2-4,3%, mobile P_2O_5 and K_2O in mg/kg 42-57 and 200-300. In 2020 year, the content of P_2O_5 after background use of ammophos increased to 105 mg/kg. In experiment No. 2: pH_{KCl} 5,2, humus content 4,5%, mobile P_2O_5 and K_2O in mg /kg 40 and 250-300. In experiment No. 1, one nitrogen fertilizer (ammonium nitrate) was used for the 2nd and 3rd crops after fallow with the expectation of an increased phosphorus content in the soil, in experiment No. 2 there were variants with one nitrogen and with the addition of phosphorus to it. Fertilizers were applied locally with a disk seeder SZ-3,6 to a depth of 5 cm. On the 1st sowing, the aftereffect of the fertilizer used in the following crop rotation fields was manifested by fallow. Wheat was sown with a SKP-2,1 seeder with rolling after, in the 1st experiment an anchor coulter was used, in the 2nd - a cultivator type. Crop care consisted of applying a mixture of dicoticides and graminicides during the tillering phase. The experimental data are summarized over 7 years (2017-2023). Precipitation in June in favorable years was 48-83 mm, in dry years – 9-13 mm, in May-August, respectively, 155-245 and 85-140 mm.

The harvest was taken into account by a Sampo-500 combine harvester with sampling to find moisture and weediness of the bunker mass. The area of the plot in m^2 in experiment No 1 is general and accounting 304 and 80, in the 2nd – 270 and 99, the repetition of variants three times.

The purpose of the article is to show the yield of spring soft wheat depending on the place in the crop rotation, fertilizer and type of tillage.

3 Results and discussion

Experience 1. The characteristics of technologies have changed significantly due to the place of wheat in crop rotation. On the 1st crop, the accumulation of moisture and nitrate nitrogen is higher, therefore the grain harvest in this field is the highest (Table 1).

Table 1. The effectiveness of the technology with zero tillage, 2017-2023.

Indicator	Without fertilizer				Fertilizer			
	1st in fallow	2nd	3rd	perma nent	1st in fallow	2nd	3rd	perma nent
Productive moisture, 1 m, mm	123	114	105	106	-	-	-	-
N-NO3 ,1 m, kg/ha	129	109	91	105	-	-	-	-
Seedlings, pcs./m^2	332	319	294	289	353	342	343	305
Prod. stems, pcs./m^2	291	274	265	243	279	296	295	256
of Grains per ear, pieces	18.1	15.0	14.4	14.1	20.2	18.2	16.8	15.9
pieces Weight of 1000 grains, g	31.5	30.5	30.1	29.0	31.9	29.6	29.9	28.9
Yield, t/ha	1.70	1.30	1.18	1.06	1.83	1.69	1.63	1.29
+- from N40	-	-	-	-	0.13	0.39	0.45	0.23
t/ha Payback, kg/kg	-	-	-	-	-	9.75	11.25	5.75
LSD_{05}, t/ha	Precursor factor 0.15; fertilizer 0.21							

With the removal of sowing from the fallow field, the yield of wheat gradually decreased, and with permanent cultivation it was the lowest. The grain harvest at the 1st sowing by fallow, fluctuating over 7 years without fertilizer from 0,74 to 2,52 t/ha, averaged 1,70 t/ha. The yield of 2,5 t/ha was obtained in the 1st field after fallow only in a favorable year, as in the next field. Due to fertilizer N40 in such a year, grain harvest increased to 2,7-3,3 t/ha in crop rotation to 2,9 t/ha for permanent wheat. The effect of nitrogen fertilizer was more noticeable on the 3rd crop with an increase in yield of 0,45 t/ha. In other technologies, nitrogen additions are 0,23-0,39 t/ha. On the 1st crop, a slight aftereffect of nitrogen was observed in the 2nd and 3rd crops, which increased the yield from 1,70 to 1,83 t/ha. Yields at the level of 1,30-1,18 t/ha were obtained by removing the crop from fallow with an increase due to fertilizer to 1,69-1,63 t/ha. Wheat grain harvest is significantly lower during its permanent cultivation – 1,06 t/ha in the control and 1,29 against the background N40. Of the elements of the crop structure, the water content of the ear and the number of productive stems were more significant. The contamination of crops in the crop rotation is 6-7%, and on permanent wheat is 14,8%.

Experience 2. On long-term repeated stubble crops, wheat productivity decreased sharply to 0,97 t/ha (Table 2).

Table 2. Productivity of permanent wheat by stubble, 2017-2023

Indicator	N0P0	N20	N40	N20P20	N40P20
N-NO3 ,1 m, kg/ha	49	63	89	58	76

Seedlings, pcs./m2	310	329	348	337	321
Productive stems, pcs./m^2	273	275	282	289	300
of Grains per ear, pcs.	12.6	13.6	13.4	15.0	16.4
Weight of 1000 grains, g	27.3	27.3	27.5	29.0	28.6
Yield, t/ha	0.97	1.12	1.13	1.36	1.50
Fertilizer increase, t/ha	-	0.15	0.16	0.39	0.53
LSD_{05}, t/ha	0.06-0.25				
Payback, kg/kg	-	7.5	4.0	9.8	8.8
Gluten in the grain,%	26.4	28.0	28.4	25.6	29.2
3rd grade for 24 years of repeated crops, % years	25	58	67	25	67

The first response to the technology is the density of sowing, for which the conditions of moisture supply, nutrition and the current concentration of soil solution are important. Further changes in this indicator under favorable conditions stimulate tillering of plants, and in case of drought, their fallout, which was observed more vividly in the experiment in the driest 2021 (85 mm in May-August), when, with shoots of 289-319 plants per 1 m2, the number of productive stems for harvesting decreased to 157-182. The role of fertilizer in maintaining the number of productive stems was positive on backgrounds with phosphorus addition to nitrogen, where the ear water content increased from 12,6 in the control to 15,0-16,4. The mass of 1000 grains in these variants increased significantly during 4 out of 7 years. On average, it increased by 1,7 and 1,3 g. The payback of fertilizers with crop growth was the best against the background of nitrogen-phosphorus fertilizer in doses of N20-40P20. The effect of phosphorus inclusion in the fertilizer is explained by the low content of mobile P_2O_5 in the soil of the experiment site (40 mg/kg). The achievement of Grade 3 wheat quality is usually observed in 100% of years in fields of fallow. On permanent wheat on stubble, the accumulation of gluten increased more reliably only due to fertilizer N40P20. An improvement in quality was noted in all variants except for the application of N20P20, where the batteries were spent only on the formation of the crop, here for all 24 years of repeated sowing of wheat, the repeatability of the 3rd class was only 25% of the years, as in the control.

4 Conclusions

1. The effect of fallow in the grain- fallow crop rotation with zero tillage extended mainly to the 1st crop, where it turned out to be possible to have an average grain harvest of 1,7 t/ha in the control and against the background of nitrogen aftereffect of the 2nd and 3rd crops after fallow of 1,83 t/ha.
2. Nitrogen fertilizer increased the yield of the 2nd and 3rd crops after fallow by 0,39-0,45 t/ha, which provided a good payback. A yield of 1,06 t/ha was obtained on permanent wheat in the control, the increase from fertilizer and its payback were 2 times lower than in crop rotation.
3. The formation of a high yield of wheat by fallow was facilitated by the preservation of the number of productive stems at the level of 291 pcs. / m2, whereas on other backgrounds it fell to 274-265 and 243 with permanent cultivation. The number of grains in a pair ear reached 18,1 pieces with 14-15 in other technologies.
4. Comparison of technologies in experiments No. 1 and No. 2 showed a strong loss of long-term repeated sowing of wheat on stubble with a drop in grain harvest in the control to 0,97 t/ha. The ability to significantly increase wheat productivity in this technology was possessed only by nitrogen-phosphorus fertilizer in doses of N20-40P20 with a yield increase of 0,39 and 0,53 t/ha and a payment of 9,8 and 8,8 kg /kg.

5. Permanent wheat fertilizer also improved grain quality. When applying N20-40, the repeatability of the 3rd class was 58-67% years, and at the same doses of nitrogen in combination with phosphorus, where grain harvest is higher, it was 25-67% years with 25% years in control.

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