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The yield structure elements variation of spring wheat variety “Novosibirskaya 31” at various farming levels

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Abstract. The article describes the results of various pesticides using and pre-sowing application of nitrogen fertilizers for the planned yield for the zoned variety of soft spring wheat «Novosibirskaya 31» in the forest-steppe of the Krasnoyarsk territory. It was found that the number of plants surviving for harvesting and productive tillering had the best reaction to the using of fertilizers and pesticides from the elements of the crop structure in spring wheat. The maximum average yield increase was observed when wheat was sown on the fertilized background using a full range of pesticides, the minimum – on the fallow.

1. Introduction

Modern zoned varieties have high biological potential of productivity and yield, which can be achieved only with the positive balance of all resources including soil and climatic conditions. The variety has been and remains the main and most effective means of productivity and yield increasing, quality, sustainability and ultimately, the competitiveness of production.

Technologies of wheat cultivation allow providing its protection against diseases, weeds and pests using a wide range of fungicides, insecticides and herbicides applied in specific soil and climatic conditions. It is necessary to calculate the doses of organic and mineral fertilizers accurately for the correct using of modern agricultural technologies.

In our time the issue of studying the influence of previous crops, pesticides, as well as mineral nutrition on the quality and yield of grain is very acute. Because little studied, uncontrolled using of chemical plant protection leads to a significant change in the environment and its pollution currently. But it is also obvious that the rejection of the intensification means in agricultural production is impossible. It is necessary to develop optimal systems for the integrated using of chemicals and look for drugs that will reduce the application rate and maintain biological efficiency. In connection with the above, the analysis of the complex impact of fertilizers and pesticides on the spring wheat yield of the most popular in the Krasnoyarsk territory zoned variety «Novosibirskaya 31» in the conditions of forest-steppe is certainly relevant.

The following aim was set: to study the reaction of the spring wheat variety «Novosibirskaya 31» to the change of agricultural techniques in the conditions of the Krasnoyarsk forest-steppe.

For achieving this aim we need to solve the following tasks:

- revealing the influence of mineral fertilizers and pesticides on spring wheat productivity of the zoned variety «Novosibirskaya 31»;



- analyzing the role of mineral fertilizers and modern pesticides in the formation of spring wheat harvest structure of the zoned variety «Novosibirskaya 31».

2. Methods and results

For implementing these tasks we conducted experiments on the basis of experimental field in the training farm "Minderlinskoe" in Borsk, Suhobuzimskoe district of the Krasnoyarsk territory in 2017. As a previous crop fallow was chosen. The soil of the experimental field was luvic chernozem. Agrochemical soil analysis conducted in the agrochemical service "KRASNOYARSKY" showed very high content of K_2O and high content of P_2O_5 and very low content of NO_3 . Ammonium nitrate NH_4NO_3 (34.4%) was used as nitrogen fertilizer. Sowing was carried out in the second May decade; the seeding rate was 5.0 million grains/ha, method of sowing was ordinary, seeding depth was 5 cm, the total area of the plot was 12 m², accounting area was 10 m², repeat seeding was fourfold. Plants in the tillering phase were sprayed with modern means of protection. Assortment of pesticides was the following: Puma Super 100 0.6 l/ha, Prosaro quantum 0.6 l/ha, Detsis Expert 0.125 l/ha, Ultramag Pro 2 l/ha. Harvesting was carried out in the second decade of September.

Weather conditions of the growing season had differences in the amount of moisture and the average daily temperature regimes in comparison with the average annual data (figure 1).

The first month of vegetation was characterized by high average daily temperature, the difference with the average annual data was more than 5°C, and on the contrary the amount of precipitation was twice lower, therefore, the hydrothermal coefficient was only 0.34 units against 0.96 units of the mean annual. This value of the hydrothermal coefficient is characteristic of severe drought and the zone of deserts and semi-deserts

July in its hydrothermal characteristics was similar to the average annual data. August was characterized by higher temperatures and precipitation amounts, therefore, the hydrothermal coefficient exceeded the average annual value by 0.3 units and amounted to 1,55, which is typical for the wet zone of sufficient moisture. In 2017 September was the most abnormal month of vegetation with high rainfall, snow and as a result the hydrothermal coefficient exceeded 3.0, which affected the period of ripening and harvesting negatively.

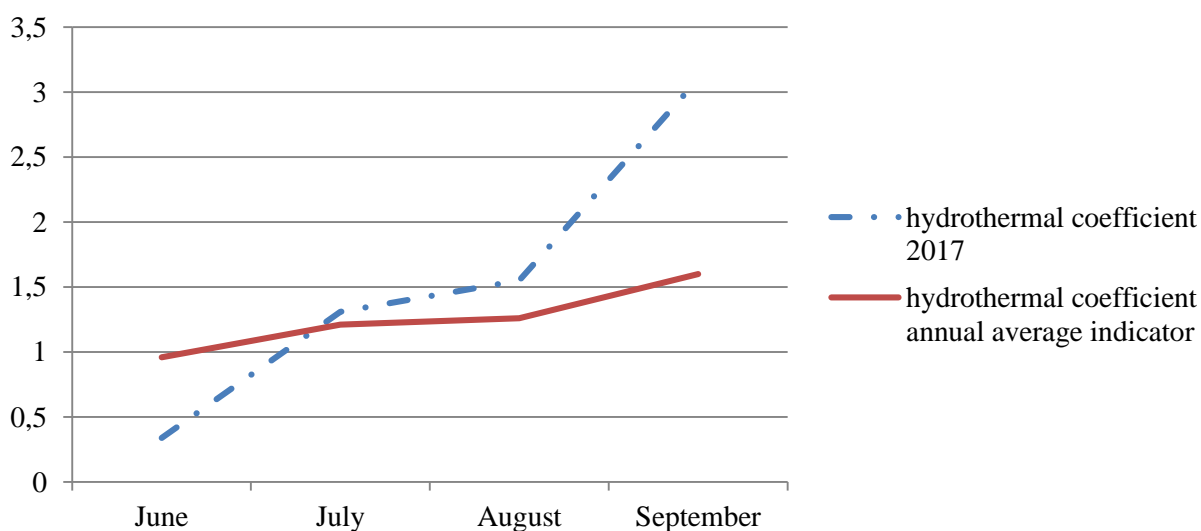


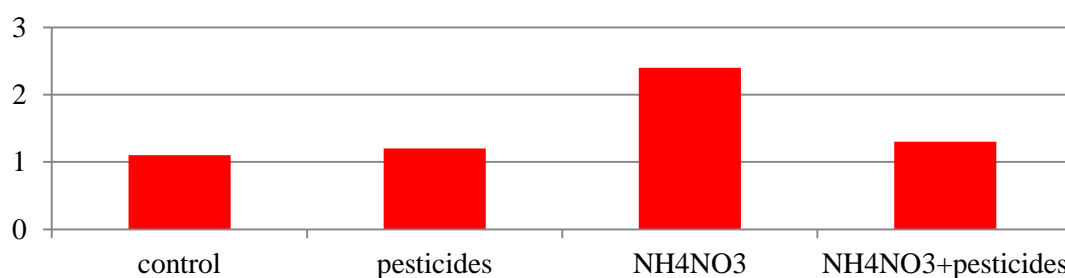
Figure 1. Conditions of heat and moisture supply in the experiment place according to the hydrometeorological service of Sukhobuzimo.

We have obtained the following results (table 1).

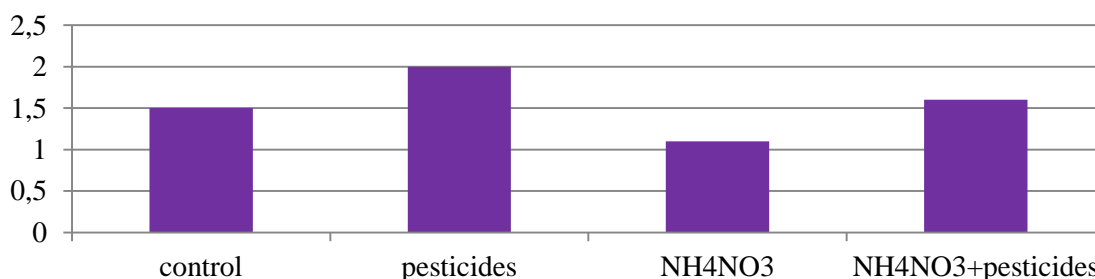
Table 1. The role of crop pesticides and fertilizers in the crop structure and productivity formation of the variety «Novosibirskaya 31».

Background of intensification	the number of plants, mln pieces/ha	productive tillering	the number of spikelets per spike, number	the number of grains per spike, number	weight of grains in spikelet, g	weight of 1000 grains, g	Yield, t/ha
control	1,1	1,5	15	34	0,92	27	15,1
Pesticides	1,2	2,0	15	39	1,16	30	28,1
NH ₄ NO ₃	2,4	1,1	14	33	0,84	26	22,7
NH ₄ NO ₃ + C3P	1,3	1,6	15	40	1,46	37	30,8
lim	1,1-2,4	1,1-2,0	14-15	33-40	0,84-1,46	26-37	15-31
M±m	1,5±0,3	1,55±0,2	14,8±0,3	36,5±1,8	1,1±0,1	30±2,5	24±3,5
reliability level (95 %)	0,96	0,59	0,79	5,59	0,44	7,90	11,02

The assessment of average indicators and their variation suggests that all elements of the crop structure had a great reaction to the introduction of modern pesticides in combination with nitrogen fertilizers.

**Figure 2.** Variability of the plants number of the variety «Novosibirskaya 31» on the background of intensification, million pieces/ha.

Of interest is a sharp increase in the total number of plants per hectare with nitrogen fertilizers, from 1.1 million to 2.4 million (figure 2). But then we can observe a sharp decrease in productive tillering and the grains number in the spike. And the weight of grains in one spike is falling more than on the unfertilized background 0, 84 g vs. 0.92 g. Such trends can be explained by the fact that the weed component outstripping the growth of cultivated plants and absorbing the reserves of productive moisture on the fertilized background grows more intensively and thus deprives wheat of any nutrients, and this affects its growth and development negatively [1].

**Figure 3.** Variability of productive tillering of the variety «Novosibirskaya 31» on the background of intensification.

Background with using of modern pesticides had the highest productive tillering in our experiments. The trait variability varied from 1.1 in the variant with the use of nitrogen fertilizers to

2.0 in the variant with pesticides (figure 3). Scope of variability was 0.9. The average productivity value for all options was fixed at the level of 1.5 units.

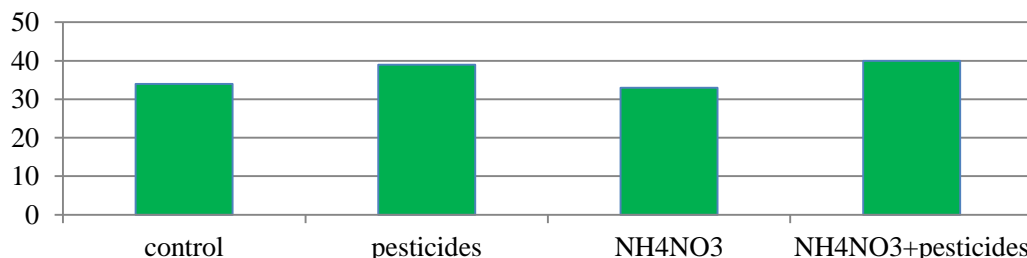


Figure 4. Variability of the grains number in the spike in the variety «Novosibirskaya 31» on the background of intensification, pieces.

A similar picture was noted in assessing the role of intensification in the study of the grains number in the spike. The reaction from the zoned variety «Novosibirskaya 31» on the high farming culture in this case was very high. The use of a full range of pesticides allowed to increase grain number in a spike to 5 grains and to pick it up from 34 to 39 pieces (figure 4). It is worth noting that the spikelets number in the spike remains unchanged, both in the application of pesticides, so when using fertilizers, so we can conclude that this feature is genetically fixed and is stable for this variety.

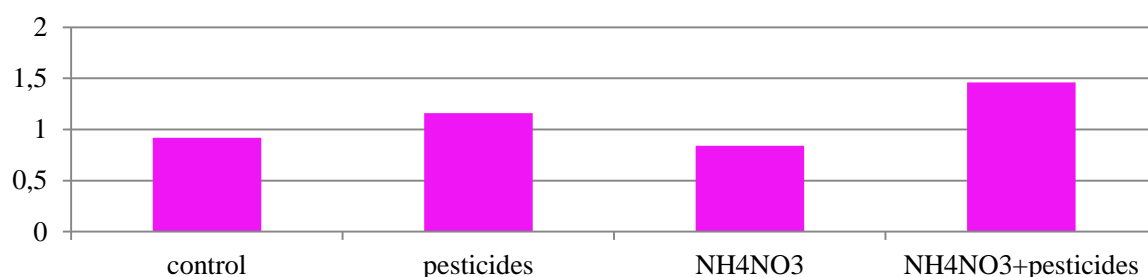


Figure 5. Variability of the grains mass in the spike of the variety «Novosibirskaya 31» on the intensification background, g.

Analysis of the grain weight variability from one spike showed that the average variants of the experiment index varied from 0.84 to 1.46 grams (figure 5). The average value of the characteristic for all intensification parameters was fixed at the level of 1.1 gram. The highest grain mass in the spike is formed in the spring wheat variety «Novosibirskaya 31» at a complex of a full range of chemical protection means against weeds, diseases and wreckers together with introduction of fertilizers. In this case it is possible to obtain average grain mass from one spike in 1.46 grams.

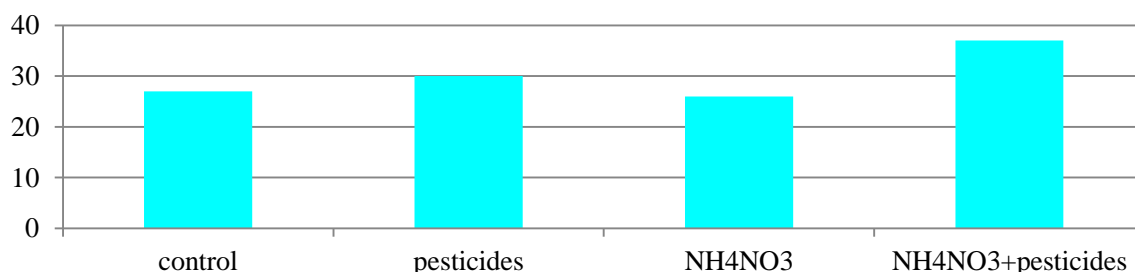


Figure 6. The variability of 1000 grains weight in the variety «Novosibirskaya 31» on the intensification background, g.

Traditionally it is considered that 1000-grains weight in spring wheat is a stable sign and amenable to adjustment loosely (figure 6). However, we have found that the minimum mass level of 1000 grains in the variety «Novosibirskaya 31» is formed in the absence of pesticides. In this variant the role of mineral substances in the soil designed to obtain the planned harvest has no effect in dry conditions. The mass of 1000 grains in the analyzed sample is only 27 grams. In the case of pesticides using that inhibit the development of pathogens and exclude the development of weeds competing for moisture the mass of 1000 grains can reach 37 grams. The average weight of 1000 grains according to the experiment variants is 30 grams, and this value is typical for the grain of strong wheat [2].

The lowest yield of the zoned variety «Novosibirskaya 31» was obtained on the fallow without means of intensification – 15.1 c/ha. This yield value can be explained easily by the fact that the productive tillering in this experiment version was only 1.1.

Introduction of modern pesticides in a full complex increases productivity on the fallow significantly. In this case the amount of harvested grains had almost doubled. This is understandable: in 2017 there was a severe drought during the critical phase in relation to moisture tillering - the formation of the stem; the hydrothermal coefficient was equal to 0.34. In conditions of water scarcity weeds oppress crops strongly, so the absence of competitors on a grain background with pesticides showed yield of 28.1 c/ha (figure 7). In this case, the amount of grains doubled only because of the increase in productive tillering: compared with the control in 0.9 units. Other elements of the crop structure also had a tendency to grow.

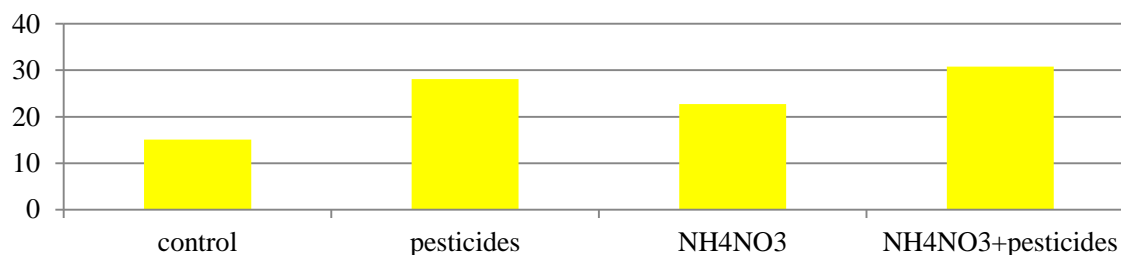


Figure 7. Yield variation when using the variety «Novosibirskaya 31» on the intensification background, c/ha.

The obtained data as a result of the experiments conducted in 2017 indicate that in conditions of moisture deficiency in the critical phase when the generative organs of the inflorescence and flower are formed the introduction of high doses of fertilizers on the fallow played a positive role. Fallow accumulated enough moisture to survive an unfavorable critical period in spring wheat without compromising yield. In our case the amount of grains per 1 ha was 22.7 c/ha, which was almost 8 kg/ha more than on the unfertilized background.

The peak in the spring wheat harvest of the variety «Novosibirskaya 31» was observed with the using of all means of intensification, in this case the amount of harvested grain in this version reached 30.8 c/ha.

After processing the data by methods of mathematical statistics [3] we obtained the following results (table 2):

Table 2. Dispersion analysis results of the background cultivation influence on the productivity of spring wheat in the forest-steppe of the Krasnoyarsk territory.

Source of variation	SS	df	MS	F	P- Value	F critical
Among backgrounds	5300,044	6	883,3407	72,08966	6,43E-13	2,572712
Inside backgrounds	257,3206	21	12,25336	-	-	-
Total	5557,365	27	-	-	-	-

Statistically significant ($p < 0.001$) differences in the average yield of spring soft wheat of the variety «Novosibirskaya 31» were found between the studied backgrounds (at $P = 5,58E-08$). Index of influence was 95.4 %. The maximum average yield increase was observed when wheat was sown on the fertilized background using a full range of plant protection products (30.8 c/ha), the minimum (15.1 c/ha) – on the fallow (control).

On the basis of the conducted research it is established that:

- Number of plants surviving for harvesting and productive tillering had the greatest reaction to the using of fertilizers and chemical pesticides from the elements of the crop structure in spring wheat variety «Novosibirskaya 31», their value varied from 1.1 to 2.4 million/ha and from 1.1 to 2.0 units respectively.
- Statistically significant ($p < 0.001$) differences in the average yield of spring soft wheat of the variety «Novosibirskaya 31» were found between the studied backgrounds (at $P = 5,58E-08$). The index of influence was 95.4 %.
- The maximum average yield increase was observed when wheat was sown on the fertilized background using a full range of plant protection products (30.8 c/ha), the minimum (15.1 c/ha) – on the fallow (control).

Acknowledgments

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