ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

The Formation Of Spring Wheat Seedlings And Yield In The After-Effect Of Organic And Non-Traditional Fertilizers.

A Kh Kulikova[1]*, SN Nikitin[2], AL Toigildin[1], and GV Saidyasheva[2].

[1]FSBEI HE Ulyanovsk State Agrarian University 1, New Venets blvd., Ulyanovsk, 432063, Russia.
[2]FSBRI «Ulyanovsk Research Institute of Agriculture» 19, Institutskaya str., settlement of Timiryazevsky, 433315, Ulyanovsk region, Ulyanovsky district, Russia.

ABSTRACT

The effectiveness of the after-effect of various types of organic fertilizers and WWS was studied in the long-term field experiment, on leached black soil. It has been found that in grain crop rotation, organic and non-traditional fertilizers in the after-effect had a positive effect on the formation of seedlings and the yield of spring wheat. The yield of spring wheat varied on average over 3 years in the range of 2.88–3.52 t / ha. The highest effectiveness of the after-effect was observed when using manure (50 t / ha) and sewage sludge (50 t / ha). They were slightly inferior to the option of green manure as a green fertilizer.

Keywords: organic fertilizers, waste water (sewage) sludge, crop rotation, yielding capacity, spring wheat.

Corresponding author

ISSN: 0975-8585

INTRODUCTION

Biologization is one of the main guidelines of improving the systems of farming in the environmental aspect, which should be considered as the intensification of biological factors in order to create favorable patterns of agrocenoses' functioning, to ensure the production of agricultural products in accordance with sanitary standards, and also keep the soil in an ecologically safe state [1].

Organic fertilizers (manure, straw, green manure, etc.) are the key ones in the cultivation of crops, the value of which is now increasing in many times, especially in connection with the necessity of biologization of farming. At the same time organic fertilizers have long after-effect, the positive effect on the crop yield is the following: on sod-podzolic sandy and sandy soils for 3–4 years, light and medium loamy - 6–8 years, heavy loamy and clay - up to 10–12 years.

The greatest effect can be obtained from the use of fertilizers by applying them in crop rotations [2, 3, 4, 5]. At the same time, it is important to correctly distribute organic and mineral fertilizers in the fields, to ensure the transition to crop rotation farming and sowing green manure crops. Taking account of the biological characteristics of cultivated crops, their economic importance, the supply of productive moisture to the soil, consideration of the effects of fertilizers are obligatory requirements of modern agriculture of the forest-steppe Volga region.

OBJECTS AND RESEARCH METHODS

Agroclimatic values for the years of research had a sharp contrast, showing fluctuations in temperature and relative humidity, uneven distribution of precipitation during the year, with significant number of dry winds, which allowed us to identify the response of the experimental crop to the studied factors under different weather conditions.

The soil of the experimental plot is leached black soil, heavy clay-loam on yellow brown carbonate clay. The humus content in the topsoil was 6.59%, total nitrogen — 0.26%, mobile $P_2 O_5$ and K_2O (according to Chirikov) 215 and 103 mg / kg of soil, pH 6.6, the total of absorbed bases was 556 mg / kg of soil .

The field trials were scheduled in 4 time replication of a grain and fallow crop rotation: complete fallow - winter wheat - spring wheat - pea - winter wheat — spring wheat. The predecessor of the experimental crop was winter wheat. The sown area of the plots is 174 m^2 (5.8 × 30), the registration area is 120 m^2 (4 × 30).

The experimental design comprised 7 main options: 1) control, 2) manure 25 t / ha (1 dose), 3) manure 50 t / ha (2 doses), 4) sewage sludge (WWS) is equivalent in N 25 t / ha manure (1 dose), 5) WWS is equivalent in N 50 t / ha of manure (2 doses), 6) straw is equivalent in N 25 t / ha of manure, 7) green manure equivalent in N 25 t / ha of manure.

The main objects of research: manure of cattle, straw, green manure (vetch and oat mixture), sewage sludge from the waste water treatment plant of Ulyanovsk.

Manure, straw and sewage sludge were plowed under with a heavy disc harrow to a depth of 10–12 cm in complete fallow (May-June). Vetch and oats crops were cultivated as green manure. The variety of spring vetch is Lgovskaya 22, oats variety - Droug. The seeding rate is 3 million vetch seeds (150 kg / ha) and 2.5 million oat seeds (70 kg / ha). The sowing was carried out in the first decade of May using nitrophoska ($N_{15}P_{15}K_{15}$). Green manure was plowed under in the 1-2 decades of July. Cultivation technologies are generally accepted in the Ulyanovsk region.

RESULTS AND THEIR DISCUSSION

One of the main factors for the formation of high yields is the timely emergence of even seedlings and the formation of the optimum stalk thickness [6].

ISSN: 0975-8585

The field germination rate was expressed as the percentage of the number of full seedlings to the number of sown seeds in the field. Field germination in our experiments was the lowest in the control variant and averaged 67% over three years. The use of organic and non-traditional fertilizers increased field germination. The application of WWS provided field germination at the level of 71–73% (Fig. 1).

The assessment of the standing density of spring wheat plants was carried out during the period of full germination and before harvesting. The best results for this indicator were on the variants with the introduction of manure and sewage sludge in high doses for 389–403 plants / m^2. At the same time, the number of spring wheat plants that have sprung up has increased over the years on average by 2.0–8.0%, respectively.

In the variant with the application of manure in an increased dose, the preservation of spring wheat plants was maximum and amounted to 79% on average for three years, the smallest was observed in the control variant -69%.

The leaf surface area was determined by the method of measuring leaf biomass of 10 plants from a plot on two non-adjacent replicates in the phases of plant development. Knowing the density of standing plants per 1 m^2, the leaf area per 1 ha was calculated. A.A. Nichiporovich (1970) considers 40–50 thousand m^2 / ha as the marginal area of wheat leaves. If the area is above this size, then the leaves are shaded and the intensity of photosynthesis decreases.

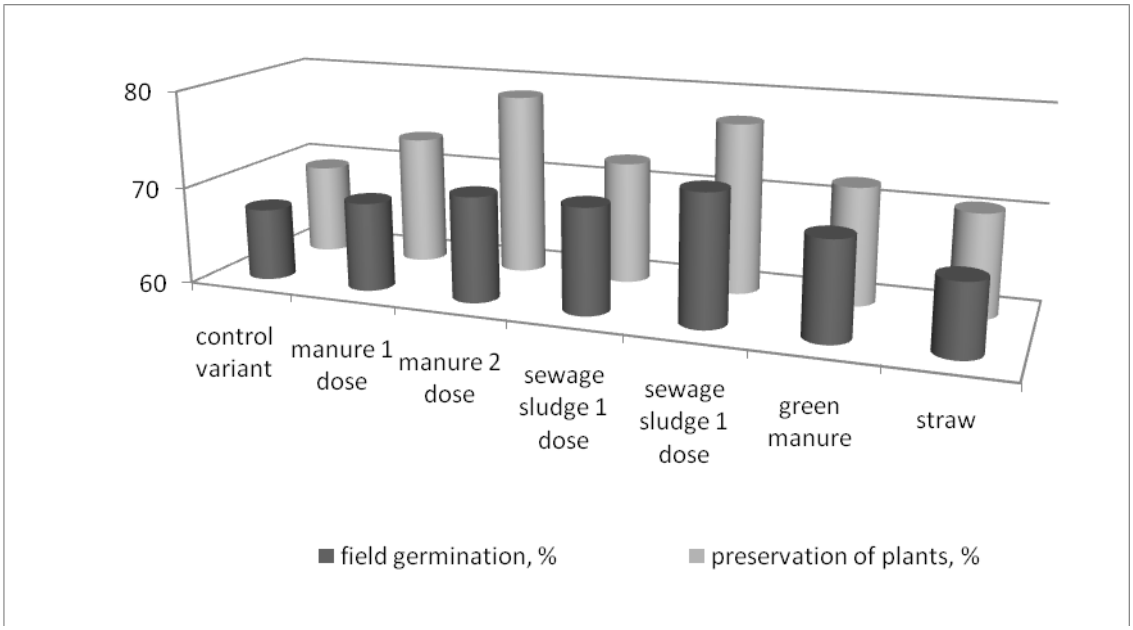

Figure 1: The influence of the aftereffect of organic and non-traditional fertilizers on the full germinating capacity of spring wheat seedlings and preservation of plants till the harvest for an average of 3 years

Organic and non-traditional fertilizers had a direct influence on the formation of the leaf surface of spring wheat. Comparing the assimilation surface of the leaves of plants during vegetation, it should be noted that it reached its maximum size in the flowering phase (Table 1) and was at the level of 34.1–36.5 thousand m^2 / ha.

ISSN: 0975-8585

Table 1: Formation of the leaf surface in spring wheat development phases ,thousand m^2/ha (average for 3 years)

Variant	Tillering	Shooting	Flowering
1.Control	5,9	27,8	34,1
2. Manure 1 dose	6,7	28,9	35,8
3. Manure 2 doses	6,9	29,6	36,5
4. WWS 1 dose	6,5	28,9	35,8
5. WWS 2 doses	6,9	29,2	36,3
6. Green manure	6,4	28,7	35,3
7. Straw	6,8	28,2	34,7

The results of our research suggest that, in general, for 3 years, the leaf area in the tillering phase changed from 5.9 to 6.9 thousand m^2 / ha. The most intensive growth and increase in the assimilation surface of the leaves in all variants were observed in the booting phase and varied from 27.8 to 29.6 thousand m^2 / ha. A significant increase in the assimilation surface of the leaves was found in the variants of the after-effect of manure and WWS in higher doses.

The regression analysis of experimental data showed a close relationship between the grain yield and leaf area in the tillering, booting, and flowering phases, obtained by direct determination. The corresponding regression equations in this case are as follows:

Tillering	y = 0,502x+0,002	(R^2 = 0,747)
Shooting	y = 0,300x – 5,336	(R^2 = 0,758)
Flowering	y = 0,214x – 4,288	(R^2 = 0,787)

where У – yield of grain, t/ha; t/ha; x – assimilation surface of leaves;
R^2 – approximation coefficient.

To form the yield it is important not only to get a large leaf surface, but also to increase the length of its functioning. The net productivity of photosynthesis (NPP) reflects the ability of plants to accumulate dry matter per day for 1 m^2 of leaves. According to the data obtained by A.A. Nichiporovich (1970) the magnitude of the NPP fluctuates from 4 to 6 g / m^2 day. Its maximum values reach 12–14 g / m^2 per day. The indices of the NPP of seedlings depend largely on the availability of nutrients to the plants [7, 8, 9].

Table 2:Net productivity of spring wheat seedlings, g / m^2 a day (mean value for 3 years)

Variant	Plant development phase	
	Tillering –shooting	Shooting–flowering
1. Control	8,3	4,7
2. Manure 1 dose	8,5	4,9
3. Manure 2 doses	8,6	5,3
4. WWS 1 dose	8,7	5,1
5. WWS 2 doses	8,8	5,3
6. Green manure	8,6	4,9
7. Straw	8,4	4,7

The net productivity of photosynthesis (NPP) was calculated with the use of the Kidd, West and Briggs formula: $NPP = (B_2 – B_1) / (L_1 + L_2) \times 0.5 \times n$, where: B_1 and B_2 are the dry biomass of the yield sample taken at the beginning and end of the accounting period, g; $B_2 - B_1$ - increase in dry mass for the reference period of n days, g .; $(L_1 + L_2) \times 0.5$ – the average working leaf area during this period of time, m^2; n is the number of days.

The data in Table 2 indicates that, on average, for 3 years, the NPP fluctuated from 4.7 to 8.8 g / m^2

ISSN: 0975-8585

per day. During the stage of shooting - flowering the NPP was from 4.7 to 5.3 g / m^2 a day. The maximum value of the NPP was observed in the period of the greatest development of the leaf surface of spring wheat (the stage of tillering - shooting). In the after-effect of organic fertilizers and WWS, the NPP varied from 8.3 to 8.8 g / m^2 a day, on variants with manure and WWS in high doses it was the highest and amounted to 8.6–8.8 g / m^2 a day.

Based on the correlation analysis, a positive relationship was established between the yield (y) and the net productivity of photosynthesis (x) of spring wheat in the corresponding periods (Fig. 2).

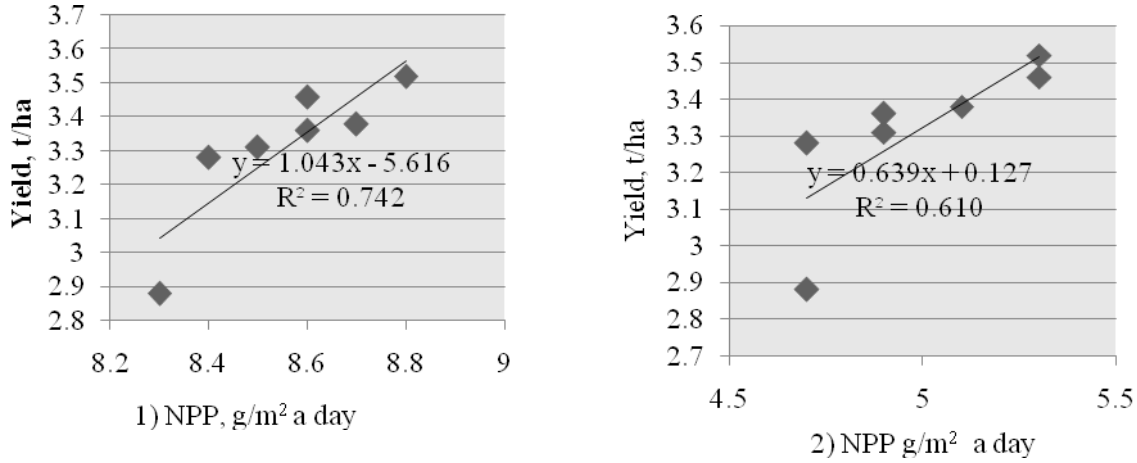

Figure 2: Relationship between the spring wheat yield and the NPP in the stage of 1) tillering-shooting, 2) shooting - flowering (mean values for 3 years)

It should be noted that, on average, for 3 years, as our studies have shown, when organic fertilizers and WWS were applied, the yield of spring wheat increased by 0.4–0.64 t / ha or by 14–22% (Table 3). Higher increases in crop yields were achieved when manure was applied at a rate of 50 t / ha for the previous crop and sewage sludge applied in equivalent doses of nitrogen to manure. The yield increase was respectively 0.58 and 0.64 t / ha. The variant of a green manure crop as a green fertilizer was insignificantly inferior to them, which explains the expediency and necessity to use green manure crops as an organic fertilizer for crops.

Table 3: Influence of various types of organic fertilizers and WWS on the yield of spring wheat (average for 3 years.), t / ha

Variant	Yield		
	t/ha	+/- to the control variant	% to the control variant
Control	2,88	–	–
Manure 1 dose	3,31	0,43	15
Manure 2 doses	3,46	0,58	20
WWS 1 dose	3,38	0,50	17
WWS 2 doses	3,52	0,64	22
Green manure	3,36	0,48	17
Straw	3,28	0,40	14
Mean value	**3,31**		
LSD_{05}	**0,23**		
P, %	**2,28**		

CONCLUSION

1. The full germinating capacity of spring wheat seedlings and their preservation varied significantly, depending on weather conditions as well as on the action of organic and non-traditional fertilizers. Various types of organic fertilizers and WWS practically did not affect the field germination and

plants' preservation, but contributed to some increase of these indicators.

2. The highest index of the assimilation surface of the leaves and PFD was observed on the variants with the introduction of manure and WWS in high doses. Based on the correlation analysis, a positive relationship has been established between the yield, leaf area and net photosynthetic productivity.
3. The highest efficiency of the after-effect of organic and non-traditional fertilizers was observed in the grain and fallow crop rotation on leached chernozem of the Middle Volga forest-steppe, when manure in (50 t / ha) and sewage sludge (50 t / ha) was used. The variant with the use of a green manure crop as a green fertilizer was insignificantly inferior to them, the yield of spring wheat increased by 0.40–0.64 t / ha, or by 14–22%.

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