ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Effect of No-till technology on erosion resistance, the population of earthworms and humus content in soil.

Viktor Korneyevich Dridiger*, Evgenia Ivanovna Godunova, Fedor Vladimirovich Eroshenko, Roman Sergeevich Stukalov, and Rasul Gadzhiumarovich Gadzhiumarov.

North-Caucasian Federal Scientific Agrarian Center, Nikonov str. 49, Mikhailovsk 356241, Russia

ABSTRACT

On chernozem ordinary zone unstable moistening Stavropol edge studied the effect of No-till technology for soil erosion control stability, population earthworms and its content of humus in the first rotation field crop rotation. The studies were conducted in a stationary experiment in 2013-2016, where crop rotation (soybean - winter wheat - sunflower - corn) with traditional crop cultivation technology and the same crop rotation with cultivation of crops using No-till technology are deployed in space by all fields. In the traditional technology, the main soil cultivation for spring crops included stubble plowing in 2 tracks and autumn plowing to a depth of 20-22 cm, winter wheat was subjected to a double treatment with a disc harrow (8-10 cm) and pre-sowing cultivation. In the No-till technology, no treatments were performed, so on the soil surface, on average, 6.36 tons of crop residues were crop rotation fields that provided good wind resistance of the soil and reliably protected it from wind and water erosion. In such soil, earthworms live, the number and mass of which per 1 m2 in the soil layer 0-20 cm is 5.3 and 5.0 times greater than in the soil treated according to traditional technology. During the first rotation of the four-field crop rotation in the 0-30 cm layer of untreated soil, the humus content increased by 0.02-0.15%, whereas in the soil treated according to traditional technology its content in the 0-20 cm layer decreased by 0.02- 0.04%, and only in the layer of 20-30 cm, which were not processed, there was an increase of this index by 0.05%.

Keywords: No-till technology, traditional technology, plant residues, anti-erosion resistance, earthworms, humus.

Corresponding author

ISSN: 0975-8585

INTRODUCTION

In Russia, a large number of scientific studies have been carried out, which have made it possible to recommend optimal soil cultivation technologies for different agricultural crops for each soil and climate zone [10, 11]. However, tillage is the most costly technological operation, which consumes up to 30-35% of the costs from all costs of cultivating crops [12]. Therefore, in recent years, more and more interest has been brought to the technologies of cultivation of field crops without tillage [9, 14], in which weeds are destroyed by herbicides of continuous action from the group of glyphosates, and high yields of cultivated crops are obtained by applying mineral fertilizers [1, 3].

At the same time, a deep scientific substantiation of the applicability of such technologies in various soil and climatic zones of the country is still not enough. Therefore, the aim of our research is to study the influence of traditional technology and No-till technology on erosion resistance, the number of earthworms and the humus content in the soil in the first rotation of the field fruit-bearing four-field crop rotation.

MATERIALS AND METHODS

The studies were carried out on the experimental field of the North Caucasus Federal Scientific Center located in the zone of unstable moistening of the Stavropol Territory. The annual sum of effective temperatures here is 3400-3500 °C. The duration of the frost-free period is 180 days. The annual amount of precipitation varies from 540 to 570 mm, during the vegetation period 350-400 mm, GTK = 0.9-1.1 [5] falls.

The soil of the experimental site is ordinary black chernozem, powerful, heavy loamy, with medium phosphorus, potassium and low humus content. The years of research varied in the amount of precipitation. In 2013 and 2014, 652 and 626 mm of precipitation fell, 98 and 72 mm more, and in 2015 and 2016, by 26 and 53 mm less than the mean multiyear values.

The studies were carried out in a stationary experiment, where crop rotation (soybean - winter wheat - sunflower - corn) with traditional crop cultivation technology (control) and the same crop rotation with cultivation without tillage (No-till technology) are spread in space by all fields.

The main tillage in the control crop rotation for spring crops included stubble plowing in 2 tracks and autumn plowing to a depth of 20-22 cm. Winter wheat was treated twice with a disc harrow (6-8 and 8-10 cm) and pre-sowing cultivation. When cultivating the studied cultures using No-till technology, no tillage was performed, but 5-7 days before spring crops were planted, the plots were sprayed with a herbicide of continuous action from the group of glyphosates, before the sowing of winter wheat (after soybean), the herbicides were not used.

Under all crops of both crop rotations, the recommended dosages of mineral fertilizers were recommended by scientific institutions. The sowing of winter wheat and soya by traditional technology was carried out by the ordinary disk seeder SZ-3,6, sunflower and corn by the Optush sowing machine, on unprocessed soil all crops were sown with the Gimetal seeder (manufactured in Argentina) equipped with corrugated discs (turbodiscs) and two-disc coulters for sowing seeds and fertilizers.

In the experiment, soil erosion resistance was determined method by the E.I. Shiyatogo [15]. The number of earthworms in the soil in the crops of the studied crops was determined in April according to the method of M.S. Gilyarova [6]. The humus content before the laying of the experiment and in the last year of rotation of the crop rotation was determined in accordance with GOST 26213-91 [8]. Repeatability of the experiment is 3-fold, plot area is 300, accounting is 90 m^2.

RESULTS AND DISCUSSION

During the harvesting of the cultures studied in the experiment for both technologies, the plant remains were crushed by a combine and distributed uniformly over the surface of the plots. During the rotational rotation of the crop rotations, on an average for a year, according to the traditional technology, 5.62% of the crop rotation area were converted per 1 ha of crop rotation, and 6.36 tonnes of plant residues from cultivated crops, without tillage. Most of the plant remains remain after harvesting maize - from 7.5 to

8.9 t / ha and winter wheat - 6.3-7.3 t / ha, soy and sunflower are much less. On the control crop rotation during the main soil cultivation, plant residues were embedded in the soil, in the crop rotation study they remained unaffected on the surface.

The plant residues remaining on the soil surface and the more structured upper five-centimeter layer of soil when cultivating the studied crops using No-till technology provide the soil surface in spring, before planting spring crops, strong wind resistance, whereas the soil treated according to traditional technology due to the absence of plant residues on its soil surface, is strongly not wind-resistant (Table 1).

Table 1: Influence of field crop cultivation technology on soil erosion resistance in spring (average for 2013-2016)

Technology	Crop	Index			Degree of erosion
		amount of stubble, pcs / m^2	lumpiness of the layer 0-5cm, %	erodibility, g	
Traditional	soybean	0	25,7	124,3	SNV
	winter wheat	124	31,2	142,2	SNV
	sunflower	0	26,7	172,1	SNV
	corn	0	26,6	118,9	SNV
No-till	soybean	518	30,5	7,6	SW
	winter wheat	318	58,2	8,2	SW
	sunflower	334	36,7	13,9	SW
	corn	452	38,8	9,15	SW

Note: SW - strongly windproof; SNV - strongly non-windproof

That is, the technology of cultivation of any culture without tillage (No-till) can be considered public health, whereas traditional technology with soil treatment, due to the lack of plant residues on its surface, is strongly not wind-resistant, that is, erosionally dangerous. Therefore, sunflower and corn, like row crops, when cultivated according to traditional technology are erosion-hazardous crops, and when cultivated using technology without tillage become soil protective.

This is of great importance in preserving and improving soil fertility, since with increasing wind, which is quite often observed in the zone of unstable moistening of the Central Ciscaucasia in the spring, traditional soil is subjected to wind erosion and strong dust storms are observed, which carry away a huge amount of the uppermost fertile layer soil [13].

In this area there are very often and intense precipitation in the form of showers [4] that the treated soil and water erosion causes soil erosion in gullies and ravines, especially in rain showers. The constant presence of plant residues on the soil surface when cultivating field crops using No-till technology reliably protects it from wind and water erosion.

The same plant remains on the soil surface are food for earthworms [7], and the more plant remains, the more earthworms. Thus under soya and sunflower, which are placed after the corn and winter wheat, leaving the largest number of plant residues upper 20 centimeters layer for research three years soil on average was 55 and 41 copies of earthworms per 1 m^2, whereas under corn and winter wheat, cultivated after sunflower and soybeans, leaving significantly less plant residues, only 12 and 24 specimens, or 1.7-4.5 times less (Table 2).

On the average for the crop rotation, where all crops were cultivated according to No-till technology, 33.1 specimens / m^2 of earthworms with live weight of 8.5 g lived in the soil for the years of research, whereas according to traditional technology in the dump-treated soil, where there are no plant residues, hence there is no food for worms, there were only 3.0 specimens / m^2 with live weight 0.9 g, which is 5.3 and 5.0 times less than in untreated soil.

ISSN: 0975-8585

Table 2: Effect of field crop cultivation technology on the number and mass of earthworms in the soil layer 0-20 cm

Technology	Crop	Amount, specimens /m^2				Weight, g / m^2			
		2014	2015	2016	average	2014	2015	2016	average
Traditional	soybean	6	5	0	4,0	1,6	1,4	0	1,0
	wheat	16	15	14	15,0	4,7	3,0	4,4	4,0
	sunflower	2	4	3	3,0	0,3	1,0	1,3	0,9
	corn	2	3	4	3,0	0,3	0,9	1,6	0,9
Average		6,5	6,8	5,3	6,2	1,7	1,7	1,8	1,7
Without tillage	soybean	86	26	52	55,0	22,9	6,7	16,3	15,3
	wheat	30	18	25	24,0	8,5	5,2	6,1	6,6
	sunflower	72	27	25	41,0	15,2	4,6	7,0	8,9
	corn	14	10	12	12,0	4,4	1,5	3,7	3,2
Average		50,5	20,3	28,5	33,1	12,8	4,5	8,3	8,5

Favorable conditions for the existence of earthworms in untreated soil, in addition to the presence of a rather large amount of plant residues, also provide an optimal structure and density of the soil when cultivating crops using No-till technology [2]. Earthworms, in turn, provide the soil with good aeration due to the penetration of air through the worms left vertical moves. According to them, the moisture of the atmospheric precipitation penetrates into the depth of the soil profile, which is used by plants to grow and form a crop.

It should be noted that the main number of earthworms (70-75%) for both technologies lives in the upper ten-centimeter layer of soil, which indicates its purity and environmental safety. This is also evidenced by the determination of the residual quantity of glyphosate acid (active ingredient of herbicides of continuous action from the group of glyphosates) conducted in the Test Center of the Branch of the Federal State Unitary Enterprise "Rosselkhozentr" for the Krasnodar Territory, which, in the cultivation of crops for both technologies, neither in soil nor in the products obtained.

The cultivation technologies had an effect on the humus content in the soil. Against the backdrop of the application of mineral fertilizers using traditional technology, on the average, in the soil layer 0-30 cm, by the end of the first rotation of the crop rotation, the humus decreased by 0.01%, which is within the error of the experiment (Table 3).

Table 3: Effect of cultivation technology on the content of humus in the first rotation of the field four-field crop rotation, %

Technology	Layer of soil, cm	Initial, 2013	After the 1st rotation, 2016	+/-	
				at the end of rotation	from technology
Traditional	0-10	3,96	3,92	-0,04	-
	10-20	3,84	3,82	-0,02	-
	20-30	3,62	3,67	0,05	-
No-till	0-10	3,96	3,98	0,02	0,06
	10-20	3,84	3,89	0,05	0,07
	20-30	3,62	3,77	0,15	0,10
$HCP_{0,95}$ for technology		-	0,06	-	-
$HCP_{0,95}$ for soil layer		-	0,04	-	-
$HCP_{0,95}$ for private mediums		-	0,05	-	-

In technology without soil treatment during the same period, the humus content increased by 0.07%, or 0.08% more than in traditional technology. The greatest increase (0.15%) is observed in the soil layer of 20-30 cm, where in the anaerobic conditions the humification of the remaining plant roots proceeds in the soil. In

this layer of soil, humus content is increased by 0.05% and by traditional technology, since this soil layer has not been treated.

In the upper layers of the soil under aerobic conditions, with air access, a complete decomposition of plant and root residues to the nutrients that plants consume during the growing season, and humus in the unprocessed soil is formed less - 0.02-0.05%, and in the cultivated soil the amount is reduced by 0.02-0.04%.

CONCLUSION

In the cultivation of crops without tillage (No-till technology) in the first rotation of the four-field field crop rotation, existing plant residues of the preceding crops provide reliable protection of the soil against wind and water erosion and contribute to an increase in the population of earthworms in the soil. No-till technology in soil is higher than in sowing by traditional technology, humus accumulates and soil fertility is increased, which ensures higher yield and economic efficiency of crop cultivation using this technology.

REFERENCES

[1] Effect of increasing doses of mineral fertilizers on development of root rot pathogen fusarium in crops winter wheat / Esaulko, A.N., Salenko, E.A., Sigida, M.S., Golosnoy, E.V., Gurueva, A.Y. // Research Journal of Pharmaceutical, Biological and Chemical Sciences 7 (3), pp. 2574-2577.

[2] Effect of No-till Technology on The Available Moisture Content and Soil Density in The Crop Rotation / Kulintsev V.V., Dridiger V.K., Godunova E.I., Kovtun V.I., Zhukova M.P. // Research Journal of Pharmaceutical, Biological and Chemical Sciences. – 2017. - # 8(6). – Page No. 795-799.

[3] Changes in the content of organic matter in black soils of Central Ciscaucasia caused by their agricultural use / Tshovrebov, V.S., Faizova, V.I., Kalugin, D.V., Nikiforova, A.M., Lysenko, V.Y. // Biosciences Biotechnology Research Asia 13 (1), pp. 231-236.

[4] Badakhova, G.Kh. Investigation of the stability of mean multi-year air temperature values / G.Kh. Badakhova // Materials of the 47th scientific-method. Conf. Stavropol State University. - Stavropol: Stavropol State University, 2002. - P. 52-58.

[5] Badakhova, G.Kh. Stavropol Territory: modern climatic conditions / G.Kh. Badakhova, A.V. Knutas. - Stavropol: State Unitary Enterprise "Territorial Communication Networks", 2007. - 272 p.

[6] Gilyarov M.S. Methods of soil zoology. - Moscow: Nauka, 1975.

[7] Godunova E.I. Soil mesofauna of forest-steppe and steppe agrolandscapes of Central Ciscaucasia: monograph / E.I. Godunova, S.I. Sigida, M.B. Patyuta. - Stavropol: AGRUS of the Stavropol State Agrarian University, 2014. - 176 p.

[8] GOST 26213-91. Method for determining humus: Interstate Standard / Official publication // Interstate Council for Standardization, Metrology and Standardization. - Minsk: IEC Publishing Standards, 1992.

[9] Dridiger V.K. Climatic, soil and economic prerequisites for the introduction of a system of farming without tillage in the Stavropol Territory / V.K. Dridiger, N.N. Shapovalova // Bulletin of the Stavropol Scientific Research Institute - 2014. - № 6. - P. 58-68.

[10] Konischev A.A. Soil cultivation: yesterday; Today; tomorrow / A.A. Konischev. - Ivanovo: Ivanovo State Agricultural Academy, 2013. - 127 p.

[11] Petrova L.N. Improvement of soil cultivation on the basis of new generation equipment / L.N. Petrova, E.I. Lipkovich, V.K. Dridiger, V.B. Rykov, D.K. Zaitsev, G.A. Zhidkov // Innovations, land management and resource-saving technologies in agriculture / Sat. doc. Vseros. scientific-practical. Conf. VNIIIZiPPE. - Kursk, 2007. - P. 253 - 257.

[12] Rykov V.B. Results of a comparative assessment of mechanized technologies for cultivation of grain crops / V.B. Rykov, S.I. Kambulov, V.K. Dridiger // Innovative technologies in science and education - Itno 2014: Sat. sci. tr. Int. scientific-practical. Conf., 2014. - P. 370-375.

[13] Ryabov E.I. The influence of unfavorable weather conditions on the harvest and land resources of the Stavropol Territory / E.I. Ryabov. - Stavropol: The Stavropol Prince. publishing house, 2001. - 319 p.

[14] Stepnykh N.V. Increase the efficiency of crop production due to minimal and zero technologies / N.V. Stepnykh, S.A. Kopyla // Protection and quarantine of plants. - 2015. - No. 6. - P. 8-10.

[15] Shiyaty, E.I. Methods for estimating the wind resistance of the soil surface and determining the width of the strips for strip placement of crops / E.I. Shiyaty // Methodological recommendations for carrying out field and laboratory experiments on agriculture and plant growing. - Tselinograd: All-Union Research Institute of Grain Economy, 1968. - P. 3-8.