The influence of varieties of sideral crops and their combinations on the structural state of meadow-turf soil of Sakhalin island

Samutenko Lyubov Viktorovna
Candidate of Agricultural Sciences, Lead Research Officer
Sakhalin Research Institute of Agriculture

Abstract. The influence of green manure crops of different botanical affiliation (cabbage, legumes, bluegrass) and their combinations on the structural state of meadow-soddy heavy loamy soil has been established. The effect of the biomass of almost all green manure on the creation and preservation of the most agronomically valuable soil units (68.7-76.7%) was assessed positively. The most efficiently influencing the structure of the soil included mono-sowing of oil radish, combinations of spring rape and oats with annual lupine, white mustard with oats and lupine.

Keywords: green manure, action, soil structure.

Interest in the structural state of the soil, which, according to researchers [1-4] is one of the most important properties of fertility, and the factors of its formation, does not dry up to the present time [4-6]. The main factor in the formation of the most valuable soil aggregates in the agronomic concept is organic matter [4, 6, 7]. It is well known that its main source is various types of organic fertilizers, which include green manure [8, 9]. The positive role of the latter in creating a favorable soil structure has been assessed in numerous studies [5, 10, 11].

In island agriculture, the use of green manure can be considered, first of all, from the standpoint of a supplier of plant organic matter to the soil and only for a very limited number of crops (winter rye and triticale, fodder root crops, perennial grasses) - as a direct source of mineral nutrients. This is due to the peculiarities of the island's climatic conditions: the optimization of the temperature regime and soil moisture begins here in the second half of May. In this situation, the beginning of the growing season of most of the agricultural plants cultivated on the island, including those intended for green manure, falls on practically the same dates.

The main results characterizing the green manures used in our experiments and their complexes as sources of biomass, NPK, humus, the effect of green fertilizers on the nutrient regime of the soil and the production process of rapeseed and oats are given in the source [12].

The proposed communication presents experimental data on the effect of a variety green manure mass on the structural state of the meadow-soddy heavy loamy soil of about. Sakhalin.

The purpose of the research - is to establish the degree of influence of varieties of green manure and their mixtures as a biological means of reproduction of fertility on the main agronomic properties of the soil.

The primary tasks of the research included the determination of the composition of green manure crops capable of adapting to the peculiar soil and climatic conditions of the island, establishing the volume of soil replenishment with plant organic matter and nutrients, and taking into account the influence of green manure on the structure of meadow soddy heavy loamy soil.

Methodology. Experiments to study the effectiveness of green manure crops and their aftereffect were laid on the lands of the SakhRAI. The meadow-soddy old-arable soil of the experiments was characterized by significant heterogeneity. The acidity indicators varied within the very acidic (pH 3.4) - medium acid (pH 4.8) categories. The humus content was 3.23-4.76%. The amount of mineral nitrogen was low - 15.8-18.1 mg/kg (N-NO3 + N-NH4). The soil was characterized by a very high content of mobile forms of phosphorus - 354.0-385.0 mg/kg, medium and high - 114.0-130.0 mg/kg - the content of exchangeable potassium. All determinations were carried out according to generally accepted methods.

On the basis of analytical data, the amount of newly formed humus and manure (approximate), which entered the soil with the plant mass of green manure, was calculated [13, 14].

The structural state of the soil was established by the method of dry sieving through a column of sieves proposed by N.I. Savvinov. [15], adopted by the RF.

Green manure crops in the described experiment were represented by white mustard, oil radish, spring rape, annual lupine, spring and winter vetch, oats. In addition to single-component crops, multicomponent crops were used, combining two (50:50%) and three crops (30:30:40%).

After plowing the green manures, stubble crops of rape and oats were carried out in order to be able to reveal the effectiveness of the action of the main green manure group on the productivity of the following crops and to obtain an additional volume of biomass, taking advantage of the favorable weather regime of the second half of the growing season.

The discussion of the results. Based on the data in the table. 1, the sums of the most agronomically valuable aggregates (10.0-0.25 mm) corresponded to the good structural state of the soil [1] in the overwhelming majority of variants. This indicator dropped slightly below 70.0% after the cultivation of spring rape and a triple mixture with white mustard, oats and winter vetch. However, in the process of structure formation, their action, as well as oats in combination with annual lupine, turned out to be the most effective relative to other green manures.

Among green manure mono-crops, the advantage of different levels (an excess of 1.9-8.4%) in improving the structure of the soil was revealed when plowing the oil radish biomass.

In accordance with the proposed in the source [3] a qualitative assessment by the value of the structural coefficient (C_{str}), the structure of the meadow-soddy soil, judging by the data

presented in Table. 1 to the values of the coefficients, had an excellent state of aggregation in all variants. In the variants with green manure, characterized as the most effective in structure formation, the values of the structure coefficients turned out to be higher than 3 units. The value of the coefficient in the control variant is also noteworthy. It is possible that here, with a low input of plant organic matter, only in the late autumn period conditions of weak mineralization of humic substances developed, which contributed to the preservation of the soil structure.

Table 1 – Influence of varietal green manure on the structural state of meadow-soddy soil

Siderat	The amount of structural aggregates,%		Structural coefficient
	10,0-0,25 mm	3,0-1,0 mm	
Control (oats - summer sowing)	72.6	35.8	2.65
Spring rape	68.7	30.6	2.19
Oil radish	76.3	36.0	3.22
White mustard	74.4	34.4	2.91
Annual lupine	72.1	33.6	2.58
Oil radish + annual lupine	74.3	35.1	2.89
White mustard + annual lupine	72.9	34.4	2.69
Spring rape + annual lupine	76.7	36.4	3.29
Oats + annual lupine	75.8	37.2	3.13
Oats + spring vetch	72.8	35.0	2.68
White mustard + oats + winter vetch	69.0	32.4	2.22
Oil radish + oats + winter vetch	74.0	35.7	2.85
White mustard + oats + annual lupine	75.3	35.9	3.05

Another indicator of a good structural condition of the soil, often mentioned in the above scientific sources, is the sum of aggregates measuring 3.0-1.0 (sometimes 0.25) mm. In the meadow-soddy soil under the characterized by green manure, these structural units occupied a significant part of the entire aggregate of valuable aggregates (more than 30%). And according to this indicator, the leaders were already allocated green manure crops: oil radish and combinations of rapeseed, oats and mustard with annual lupine.

Table 2 shows more detailed results of the action of varietal green manure and their combinations on the formation of soil structural aggregates of different sizes. The data illustrated a higher accumulation of the blocky fraction (>10 mm) in the soil after plowing rapeseed and

mustard with oats and vetch. In the variant with the spring rapeseed + annual lupine complex, the content of the silty-silty fraction is higher than in other variants.

Some explanations of the effectiveness of the selected options can be contained in tab. 3, which shows the calculated data on the possible accumulation of newly formed humus in the soil after the mobilization of the biomass supplied with green manure. We understand a certain conventionality of the proposed results, and nevertheless, they can contribute to the correct decision when choosing green manure, not only to ensure favorable agrochemical, but also optimal agrophysical properties of the soil, especially with a heavy particle size distribution. The amount of accumulation of newly formed humus of plants of different botanical composition is obviously dependent on the coefficient of humification. For cabbage crops, it is low [15], therefore, cabbage-legume combinations of green manure were inferior in terms of the amount of humus and manure created to options with the inclusion of oats as a supplier of carbon with a straw part.

Table 2 – Influence of varietal green manure on the formation of structural aggregates in meadow-soddy soil

Siderat	Structural aggregates, %							
	>10 mm	10-7 mm	7-5 mm	5-3 mm	3-2 mm	2-1 mm	1-0.25 mm	< 0.25 mm
Control (oats - summer sowing)	23.0	9.6	9.2	14.4	13.8	22.0	3.6	4.4
Spring rape	27.5	11.0	9.9	14.2	14.0	16.6	3.0	3.8
Oil radish	19.5	10.8	11.9	14.0	17.8	18.2	3.6	4.2
White mustard	22.2	10.8	11.8	14.4	15.4	19.0	3.0	3.4
Annual lupine	24.6	11.1	10.1	14.0	14.1	19.5	3.3	3.3
Oil radish + annual lupine	21.4	10.8	10.4	14.2	14.5	20.6	3.8	4.3
White mustard + annual lupine	23.0	10.3	10.0	14.7	16.1	18.3	3.5	4.1
Spring rape + annual lupine	17.4	10.5	10.1	15.0	16.3	20.1	4.7	5.9
Oats + annual lupine	20.6	10.5	10.1	15.0	18.3	18.9	3.0	3.6
Oats + spring vetch	23.0	9.8	9.9	14.7	18.1	16.9	3.4	4.2
White mustard + oats + winter vetch	27.0	10.2	9.2	14.1	16.0	16.4	3.1	4.0
Oil radish + oats + winter vetch	22.0	10.4	9.9	14.6	15.3	20.4	3.4	4.0
White mustard + oats + annual lupine	19.9	9.5	10.5	14.8	18.6	17.3	4.6	4.8
HCP_{05}	2.3	$F_{05} < F_t$	0.7	$F_{05} < F_t$	1.5	1.5	0.5	0.6

Table 3 – Influence of varietal green manure on the accumulation of newly formed humus and manure in the meadow-soddy soil (calculated data for one year)

Siderat	Dry matter (vegetative part + roots)	Newly formed humus	Manure
	t/ha	kg/ha	t/ha
Control (oats - summer sowing)	-	-	-
Spring rape	5.1	412.5	8.2
Oil radish	5.4	440.1	8.8
Mustard white	5.0	405.6	8.1
Annual lupine	4.9	657.9	13.2
Oil radish + annual lupine	5.1	557.2	11.1
White mustard + annual lupine	4.9	501.1	10.0
Spring rape + annual lupine	5.1	534.1	10.7
Oats + annual lupine	5.3	732.9	14.6
Oats + spring vetch	5.7	649.3	13.0
White mustard + oats + winter vetch	5.7	684.9	13.7
Oil radish + oats + winter vetch	5.2	658.9	13.2
White mustard + oats + annual lupine	5.5	618.1	12.4

Conclusion. The analysis of the influence of different green manure crops and their combinations made it possible to conclude that they all contributed to a good level of structure formation in the meadow-soddy old-arable soil with a heavy granulometric composition. A higher effect in the formation of the structural units most valuable in the agronomic sense was characterized by the effect of the mono-sowing biomass of oil radish, spring rape and oats in mixtures with annual lupine, mustard in combination with oats and lupines. The presented results make it possible to make a choice in favor of a certain green manure option and its purposeful use in order to improve the agrophysical properties of the soil.

References

1.Kachinsky N.A. Soil physics. – M.: Higher school, 1965. – 297 P.

2Lalomova T.V. Structural state, group composition of organomineral colloids and productivity of sod-podzolic light loamy soil // Results of scientific research of the Geographic network of experiments with fertilizers and other agrochemical means. VIUA Bulletin. – M.: Agroconsult, 2003. – P. 50-53.

3.Kiryushin V.I. Agroecological assessment of lands, design of adaptive landscape systems of agriculture and agricultural technologies. Methodical guidance / Ed. V.I. Kiryushina, A.L. Ivanova– M.: FGNU "Rosinformagrotech", 2005. – 784 P.

4.Prudnikova A.G. Structure as a factor of soil fertility: textbook. – FSEI HPE "Smolensk State Agricultural Academy", 2015. – 139 P.

5. Khasanova R.F. Agroecological analysis of the structural state and optimization of the properties of the Trans-Urals chernozems during phytomelioration: diss….dr. biol. sci: 03.02.13. – Ufa, 2016. – 303 P.

6.Lykhman V.A., Dubinina M.N. On the issue of studying the experience of research on the role of grass mixtures in the formation of soil structure // Bulletin of the Don State Agrarian University, 2019. – № 3-1 (33). – P. 87-91.

7.Revut I.B. Soil physics. – L., 1972. – 365 P.

8.Borisova E.E. The use of green manure in the world // Bulletin of the Nizhny Novgorod State Engineering and Economic Institute (NNSEEI). Series, Engineering Sciences, 2015. – Iss. 6 (49). – P. 24-33.

9.Novikov M.N., Frolova L.D. Green manure as a factor in optimizing the use of organic fertilizers // Agrochemistry, 2015. – № 4. – P. 44-53.

10.Dovban K.I. Green fertilizer in modern agriculture: theory and practice. – Minsk: Belarusian Science, 2009. – 404 P.

11.Mitropolova L.V., Korotkikh E.V., Pavlova O.V., Ievleva O.E., Dudenko G.A. The role of green manure in improving the agrophysical indicators of brown soil-meadow soil in the conditions of Primorsky Territory // Chronos, 2020. – № 7 (44). – P. 52-56.

12.Samutenko L.V., Milovskikh T.A. Biologization of Sakhalin soil fertility reproduction // Bulletin of the Far Eastern Branch of the Russian Academy of Sciences, 2018. – № 3 (199). – 72-82.

13 Ivanov, Yu.D. Forage crop rotations in the Non-Black Earth Zone of the RSFSR. – M.: Rosselhozizdat, 1987. – 189 P.

14. Ushakov R.N. Energy assessment of the use of straw // Agriculture, 2000. – № 4. – P. 39.

15. Dospekhov B.A., Vasiliev I.P., Tulikov A.M. Workshop on agriculture M.: Kolos, 1977. – 368 P.