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THE IMPACT OF GRASSING ON AGROPHYSICAL AND AGROCHEMICAL PROPERTIES OF DRAINED PEAT-BOG SOIL UNDER SOWN HAYLAND

Vladimir M. Kosolapov ,Williams Fodder Research Institute (WFRI), town Lobnia, Moscow region, 141055 Russia
Vera N. Kreshtapova , V. V. Dokuchaev Soil Science Institute, per. Pyzhevskii 7, Moscow, 119017 Russia. e-mail: vas1988@yandex.ru
Boris S. Maslov, Russian Academy of Agricultural Sciences, Department of Land Reclamation and Water Management, Krzhizhanovsky st. 15, Moscow, 117218 Russia
Nicolay A. Semionov , WFRI, town Lobnia, Moscow region, 141055 Russia
Alexandr A. Zotov, WFRI, town Lobnia, Moscow region, 141055 Russia

SUMMARY

186 Gt of peat resources are concentrated in Russia where peatlands cover the area of some 570,000 km2; the area of arable organic soils is about 10 mln ha. The scientific basics for methodology and methods of peatlands and peat use in agriculture have been developed due to expedition investigations and experimental researches on peatland reclamation stations (1874-2008). The results of long-term experimental studies of peatlands in different regions were thoroughly analysed.

The paper reviews extensive literature on change of peat soils under amelioration and generalized of original experiments conducted at lowland peat soils of research station in Moscow, Ryazan' and Smolensk oblasts in the European Russia. The study was concerned with changes in water and temperature regimes, water-physical and agrochemical properties of soil drainage and cultivation. The experiments were initiated in 1953-1954 and lasted until 2008. Cultivation of a reclamation regime for proper type of agricultural use is determined basing on theoretically well-founded formulae. Optimal significance of drainage standard for meadows on fens is 60-70 cm, for tilled crops - 100-120 cm.
It was found that sowing perennial grasses for forage and cattle grazing on peatlands is the most available usage of organic soils. Utilization of peat soils as fallow lands and complete use of tilled crops leads to organic matter mineralization and ground water contamination. The paper summarizes the experimental data. The power equivalent (through the summary of energy (MJ)) for any use of peat and peat soils was calculated as well.

KEYWORDS: reclamation, peat, peat soils, agriculture.

INTRODUCTION

Water-physical soil properties were determined by potential, as well as effective soil fertility (Sunkevich 1985; Semenov *et al.*, 2005). So, the problem of water and physical soil properties regulation and their preserve on a necessary level becomes very actual due to condensing and destructive impact of agricultural technique movers on soil and sod of the grass. The change of agrophysical and agrochemical properties of drained peat-boggy soils has a very significant sense, since it directly or indirectly reflects the conditions of plants mineral conditions (Koslapov *et al.*, 2009).

Drainage and utilization of peat-boggy soils changes their water-and-air regime, biological circulation of nitrogen and high-ash nutrition elements for perennial grasses. The main features of such circulation is the increase of nutrients outflow with yield, as well as their accumulation in upper layers of peat soils. This is stipulated by the thing, that peat-boggy soils, as against mineral, on 80-95% are presented with organic matter, and, in general, have a small amount of high-ash elements. Besides, the high content of water-soluble organic matter, reducting processes prevailing in complex with water-washing regime and moist desuction in some dry periods of plant vegetation lead to high mobility of a range of high-ash elements.

METHODS

To determine the impact of tillage on agrophysical and agrochemical properties of soils, the experiments on drained peat-bog with low degree of decomposition (30%) of peat in Central Region of Nonchernozemic Area on old-sown (10 years old) degraded gramineous herbage, were conducted. At the re-grassing of this herbage different types of tillage were tried, including chemical - complete destroy of the old herbage by herbicide (roundup 6 kg/ha) and the plantation of valuable herbs - Bromus inermis Leyss+ Phleum pratense L+ Festuca pratensis Huds. Herb seeding amount: Bromus inermis Leyss – 6 kg/ha, Phleum pratense L – 4,5, Festuca pratensis Huds – 6 kg/ha. N180P60K120 fertilizer dose; utilization – 3x mowed.

RESULTS

The results (table1) show, that drained hollowland peat-bog soil in 0-30 cm layir is characterized by low density (0,168-0,172 g/cm³), high moisture (396-409% of total amount, or 71-74% of MMC – minimal moisture-holding capacity), pore volume (90,4-91,1%), and aeration (23-27%). The difference of impact of tillage methods on water-physical soil properties was significant. So, the highest density was registered for the soil after disking in 6 steps (0,172 g/cm³ in 0-30 cm layer and 0,204 g/cm³ in layer 0-10 cm), and the lowest (0,161 g/cm³ in 0-30 cm layer) at plowing with further. After plowing and spraying of herbage by roundup, the peat differed by the high moisture - 407-409%. The highest aeration (35%) was marked in peat in 0-10 cm layer after soil rotatilling on 30-35 cm depth, and the lowest (23%) - after sod layer disking (23% in 0-30 cm layer).
After peat-bog drainage due to mineralization of organic matter of peat, its content gradually decrease (Maslov 2007). The intensity of mineralization process first of all is determined by the climatic conditions - in northern regions it is minimal, and increases to the south. The amount of organic matter annually decreases from 2,0 to 5,4 t/ha, minimal values correspond to the utilization of peat soils under grasslands, maximal - under tilled crops (vegetable rotations). To decrease the organic matter losses it is necessary to implement the balanced in organic matter crop rotations or to grow perennial grasses.
The investigation results (table 2) showed, that hollowland peat-bog soil in 0-20 cm layer on the third year of agrophytocenosis formation is characterized by very high content of average nitrogen content (1,57-1,98%), and humus (36,3-38,4,3%), low ash-content (8,42-10,48%), medium Ca content (2,34-3,48%), from low to medium – K (28,0-53,0 mg on

100 g) and P (56,7-98,4 mg on 100 g), from weak to medium acidity (pH = 4,76-5,95) and hydrologic (3,3-5,7 mg-equivalent on 100 g of the soil) acidity. All the investigated methods of soil tillage, except chemical, at re-grassing of old-sown (10 years) gramineous herbage due to improvement of water-air regime encouraged the processes of peat mineralization and humification, and some of them to N accumulation in soil. So, the ash-content in 0-20 cm layer increased from 8,57 to 9,81-10,48%, humus - from 35,9 to 36,3-38,4%, total N (except chemical elaboration + rotating with FBN–1,5) from 1,71 to 1,77-1,98%. Soil tillage methods in complex with mineral fertilizers implementation (N180P60K120), as a rule, also encouraged the increase of mobile P forms content in (from 41,0 to 56,7-98,4 mg on 100 g), K (from 18,5 to 28,0-53,0 mg on 100 g), Ca (from 2,34 to 2,77-3,48%), and some – to the decrease of exchange (from pH = 5,05 to 5,06-5,95) and hydrolytic (from 5,3 to 4,4-3,3 mg-equivalent on 100 g of soil) acidity. Despite the high N concentration in peat 0-20 cm its volume is low 5,3-7,1 t/ha, and on mineral soils of the zone 4,8-9,9 t/ha. It is set, that the upper peat layer (0-10 cm) was characterized by the higher ash content at any soil tillage method. The ash content in peat in 10-20 cm (table 2) contained 7,68-10,54%, and in the upper layer 0-10 cm - 8,68-12,98%. This speaks about the higher intensity of peat mineralization in the upper layer. According to high concentration of CaO in the upper layer of the peat it can be concluded that the soil tillage, which affects, first of all, on the upper layer intensifies the processes of mineralization and humification, encouraging the CaO accumulation in peat. For example, at disking of sod layer as the basic tillage, the content of CaO in 10-20 cm layer contained 2.8%, and in the layer 0-10 cm increased to 4,17%.

During the reclamation of lowland peat-bog soil for 30 to 50 years the soil acidity increases (pH annually decreases on 0,02 units). Hydrolitic acidity increases from 0,15 to 25 mg-equivalent on 100 g of the soil per year. Chalking is necessary when peat soil is used. The sum of consumed bases annually increases from 0,1 to 0,4 mg-equivalent on 100 g of the soil. The content of iron and aluminum (Al_2O_3 + Fe_2O_3) annually decreases approximately from 0,15 to 0,20 mg-equivalent on 100 g of the soil. At long-term use of peat-bog soil (50 -70 years) the content of Al_2O_3 decreasing with the intensity from 0,02 to 0,05 t/ha, and Fe_2O_3 - increasing with intensity from 0,20 to 0,25 t/ha per year (Maslov 2007).

The content of CaO increasing from 0,15 to 0,25 t/ha per year, in first years of the reclamation this value reaches from 0,4 to 0,5 t/ha, MgO - annually increases from 0,01 to 0,07 t/ha, SO_3 annually increases from 0,02 to 0,08 t/ha, SiO_2 increases within 0,3-0,9 t/ha per year. The change of nutrient elements content (N, P, K) is in direct dependence on implemented fertilizers amount. As a result of long-term utilization in productional conditions the following trends are marked: the content of P_2O_5 increases from 0,03 to 0,05 t/ha per year, K_2O decreases from 0,005 to 0,015 t/ha. The interaction of fertilizers and soils tillage character determines, first of all, the content of the one of the most important nutrient elements - nitrate nitrogen. The accumulation of nitrates significantly decelerates at the implementation of P-K fertilizers. With the increase of PK-fertilizer doses the nitrate content under perennial grasses decreases on the background of all N contents. The increase of N-fertilizers dozes lead to the increase of nitrate nitrogen content, concentration of ammonium nitrogen changes weakly at the increase of N, as well as P-K fertilizers. The correlation C: N annually decreases from 1 to 2 units.
N balance evaluation was given according to the obtained data of lysimetric measurements. Main balance figures were determined for N at the implementation of N240P60K120 (annually) on the grass sward. N outflow with grass yield contained 59-

74% of entered in agrocenosis (on sand and clay loams correspondingly) and 11% on peat soil; and with it 94% N entered with fertilizers, 6 % – because of precipitation and irrigation (table 3).

The significant N decrease in the soil is marked (500 kg/ha on clay loam 600 kg/ha on sandy loam), on peat bog (in lowland with degradation degree 35%) soil 830 kg/ha for 3 years, compensation because of root anchoring contained 36-50 %, and hence, negative N balance in soil was set (correspondingly 383, 254 and 484 kg/ha for 3 years). The lowest N losses with infiltrate were on clay loam soils (8 % of entered in system), almost in 3 and 4 times higher in sandy loam and peat-bog soil, which is stipulated by their properties and the initial lap of sod layer forming. Gas N losses as a result of denitrification processes on a mineral soil (50-65%) in 2,5-3 times increased losses from the peat bog soil (21 %). N total balance in agroecosystem is negative its losses (of entered the soil)for the 3 years contained 65% on clay loam, 100 on sandy loam, and 126 % on peat soils.

N-NO_3 concentration in infiltrate on the 2 year of life of herbs on a mineral soil (14-58 mg/l) and during the whole time on peat-bog soil (12-102 mg/l) exceeds MAC in 4-33 times, although the feeding quality according to nitrates conformed with norms (less than 1000 mg NO_3^- in 1 kg CB). The decrease of N losses (gas predominantly) 31-56 % were achieved due to longer (5 and 9 year) grass utilization, within its anchoring in underground mass in 1,2-2,2 times exceeded N decrease in the soil. Additional plowdown of break crop (ryegrass annual) did not affected N consumption by gramineous agrophytocenosis and the N balance in peatland soil even for 5 years.

CONCLUSION

At the grassing of the old-sown herbage on drained lowland peat-bog soil (in 0-30 cm layer) higher values of agrophysical properties of that type were: density after disking (0,172 g/cm^2), moisture after plowing and herbage spraying with herbicide (407-409%), aeration porosity after plowing and rotating (27%). All the investigated tillage methods for peat soil (except chemical) encouraged the increase of some elements in a pit layer 0-20 cm: ash from 8,6 to 9,8-10,5%, humus from 35,9 to 36,-38,4%, total N from 1,71 to 1,77-1,98%, and at fertilizer implementation – P, K, and Ca.
After peat-bogs drainage and their utilization intensification, mineralization processes strengthen, encouraging annual organic matter content decrease (drawoff) on 2,0 t/ha under grassland herbs and on 5,4 t/ha under tilled crops.
Comparing to mineral soils on the lowland peat soil the significant decrease of N, which is 830 kg/ha for 3 years, and its compensation at root anchoring cost contained 43% in average. Total N balance in the ecosystem was negative and for 3 years contained 126%, and, for example on a mineral clay loam it was 65%.

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