Mechanized application of ameliorants for preservation of soil moisture on cultivated lands

S A Vasilyev¹, A A Vasilyev¹, M Y Ivanov² and A V Vasilyeva³

¹ Novgorod State Engineering-Economic University, Knyaginino, Russia
² Volzhsky branch of Moscow automobile and road construction state technical university, Cheboksary, Russia
³ Cheboksarskiy technical school of construction and urban development, Cheboksary, Russia

E-mail: alexei.21@mail.ru

Abstract. During the drought season agronomic crops get into a critical situation when a lack of moisture and nutritional chemicals can result in plant wilting and crop loss. To prevent the following situation, it is proposed to apply liquid ameliorants in the process of subsurface tillage which can accumulate moisture in a soil. The introduction of ameliorants offered to carry out work on liquid ameliorants directly into the root soil layer, to create favorable conditions for the development of the plant. Also, when making soil ameliorants preventing the leaching of their streams generated from rainfall and meltwater. Experimental studies have shown that zero tillage with simultaneous application of liquid ameliorants (in the process of experiment was used urea-ammonium nitrate) can increase soil moisture at cultivation depth from 22 to 47%. Moisture of the soil was determined in two months after cultivation and applying of liquid ameliorants according to the National Standard 28268-89 “Soils. Methods of moisture determination, maximum hydroscopic moisture and permanent wilting coefficient of plants”. In this case, received values of filtration filters and soil porosity show qualitative soil cultivation for crop growing.

1. Introduction

Greater focus should be placed on preparation of field in the process of cultivation. The most important is preserving of moisture and nutritional chemicals in the soil as during the drought season this affects process of sprouting and vegetation that directly influences on the yield. For this it is necessary to carry out soil cultivation oriented on preservation of moisture, mineral and nutritional chemicals for creation of favorable condition of developing withstanding root system. Also, topsoil can be affected drying that can lead to destruction of a plant. In this case applied ameliorants placed in the substrate allow the roots to feed moisture and nutritional chemicals.

In this case the application of liquid ameliorants having high sorption capacity to accumulate moisture is of current interest [1].

Ameliorants occur as:

- powder or gel mass (hydrogel, polyacrylimide) can absorb a large volume of liquid and grow in size [2, 3];
solution and emulsion (cryogel, carbamide- ammonium nitrate, liquid complex fertilizers) high-nitrogen and phosphate [4].

It’s better to apply ameliorants to a depth -25…30 cm. formed by a deep tiller. Because in this case the removal of ameliorants from the surface by runlets resulted from rainfall and melt waters is prevented.

The effectiveness of applying of liquid ameliorants is determined by soil water conductivity as thereat may be liquid stagnation [5]. This can result in overwatering of roots or running off along a slope and consequently creates erosion process. Filtration factors are a part of this process and threshold is moisture absorption when soil pores gradual full of liquid.

2. Experimental part

Experimental work is aimed to retain soil moisture after application of liquid meliorants and their impact on filter factors and soil porosity.

Figure 1a shows an attachment for applying of liquid ameliorants for subsurface tillage mounted on the KPG-250 frame.

The attachment for applying of liquid ameliorants [6, 7] is a hat hoe having a device allowing to pulverize liquid ameliorants during soil cultivation mounted in under the surface of the hat hoe. (figure 1b and 1c).

Experimental research was conducted at the Integrated Agricultural Production Centre “Trud” in Batyrevsky region of Chuvash Republic. Tilth-top soil is presented by heavy loamy chernozem.

Experimental work was conducted on the place with smooth relief and minimal field slope at the speed of aggregate 6…8 km/h.

Applied liquid ameliorants are urea ammonium nitrate.

Samples of soil for analysis were chosen as at the parcel cultivated by work tool for applying of liquid ameliorants so at the parcel cultivated by hat hoe without applying of liquid ameliorants.

Moisture of the soil was determined in two months after cultivation and applying of liquid ameliorants according to the National Standard 28268-89 “Soils. Methods of moisture determination, maximum hydroscopic moisture and permanent wilting coefficient of plants”.

Figure 1. The attachment for applying of liquid ameliorants: a) the attachment is mounted on the KPG-250 frame; b) open furrow after using the attachment; c) spreading of ameliorants into the furrow bottom.
Measurement of moisture was carried out by soil samples taken every 10 cm at the depth of 0 - 30 cm. Each sample was placed into the numbered aluminum tubes, weighed and then sent to the laboratory where it was kept for 7 hours at 105 °C in drying closet. After drying and cooling the soil samples were weighed. Further on the basis of the received measurements soil moisture of the sample was determined in percentage correlation.

Determination of filtration factors and porosity was conducted according to National Standard 25584-90 “Soils. Laboratory methods for determination of filtration factors”.

3. Results of the experimental work

After mechanized application of liquid ameliorants based on the results of experimental research of soil moisture $W_w$ in different layers a diagram of moisture variance was constructed (figure 2).

Figure 2. Soil moisture after cultivation by the work tool for applying of liquid ameliorants.

Moisture values of soil samples on the surface decrease from 25.23% to 22.92% after cultivation in layers of 10÷20 cm (figure 2). It so happens because of appearance of new pores filling out with air. High values of moisture are noticed in soil layer 20-30cm more than 47% as liquid ameliorants applied just in this zone. Cultivation by work tool without applying of liquid ameliorants values at the same depth no more than 23% (the figure 2 shows it with the dashed line).

Also figure 2 demonstrates with mark-making a zone of steady wilt of plants. So, sandy loam appears if moisture is 3.5…12%, for sandy clay is 1.5…4% and for loam is 12…20% [8]. According to the research carried out on definition of filtration factors and soil porosity, we can tell about proper soil preparation by applying of liquid ameliorants [9, 10].

Filtration factors allow characterizing hydraulic conductivity of soil under hydrostatic pressure force. Herewith a liquid permeated in a ground spreads and provides necessary access of moisture to roots.

Figure 3 shows the data of filtration factors in different soil layers after employing the tool for applying liquid ameliorants.

Filtration factors taken from results of soil samples have more high values in the depth of 20-30 cm- from 90.6 to 106 cm/d where direct tillage and damage of soil layer by work tool happens (figure 3). This process is characterized by crumbling of lower layer of soil. Also in formed space liquid ameliorants are pulverized and so affect with stream on the layer.

For comparison half values of filtration factors in different sources are presented for different types of soil. For sand it is 300…800 cm/d, sandy loam is 20…100 cm/d, loam is 1…50 cm/d [11].

Porosity is characterized by existence of pores which fill out with liquid or air. Their presence creates stable deposit of moisture concurrent with good air exchange [12–14].
Figure 4 presents data about porosity of different soil layers before and after using of work tool for applying of liquid ameliorants. Soil layers were taken in 5 sample points. The diagram shows the best porosity value after soil cultivation at depth of 20÷30 cm. This is the depth at which liquid ameliorants are applied while subsurface tillage. The porous spaces formed while subsurface tillage are filled with air and nutrient elements of ameliorants. Higher soil layers show lower values resulted from subsurface tillage.

![Figure 3](image1.png) Filtration factors of soil samples taken from different places of experimental parcels before and after application of the work tool for applying of liquid ameliorants.

![Figure 4](image2.png) Porosity of different soil layers before and after using of work tool for applying of liquid ameliorants.

4. Conclusion
Applying liquid ameliorants created conditions for preventing plants from critical situation which can appear in case of the drought season characterized by lack of precipitations and increase of regular temperature range. In this case, received values of filtration filters and soil porosity show qualitative soil cultivation for crop growing.

Thus, application of liquid ameliorants makes it possible to save and increase soil moisture that helps plants to survive during the drought seasons.

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