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

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Abstract. During the drought season agronomic crops get into a critical situation when a lack of moisture and nutritional chemicals may lead to a wilt of plants and crop loss. For preventing of 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 soil determined after two months after cultivation and applying of liquid ameliorants according to the National Standard 28268-89 “Soils. Methods for determination of moisture, maximum hydroscopic moisture and moisture of steady plant fading”. 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.

It’s of great current interest application of liquid ameliorants have a high sorption capacity to accumulate moisture [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 the best of all to apply ameliorants to a depth of cultivation by deep tillage cultivator-25…30 cm. As in this case it is prevented illuviation of ameliorants from surface by runlets formed by rainfall and melt waters.

Quality of applying of liquid ameliorants is determined by soil water conductivity as thereat may be liquid stagnation [5]. This may lead to 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

Experimental researches were aimed at the determination of moisture after applying of liquid ameliorants and its impact on filter factors and soil porosity.

In Figure 1a is shown work tool for applying of liquid ameliorants for subsurface tillage set at the frame of KPG-250.

Work tool for applying of liquid ameliorants [6, 7] is a hat hoe, under the space of it set a device allowing to pulverize liquid ameliorants during the process of soil cultivation (Figures 1b and 1c).

![Figure 1. Work tool for applying of liquid ameliorants, where a is work tool state on the frame KPG-250; b is open furrow after using of work tool; c is spreading of ameliorants on the furrow sole.](image)

Experimental researches were conducted in Integrated Agricultural Production Centre “Trud” in Baturevskiy region of Chuvash Republic. Tilth-top soil is presented by heavy loamy chernozem.

Experimental 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 carbamide-ammonium nitrates.

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 soil determined after two months after cultivation and applying of liquid ameliorants according to the National Standard 28268-89 “Soils. Methods for determination of moisture, maximum hydroscopic moisture and moisture of steady plant fading”.

Measurement of moisture was carried out with a help of soil samples taken every each 10 cm to a depth of 0 to 30 cm. Each sample was placed into numbered aluminum small glasses weighed and then delivered to laboratory where it was kept for 7 hours with the temperature of 105 °C in drying closet. After drying and cooling soil was weighed. Further on the base of received measurements was determined soil moisture of study sample 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 and Considerations

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

 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 research carried out on definition of filtration factors and soil porosity let to judge about qualitative soil preparation with 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.

The Figure 3 shows data of filtration factors in different soil layers after pass of tool for applying of 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.

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 [12–15].

The 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 best porosity on the graph (Figure 4) pointed after soil cultivation in depth of 20÷30 cm. Right in this depth applied liquid ameliorants in the process of soil cultivation without soil overturning. Formed porous spaces fill out with air and nutrient elements of ameliorants. In higher slices of soil horizon values down fall because of subsurface tillage. Herewith tillage goes with cutting of layer and action of shank of the tool.

![Figure 3](image1.png)

**Figure 3.** Filtration factors of soil samples taken from different places of experimental parcels before and after pass of work tool for applying of liquid ameliorants.

![Figure 4](image2.png)

**Figure 4.** 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 during the drought season characterized by a lack of past precipitations and temperature rise from a norm.

In this case, received values of filtration filters and soil porosity show qualitative soil cultivation for crop growing.
Thus, applying of liquid ameliorants lets save and increase soil moisture that helps plants to survive during the drought seasons.

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