Mechanized spraying of liquid meliorants

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Abstract. This article deals with the process of distribution of liquid meliorants on the surface of their application by means of a device for introducing liquid meliorants. The device itself is attached to the tillage working organ-the plane-cutting leg of the cultivator-deep-digger. In order to determine the quality of liquid spray and its distribution on the application surface, laboratory studies were conducted. The research was aimed at determining the optimal size of the hole diameters of the device to create a high-quality spray torch of the gas-liquid jet of meliorants. In the course of experiments, it was revealed that the rational diameters of the external (D) and internal (d) pipelines of the device for introducing liquid meliorants are D = 7 mm, d = 5 mm.

1. Introduction
Liquid meliorants are substances in the form of solutions and emulsions that affect the processes taking place in the soil, which are able to accumulate moisture and have sorption properties, as well as increase mechanical strength [1]. Introduction of liquid meliorants is made by the tillage of the working body as which the plane-cutting paw acts [2, 3, 4]. A device for introducing liquid meliorants is attached directly to the sub-valve space of the working body [5].

In the process, the plane-cutting paw cuts the soil layer and lifts it, resulting in a space where the device sprays liquid meliorants. Meliorants are distributed on the smooth surface of the bottom of the furrow. The quality of the liquid distribution depends on the parameters of the device, namely the size of the hole diameters and the head [1, 2]. Major factor of a local importation of liquid soil binders, fertilizers and ameliorants into the subsoil space is the constant discharge of material on all length of the pipeline. The meliorants introduced in this way are effectively distributed in the soil layer, which has a beneficial effect on the cultivation of cultivated plants, retains moisture and nutrients [6, 7].

2. Experimental part
The device for introducing liquid ameliorants consists of two pipelines [1, 2], where one pipeline is installed in the other and holes are coaxially drilled (figure 1).

The internal pipeline is supplied with compressed air, and in the cavity between the pipes - liquid meliorants. Compressed air, leaving the hole of the inner pipeline, acts on the liquid and pushes it into the hole of the outer pipeline, resulting in a gas-liquid jet, which is distributed to the introduced surface. Also between the pipelines is a spiral screw, which prevents from clogging the hole with foreign inclusions and allows you to evenly distribute the liquid along the length of the device, which leads to the same output volume of meliorants from all holes.
Figure 1. Device for making liquid meliorants in the section: 1-leash to drive a spiral screw; 2-outer pipeline; 3-inner pipeline; 4-spiral screw.

In laboratory conditions, the device for the introduction of liquid ameliorants was studied to determine the main parameters. The main emphasis was on identifying the optimal size of the hole diameters of the device to create a high-quality spray jet of liquid. Taking into account, the space formed in the process of tillage with a flat-cutting paw as small, the length of the jet should also correspond to the possibility of distribution on the plow sole before laying the soil layer.

To determine the quality of distribution of liquid droplets on the surface, a trap with a point arrangement of many containers was used, the filling of which allows visually observing the drop drop on the introduced surface, both in width and length (figure 2). Using different combinations of the sizes of diameters of apertures in external (D) and internal (d) pipelines, empirically picked up optimum values which are rational for qualitative introduction of liquid meliorants at flat-cut processing of the soil.

In the study, values from 0.2 to 0.6 MPa were used, the spray time of the steady-state gas-liquid jet was 30 seconds.

Figure 2. The distribution of the liquid working body with different diameters:
A) D = 7 mm; d = 5 mm; C) D = 4 mm; d = 2 mm.

Experimental studies were aimed at determining the effect after application of liquid meliorants on filtering factors and soil porosity.

In figure 3A 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 is a hat hoe, under the space of it set a device allowing to pulverize liquid ameliorants during the process of soil cultivation (figure 3B).
Figure 3. 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.

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.

After the passage of the working body, in the open furrow, you can observe the process of distribution of liquid meliorants in the subsurface space.

Changes occurring in the soil after application of ameliorants were investigated according to the Annex with the national standard 28268-89 "Soils. Methods of determination of humidity, maximum hydroscopic humidity and humidity of sustainable wilting of plants".

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

The analysis of liquid spraying on the surface of the droplet collector allowed to determine the rational diameters of the external and internal pipelines of the device for introducing liquid meliorants (D = 7 mm, d = 5 mm). In this case, the jet is crushed and compactly distributed over the surface of the collector, as can be seen from the filled dimensional containers (figure 4).

The spray torch of the gas-liquid jet, i.e. the length, width and number of distributed meliorants on the surface, was determined by the points of location of the measuring tanks in the collection, with the measuring tanks. To do this, the working body selected different versions of the diameters of the holes of the outer (D) and inner (d) pipelines.

The width of the gas-liquid jet torch allows determining the required number of outlet holes in the pipelines of the working body. It is determined that 5 holes in the pipeline of one section of the working body are the most rational number, since there is a slight crossing of the liquid jets, as a result of which it is completely distributed on the introduced surface.

The length of the jet causes the liquid droplets to fly a distance when the soil layer coming down from the plane-cutting paw comes into contact with the bottom of the furrow. In this case, the jet torch will be distributed in the space between the bottom of the furrow and the soil layer.

It should be noted that the impact of compressed air had an impact on the size of the droplets when spraying the liquid. The higher the air pressure was raised, the more drops of the jet torch became, which were observed when distributed to the surface of the collector with dimensional containers.
Variant 1 – $D=4$ mm, $d=2$ mm

Variant 2 – $D=7$ mm, $d=5$ mm

**Figure 4.** The process of distribution of gas-liquid jet on the surface of the collection with dimensional containers during laboratory studies

4. Conclusion

Thus, the conducted researches of the device for spreading liquid ameliorants, in the laboratory was aimed at defining the main parameters of this device with the aim of creating high-quality spray and its uniform distribution on the insertion surface.

Rational values of diameters of external (D) and internal (d) pipelines of the device for introduction of liquid meliorants made $D = 7$ mm, $d = 5$ mm. In this case the stream is crushed and compactly distributed on a surface of the collector about what it is possible to judge on filled dimensional capacities.

In the process of soil treatment with simultaneous introduction of liquid meliorants, the jet is distributed to the surface of the bottom of the furrow, which is formed when cutting the soil layer with a flat-cutting paw. At the same time, before the descent of the soil layer from the impeller of the paw, the liquid spreads along the bottom of the furrow, which corresponds to the uniform introduction of liquid meliorants and meets the technological requirements.

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