The process of ultra low-volume seed etching with an experimental device

Svetlana M Borisova, Sergey K Papusha* and Evgeny M Sivovalov

Federal State Budgetary Educational Institution of Higher Education «Kuban State Agrarian University named after I.T. Trubilin» Krasnodar, Russia

*serega0318@mail.ru

Abstract. The main way to protect plants from diseases and pests is to treat the seed material with pesticides. To achieve maximum efficiency from complex seed treatment, it is necessary to distribute evenly the preparation over the surface of all available seeds. One of the conditions for the operation of the etcher is the ability to connect to the compressor unit and the power network. Studies of the performance of the sprayer depending on the pressure in the pneumatic system of the spraying device and the feed tube diameter have been carried out.

Seed treatment with pesticides is one of the main ways to protect plants from pathogens. In addition, this technique is widely used in protecting plants from sucking and gnawing pests due to the intensification of young sprouts. However, the high efficiency of complex treatment of seeds with pesticides is achieved only when the preparation is applied evenly to the surface of each seed.

The analysis of modern etching machines work shows that the treatment of seeds does not achieve a uniform distribution of the chemical on their surface, the coefficient of unevenness ranges from 0 to 100%.

To intensify the process of seed treatment, it is necessary to universalize individual devices, namely seed distributors and spraying devices. Both should be installed in mixing chambers, as well as on the unloading conveyors of seeder loaders and loading and unloading machines. This will make it possible to treat seeds with various chemicals that cannot be combined with simultaneous treatment. In addition, the use of biobacterial chemicals for seed treatment when laying for storage should be applied immediately before sowing without exposure to sunlight, which can significantly strengthen the plant's immune system and protect them from diseases and pests. The use of ultra-low-volume treatment of seeds with liquid chemicals with high-quality covering with pneumatic slot sprayers will reduce the consumption of the chemical and their losses [1].

The practical significance of the study of the experimental device designed in Kuban State Agrarian University is to use the proposed scheme of the etcher for seed treatment during loading and unloading operations and pre-etching to reduce operating costs and improve the quality of treatment.

The modernized sprayer is intended for semi-dry treatment of cereals, legumes and industrial crops with water suspensions of pesticides to struggle with pathogens transmitted through seeds and to improve the sowing qualities of seeds.

The etcher is intended for use in closed premises (warehouses, storages) at grain cleaning points and on covered platforms. The necessary condition is that you can connect to the power network and the compressor unit [2].
The spraying unit consists of a frame, loading-cleaning conveyor, tank, unloading screw, tank of hydraulic fluid, equalizing tanks, dispensers, electrical system, pneumatic pipes from the compressor with pressure regulator, connecting pipes and hoses. The technological process of the upgraded machine is shown in Fig. 1

![Figure 1. The technological process of the unit operation.](image)

1-pitched pipe; 2-loading conveyor; 3-seed hopper; 4-adapter; 5,6,14-pneumatic slot sprayers; 7-screw; 8-hydraulic drive; 9-pneumatic drive; 10-tank with working liquid; 11-pitched board; 12-equalizing tank; 13-tap.

When the machine moves along the seed storage, screw feeders capture the seed material and bring it to the lifting pipe of the loader (scraper conveyor), which feeds it to the distribution loading screw [3]. The screw distributes the seed material along the width and feeds it to the hopper, where the seeds accumulate. Next, the grain from the hopper through the holes regulated by the flap enters the vibrating pitched boards, on which there is a uniform distribution of the material, which is necessary to ensure the quality of etching. Since the angle of inclination of the pitched boards is less than the angle of internal friction of the seeds, a uniform distribution is achieved by means of vibration created by a vibrator with the assistance of a pulse generator.

From the pitched board, seeds fall freely in an even layer into the cavity of the working chamber on an air-drop jet formed by a pneumatic slot spray.

From the reservoir, the working fluid with overpressure is fed to the equalizing tank and get to the distribution collector and pneumatic slot sprayers from it. In the sprayer, the working fluid is sprayed to a misty fine state and fed into the seed stream. Spraying of the chemical occurs by a stream of swirling compressed air, which flows at a high speed from the slot nozzle of the sprayer. Compressed air is supplied to the sprayer from the compressor through a receiver, pressure regulator, and collector. The unit uses a stationary compressor of the grain cleaning station, and it is possible to use a mobile compressor [4].

The processed seed material is fed into the pipe of the discharge screw, where it is captured by the screw, rises to a height of 2.7 m and is unloaded. It is possible to unload the etched grain, both in burs
and in bags. Grain coming from the screw conveyor falls on the pitched board-distributor and is processed additionally with protective and stimulating liquids that cannot be used in tank mixtures with pesticides or other chemicals. The treatment scheme and elements of the basic design of the unit are similar to those used for seed material treatment in the mixer-adapter with the etchant "Mobitox". We have studied the performance of the sprayer depending on the diameter of the feed tube and the pressure in the pneumatic system of the spraying unit.

For the test, a unit was used to determine the performance of the sprayer. In this case, the measuring cup with the platform was fixed on a tripod, fixed at a height of 0-30 cm relative to the sprayer (which corresponds to the position of the equalizing container).

A sprayer with a feed tube diameter of 3 mm was used for testing. Water from a measuring cup and air from a compressor unit were fed to the sprayer by gravity. The pressure in the pneumatic system was set by a pressure regulator at 0.15 MPa. The flow time of 100 ml of liquid was measured and the performance of the sprayer was calculated. Then similar tests were carried out at a pressure in the pneumatic system of 0.2; 0.25 MPa. After that, feeding tubes with a diameter of 3,4,5 mm were installed in the sprayer and the experiments were repeated.

The tube diameters taken are 3, 4, 5 mm, since different tube diameters achieve different median mass diameter of drops (MMD), which, depending on the object and purpose of treatment, must be within certain limits. A diameter of less than 3 mm is undesirable, since it is possible to clog the feed tube, and at a diameter of 5 mm, the maximum required MMD and fluid flow are achieved.

Based on the results of experiments, graphs of the dependence of the sprayer’s parameters are constructed and shown in the figures (Fig. 2, Fig. 3)

![Figure 2](image.png)

**Figure 2.** Dependence of the sprayer’s performance on the position of the equalizing tank.

The graph shows that the performance of the sprayer varies from 0.3 to 1.0 l/min when the equalizing tank is positioned relative to the sprayer from 0 to 0.3 m. When installing the sprayer at a height below 0.1 m, the performance increases slightly within 10%. And as the feed tube diameter increases, productivity rises as well.
Figure 3. Dependence of the sprayer capacity on the diameter of the feed tube.

sprayer with a lemniscate nozzle profile, nozzle size 0,35x7,5 mm. 

sprayer with a lemniscate nozzle profile, nozzle size 0,35x7,5 mm.

The graph shows that a sprayer with nozzle parameters of 0,35x7,5 mm has a higher performance approximately twice as compared to a sprayer with a nozzle with a profile of 0,35x5 mm.

In a sprayer with nozzle parameters 0,35x7,5 mm, the performance with a change in the diameter of the feed tube varies within 15%. With a change in the pressure in the pneumatic system, the performance of the sprayer changes slightly (within 7%).

Conclusions
The analysis of the operation process of a pneumatic slot sprayer showed that the range of the sprayed droplets to the object of treatment depends mainly on the air pressure in the pneumatic pipe, which can vary from 10 to 3.0 MPa and is 1.2...1.4 m. The flow rate of the working fluid with a pneumatic slot sprayer can vary from 0.05 to 1.2 l/min. The performance of the sprayer depends on the shape of the jet nozzle.

It is recommended to install a device in the form of a pitched board-distributor and a unit in the adapter for a mobile or stationary sprayer, loading and unloading machines for seed treatment with protective and stimulating liquids, not only pesticides, but also bio- and bacterial chemicals.

It is possible to upgrade sprayers of various designs by using a unit with pneumatic slot sprayers designed in Kuban State Agrarian University.

References
[1] Patent 237367711032008 Russian Federation. Seed sprayer [Text] / E. G. Shevchenko, G. G. Maslov, S. M. Borisova; applicant and patent holder Federal State Educational Institution of Higher professional education "Kuban State Agrarian University".
[2] Ejection-slot sprayer for seed etching [Text] / S. M. Borisova, N. A. Rinas / / Rural mechanizer. - 2014. - № 9(67). -P. 16.
[3] Advantages of ultra-low-volume sprayers Ejection-slot sprayer for seed etching [Text] / S. M. Borisova, K. V. Ermakov, D. M. Nedogreev / / Rural mechanizer, - V.2015. - №3. - P. 10-11.
[4] Patent 2693258 Russian Federation. Device for treating potato tubers with protective and stimulating liquids when planting [Text] / S. M. Borisova, S. K. Papusha, N. P. Chistyakov, N. A. Nikitenko, applicant and patent holder Federal State Educational Institution of Higher professional education "Kuban State Agrarian University".