Improvement of the technological scheme fan cotton sprayer OBX-600 for biologically effective plant protection

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Abstract. The article presents the developed technological scheme of the OBX-600 fan cotton sprayer, to switch to a low-volume spraying method with flow rate of working fluid in the range of 50-100 liters per hectare. Conducted studies of the technological scheme sprayer show that to ensure agrotechnical requirements of the low-volume process spraying needs improvement system for supplying working fluid to the sprayer. That is, the supplied working fluid must be the most homogeneous and given volume. Solving these problems for installation on the sprayer flow diagram led installation of a self-cleaning filter and dispenser tap. For facilitating installation and dismantling of the sprayer, as well it is proposed to reduce non-operating costs completely mounted version of the fan sprayer, without special constructive changes.

1 Introduction

The main industrial crop cultivated in the Republic of Uzbekistan is cotton – [1-3]. And the most labor-intensive and technically complex operation when growing cotton is machine harvesting, where a mandatory and important condition for preparing cotton crops for machine harvesting is pre-harvest defoliation [4].

Treatment of cotton with pesticides on such vast areas (more than 2 million hectares) and in such large volumes (more than 9 million hectares due to multiple treatments) in a short time (10...15 days) is unthinkable without highly productive, reliable, economical and safe environment of technical means of mechanization [6,7,8]. Therefore, the creation of a high-performance sprayer that meets the requirements of low-volume spraying of cotton is an urgent task.

The purpose of this work is to study the technological scheme of the OBX-600 fan cotton sprayer for the transition to a low-volume method of spraying cotton.

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2 Materials and methods

Analytical and experimental study of the technological scheme of operation of a fan sprayer based on the “Method for testing agricultural machinery (Sprayers and pollinators)” [5].

3 Research results and discussion

The OBX-600 cotton sprayer (Figure 1) is designed for treating cotton fields with liquid pesticides using the rear scattering spray method or the side spray method. It is also possible to use it for continuous pre-sowing application of herbicides, as well as focal treatments using fire nozzles. The cotton fan sprayer OBX-600 [6] is a mounted machine and consists of the following components and mechanisms: two containers with a capacity of 300 liters each, suction and discharge hoses, a three-way valve, coarse and fine filters, a pump, a discharge hose, a pressure regulator with a pressure gauge, fine filter, nozzle stand, nozzles, pressure hose, fan, nozzle, water intake hose, filter with valve, water source.

Technological process of spraying: the pump sucks the working fluid from the tanks of the OVH-600 sprayer through suction hoses, a three-way valve and a coarse filter. The pump, applying a certain pressure to the working fluid through the pressure hose, delivers it through the valve chamber of the pressure regulator, a fine filter and through which it is supplied to the stand and sprayers, and the excess liquid is directed through the pressure hose back into the mixing tanks. The working fluid is sprayed into the passing air flow through the sprayer nozzles, created by the sprayer fan. Thus, the fan randomly directs the air flow with chemicals sprayed in a misty form into the open atmosphere. Particles of a chemical substance suspended in the air under the influence of their own weight (Archimedes' force) at a certain very low speed, that is, lagging behind the speed of the air flow, move down and settle on surfaces encountered along the path of movement.

Fig. 1. OVKh-600 sprayer with technical characteristics.
Technical specifications:
Productivity per hour of main time when spraying, ha/hour
- cotton and field crops - 18-24
- gardens - 2.8-5.6
- vineyards - 4.5-4.8

Working width at bush height 30 cm, m - 30
Operating speed during main operations, km/hour - 6.3-7.4
Liquid consumption rate, l/ha - 100-300
Tank capacity, l - 630 (2 tanks)

Specifications - TSh 23.2.2162: 200

However, along with this, as operating practice on farms has shown, the OVKh-600 (OVKh-28) sprayer has a number of serious disadvantages [6-9], which reduce its technical level:
- Low quality of dispersion of working fluid by hydraulic sprayers (350-420 microns), which is insufficient for effective treatment of cotton crops using low-volume spraying technology;
- High consumption of working fluid, which is 200-300 l/ha;
- Labor intensity when preparing and filling containers with pesticides;
- Low operational productivity, which sometimes amounts to 4-6 ha/hour, which violates the timing of plant treatment with pesticides.

The improvement of machines for ground-based chemical plant protection and in particular for cotton, both here and abroad, consists of the transition to unit-unit unification, facilitating the implementation of high-performance MO and ULV spraying methods [10-12]. The economic feasibility of switching to MO spraying of cotton is questionable.

In practice, this progressive method is not being implemented due to the lack of a sufficiently reliable working body and technological scheme for spraying, providing a highly dispersed spray and the ability to regulate droplet diameters in a wide range, simultaneously operating a high-performance liquid flow, as well as a technological scheme capable of applying the sprayed solution evenly on the processed cotton bush [13-14].

Based on the results of theoretical and experimental studies, it has been established [15-17] that with the use of a pneumatic disk sprayer at the nozzle end of the fan unit of the OVKh-600 sprayer, it is possible to obtain a monodisperse spray of the working fluid within the range of 80-120 microns, which makes it possible to switch to a low-volume (50 - 100 liters per hectare) method of spraying cotton.

But, at the same time, to solve such issues as labor intensity in preparing and filling containers with pesticides, as well as to increase the operational performance of the sprayer, it is necessary to consider the spraying technological scheme [18-20].

Analysis of the technological scheme of the fan sprayer showed that the working fluid is supplied to centrifugal sprayers through the main filter and insoluble defoliant particles entering the working cavity of the sprayer negatively affect the process of droplet formation. In addition, the pressure of the working fluid in the technological system depends on the rotary pump, which is connected to the tractor power take-off shaft. That is, a change in the rotation speed of the power take-off shaft from the load will lead to an unstable supply of the required amount of working fluid to the sprayers, where uneven treatment of the plant with pesticides occurs. These factors influence the quality and timing of chemical treatment of cotton within agrotechnical terms.

To solve this issue, we proposed an improved technological scheme for the OVKh-600 sprayer, mounted on a tractor using a standard three-point hitch and consisting of the following main components: frame, one polyethylene tank, cardan drive, power gearbox, roller pump, main filter, dispenser tap, an additional self-cleaning filter, an oscillating mechanism, a fan unit and a pneumatic disk sprayer (Figure 2).
1-tank; 2-suction line; 3-way valve; 4-filling hose; 5-main filter; 6-rotor pump; 7-additional self-cleaning filter; 8-discharge line; 9-pressure regulator; 10-hydraulic mixer; 11-electronic dispenser tap; 12-feed line; 13-fan installation; 14-pneumatic disc sprayer.

Fig. 2. Improved technological diagram of the OVKh-600 sprayer with a pneumatic disk sprayer.

A pneumatic disk sprayer installed at the outlet section of the fan unit nozzle [14-17] is rotated by the air flow created by the centrifugal fan of the sprayer. The fundamental difference from the existing sprayer is the original design of the attachment (mounted instead of mounted) on the tractor, the presence of a disk sprayer, a dosing device and an additional self-cleaning filter. The working solution, sucked from reservoir 1 by pump 6 along the suction line 2, passing through a three-way valve 3 and the main filter 4, is supplied to an additional self-cleaning filter 7, where the liquid is divided into two parts. The main flow, passing through the pressure regulator 9 along the discharge line, returns back to the tank, thereby making up the hydraulic mixer 10 of the working solution, the pressure regulator serves to maintain a constant pressure within the range of 1-1.2 atm. in the hydraulic system. And the filtered part of the working fluid along the supply line 12, passing through the electronic dispenser tap 11, is supplied to the pneumatic disk sprayer 14, which sprays the liquid through the air flow of the fan unit.

4 Conclusion

Based on the research results, the following conclusions can be drawn.

1. All structural elements of the sprayer are placed on the main frame, which is attached to the tractor frame using hinged joints. In this case, the installation of 2 tanks on the side members of the tractor using brackets is excluded, that is, the unit becomes completely mounted. This allows you to save working time when preparing the unit for operation.

2. The presence of an additional self-cleaning filter makes it possible to periodically mechanically clean the filter from contaminants without stopping the filtration process. When the filter is automatically switched to self-cleaning mode, the flow of the initial medium inside the filter housing is redistributed. That is, the principle of operation is the difference in liquid pressure in the inner and outer parts of the filter mesh.

3. The use of a dispenser tap in the technological diagram makes it possible to automatically measure (dosage) and direct a given volume of working fluid to the pneumatic disk sprayer, which makes it possible to regulate the median mass diameter of the droplets depending on the spraying method, the type of plant and its parameters.
Based on the above proposals and analysis of the work, we can conclude that improving the technological scheme of the OVH-600 fan cotton sprayer, without design changes, allows you to save time when installing and dismantling the unit, since the location of the unit at the rear of the tractor makes it completely mounted. In addition, the presence of an additional self-cleaning filter and a dispenser tap in the technological scheme allows automatic regulation of the supply of working fluid to the sprayer, which in turn switches to a method of low-volume spraying of cotton.

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