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Formation of highly dispersed droplets with harmless effect on the environment and the results of their mathematical and statistical processing

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Abstract. In this article, given density, diameter, and dispersion of high-dispersion drops in the process of processing plant leaves with an improved cutter were studied. Digital drip cards 9950-0028, which are liquid sensitive, were used and analysed using Deposit Scan software. As a result of the mathematical-statistical processing of the data collected, the number of lines of variation, the diameter of the largest and smallest drops, the arithmetic mean, the standard deviation, and the coefficient of variation were determined. On the volumetric dimensions of the droplets, an integral curve line of the curve and distribution of the differential function of the Gaussian distribution law was constructed. It was observed in the tests that the limit of distribution by volume measurement of drops was equal to 53-149 mkm. With the agro technical reduction of the size of the drops that is with an increase in the quality of the spray, the working fluid consumption can be saved, and the negative effect on other plants in the environment, on products consumed by the people, can be reduced.

1 Introduction

It is an important issue of ensuring the implementation of the decree of the president of the Republic of Uzbekistan "On approval of the concept of Environmental Protection of the Republic of Uzbekistan for the period up to 2030" dated October 30, 2019 PF-5863, protection of agricultural plants from diseases and pests and reducing the negative impact of the spraying process.

At present, scientific research work on the improvement of the means of spraying in the world for the protection of agricultural plants from diseases and damage, defoliation, and desiccation processes has been carried out [1,2,3,4], and thousands of rubles were created. To distinguish the working fluid of the sprayers from each other depends on the method of spraying in the form of a stream through a cyclone or through a rotating disk [1,2,3,4,5,6,7,8].

The working fluid depends on the method of spraying. When spraying, the drug is sprinkled on the object in the form of a liquid. One of the main factors is the achievement

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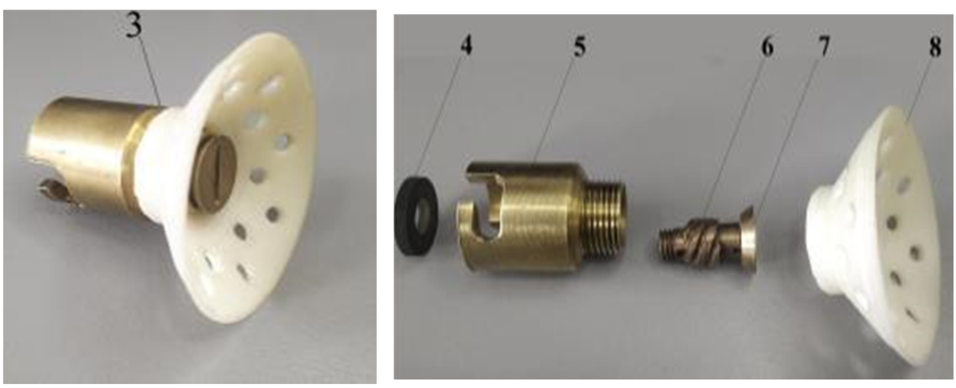
of the effective size of the drops. The size of the sprayed drops determines the economic efficiency of processing. As the drop sizes decrease, that is, the working fluid consumption decreases as the spray quality level increases.

There are the following categories according to the size and consumption of the spray dropper: large drop (>300 mkm); small droplets (150-300 mkm); highly dispersed (50-150 mkm); aerosol (< 50 mkm).

The above-mentioned aerosol drip spraying method allows you to get drops of almost the same size, but much of them can spread to residential areas and other types of crops in the environment under the influence of a weak natural wind without falling into the cultivated fields. This negatively affects other plants in the environment and products consumed by the people.

2 Materials and methods

The work on determining the technical efficiency of chemical treatment in the process of defoliation of the porous with improved cutter (Figure 1) [9,10] was carried out in accordance with the methods of testing of agricultural machinery (sprayer and pollinator) O'zDst 3202:2017 [11].



a) *b)*

1 - fan; 2-speaker; 3 - restoration; 4 - densifier;5 - cover; 6 - Central tube; 7-flow regulator; 8-turbolizer

Fig. 1. Improved restoration (a), components (b).

When choosing a place for chemical treatment the thickness of the porous soils, the state of deacidification of the branches (in percent), the degree of opening of the breasts (according to agrotechnical requirements this indicator is not less than 40%), the average height of the porous soils was taken into account. Depending on this average height, the norms of spraying super chlorate magnesium consumption per hectare ranged from 8-12 kg/ha. The selected place for chemical treatment effective coverage width for each machine was calculated three times the input for the aggregate depending on VR, in which the calculation of the aggregate in the average input state was carried out, and the repetition of the tests was considered equal to 3. Work on the placement and numbering of horns was carried out just like in the process of determining the quality indicators. The pores on the test sites were numbered and the number of leaves on each of the pores was counted [11].

Air temperature and wind speed were studied before spraying. The cotton fields were treated with Super Chlorate Magnesium. Working fluid consumption ranged from 100–125 l / ha, depending on the thickness of the cotton for defoliation. On the 6th and 12th days after processing, leaf shedding was accounted for and statistical analysis of the technical efficiency of the height of the branches and the coverage width of the unit was carried out.

High dispersion processing quality in order to determine the coating density, diameter of the drops being treated, and their dispersion, digital drop cards with a fluid sensitivity of 26x76 mm were used and analysed using Deposit Scan software [12,13].

3 Results and Discussion

At the time of the scanning of the drop cards, a drop sample was formed, consisting of a certain amount of measured drops, distributed in the measurement classes. In order to simplify the computational measurement of drops, measurements using the Deposit Scan program scanning were expressed as follows in cross-section numbers [11,14,15]:

$$K_1 = \frac{K_{min}+K_{max}}{2} \qquad (1)$$

where: Kmin – the lower limit in each drop class, Kmax – the upper limit in each drop class, K1 – is their average limit.

The drop cards were scanned. Observations were carried out on the cross-section with a width of 26x76 mm. On the basis of our theoretical work, the diameter of high dispersion drops, which are sprinkled from the cutter to the crop area, – has a random feature. The variability of the diameter of the formed droplets was determined using the lines of the variation and the curves of the variation.

The variation rows and curve lines obtained in the experiment cross-compare their expectation value (arithmetic mean) and standard deviation (square root of the main square deviation), σ values is one of the main objectives of our research work. The arithmetic mean of the variation range was determined using the following expression [11]:

$$\underline{x} = \frac{x_1 m_1 + x_2 m_2 + \ldots + x_i m_i}{m_1 + m_2 + \ldots + m_i} = \frac{\Sigma \quad x_i m_i}{\Sigma \quad m_i}, \qquad (2)$$

where: x1 + x2 +… + xi – diameter of drops, [mkm], m1 + m2 +… + mi – intervals, pieces.

The standard deviation was determined by the following expression while the number of mathematical [16,17] and statistical information in the calculations was significantly greater (N>25) in the case [11]:

$$= \sqrt{\frac{(x_1-\underline{x})^2 m_1 + (x_2-\underline{x})^2 m_2 + \ldots + (x_i-\underline{x})^2 m_i}{\Sigma \quad m_i}} = \sqrt{\frac{\Sigma \quad (x_i-\underline{x})^2 m_i}{\Sigma \quad m_i}}, \qquad (3)$$

$\sum \quad m_i = N$ – is the total number of mathematical and statistical information, pieces.

Studies have shown that the change in the diameter of the sprinkled high-dispersion drops is subject to the laws of normal (Gauss) distribution in most cases. Their affiliation to the law is provided for by the coefficient of variation V [11]:

$$V = \frac{}{\underline{x}} 100\%, \qquad (4)$$

According to the results of mathematical and statistical analysis of the corresponding data N = 500 pieces, Xmax=146 mkm; Xmin=53 mkm, K3=93 mkm, K=22.36, η=4.16, $\overline{x}$ =95 mkm, σ=18.17, V=0.19, the droplets belong to Gaussian distribution law. The distribution of high-dispersion drops formed for Gaussian (normal) distribution law was determined by constructing the differential function curve with the following expression (table 1) [11]:

$$f(x_i) = \frac{1}{\sqrt{2}} e^{-\frac{(x_i-\underline{x})^2}{2 \quad 2}} . \qquad (5)$$

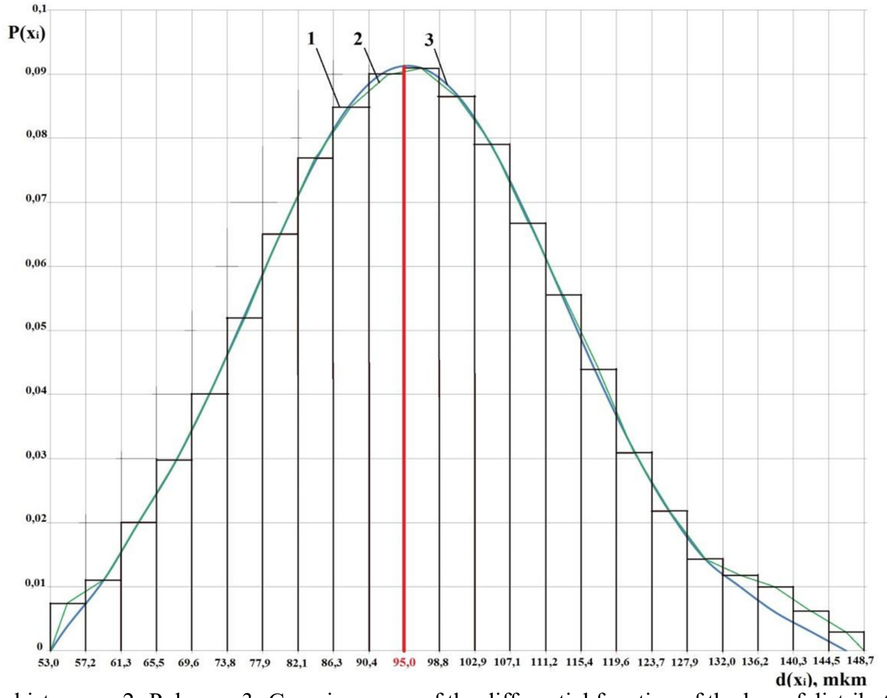
Table 1. Determining the disintegration of the working fluid in the spray.

(Results of calculation of values for the collected information ($\underline{x}$, , $V, f(x_i), P(x_i), m_i^H$)
Type of spray, turbulence atomizer, Working fluid consumption, l/min _18.5,
Ring hole diameter, mm_h=0,6

Number	Interval middle, xi	Number of falls in intervals mi	Probability of intervals, P experience	$f(x_i)$	$P(x_i)$	m_i^H	Accumulated probabilities	
							Real $\sum m$	Theoretic $\sum m_i^H$
1	55,08	11	0,003	0,036	0,008	5	11	5
2	59,24	15	0,007	0,058	0,013	7	26	12
3	63,4	10	0,014	0,088	0,020	12	36	24
4	67,56	10	0,019	0,128	0,029	15	46	39
5	71,72	19	0,027	0,176	0,040	21	65	60
6	75,87	12	0,035	0,229	0,052	26	77	86
7	80,03	17	0,045	0,284	0,065	33	94	119
8	84,19	25	0,057	0,334	0,077	38	119	157
9	88,35	31	0,07	0,373	0,085	43	150	200
10	92,51	41	0,09	0,395	0,090	45	191	245
11	96,67	57	0,115	0,397	0,091	45	248	290
12	100,83	64	0,15	0,379	0,087	43	312	333
13	104,99	89	0,178	0,343	0,079	39	401	372
14	109,15	31	0,07	0,295	0,067	35	432	407
15	113,31	21	0,042	0,240	0,055	27	453	434
16	117,47	14	0,028	0,186	0,043	21	467	455
17	121,62	11	0,018	0,136	0,031	16	478	471
18	125,78	7	0,011	0,095	0,022	12	485	483
19	129,94	4	0,007	0,063	0,014	7	489	490
20	134,1	4	0,005	0,039	0,012	5	493	495
21	138,26	3	0,004	0,023	0,010	3	496	498
22	142,42	3	0,003	0,013	0,006	1	499	499
23	146,58	1	0,002	0,007	0,003	1	500	500
Total		**500**	**1**		**1**	**500**		

Based on the analysis of mathematical and statistical processing (table 1) and an integral curve on the volume of droplets in the coordinates $\sum P(x_i)$, and dxi (Figure 2).

At the axis of the abscissa on the graph, the upper limits of each measuring class of drops to dxi microns were set $\sum_{i=1}^{i} P(x_i)$. Fraction of the liquid mass corresponding to the size of each drop on the ordinate axis, the values of the percentage were collected (Figure 3).



1- histogram; 2- Polygon; 3- Gaussian curve of the differential function of the law of distribution

Fig. 2. Dynamic row mathematically-static processing results.

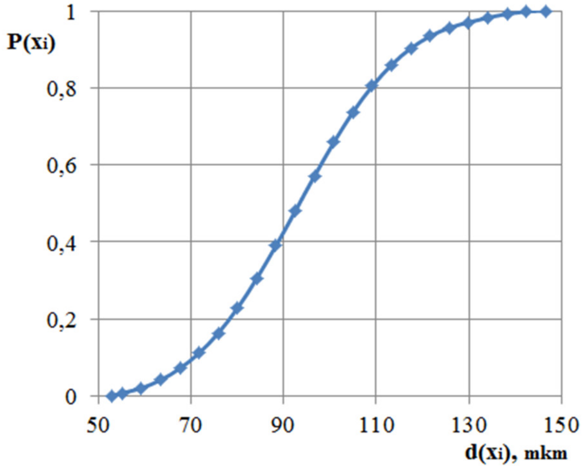


Fig. 3. Integral curve line of distribution of drops by volume.

4 Conclusion

The analysis using the Deposit Scan software to determine the processing quality indicators such as the density of coating on drop cards, the diameter of the drops and the dispersity of them showed that it is convenient and reliable compared to simple microscopic methods.

According to the results of mathematical and statistical analysis of the collected data when the working fluid consumption of the turbulizer is 18.5 l / min, N = 500 units, Xmax=146 mkm, Xmin=53 mkm, K3=93 mkm, K=22.36, η=4.16, $\overline{x}$ =95 mkm, σ=18.17, V=0.19, the droplets follow a Gaussian distribution law. The size limit of the droplets was found to be 53–149 mkm.

According to agrotechnical requirements, the distribution limit of the size of the drop formed by the proposed cutter is within 50-150 mkm the economic efficiency of the chemical treatment is improved. With the agrotechnical reduction in the size of the drops, that is with an increase in the quality of the spray, the working fluid consumption can be saved, and the negative effect on other plants in the environment, and on products consumed by the people can be reduced.

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