Studies on the Speedmister

Part II. Comparative Experiments of the Performance of Each Nozzle Made by Way of Trial*

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Received September 13, 1968

In this paper, we report about some nozzles for speedmister made by the authors by way of trial and used for the experiment. There were 4 kinds of nozzles for speedsprayer, 5 kinds of nozzles for speedmister and 6 kinds of nozzles for speedmister made in U. S. A.. Each nozzle was experienced in comparison with its mutual characteristics in regard to the range of deposit of particles, mean diameter of particles, relative frequency and analysis of particle diameter etc.. Those experiments were carried out with the following results. In the case of speedsprayer nozzles particles of about 50μ diameter were contained, but in the case of speedmister the particles were smaller. A few favorable types of nozzles for speedmister were found out in those test nozzles.

Introduction

In a previous paper, our studies clearly indicated that the principle of speedmister is possible to realize. So, some nozzles for speedmister were made by way of trial by the authors. There were 4 kinds of nozzles for the speedsprayer, 5 kinds of nozzles for the speedmister and another 6 kinds of nozzles made in U.S.A. were applied for experiments. Therefore, a total number of 15 kinds of nozzles shown in Table 1 were applied in this experiment.

Those nozzles were fixed to the nozzle head of the 1/10 model speedmister, and each nozzle was experimenced in comparison with its mutual characteristics. As the nozzle of speedmister and the nozzle made in U. S. A. have a shutoff needle, particle diameter and discharge rate can be adjusted.

Table 1

Nozzle body / Nozzle head	Nozzle of speedsprayer	Nozzle of speedmister	Nozzle of speedmister made in U. S. A.	
			No. 40100	No. 60100
Wide angle round spray	No. 1	No. 5	No. 10	No. 13
Round spray	No. 2	No. 9	No. 12	No. 15
Rounde spray (with net core)	No. 4			
Flat spray		No. 8	No. 11	No. 14
Closs notch spray		No. 6		
Single notch spray		No. 7		
Whirl nozzle	No. 3			

*Paper presented at the meeting of the Japanese Society of Agricultural Machinery at Kyoto, April 1968.

**Marunaka sprayer & duster mfg. Co., Ltd.

Conditions of the Experiment

Experiments were carried out under the following conditions,

a. Arriving performance of particles (measuring the range of deposit of particle).

b. Atomizing performance of nozzle (measuring the mean diameter of particle by taking photographs using microscope, and calculating the analysis of particle diameter).

Experimental Apparatus and Method

1) Experimental apparatus.

The experimental apparatus is shown in Fig. 1. This is the 1/10 model speedmister which is explained and used in the previous paper. This experiment was done in the laboratory to avoid the effects of the natural wind. Axial flow type blower is 1 ps, 1800 rpm and driven with electric motor. Diameter of blower outlet section is 470 mm in the case of not using a cover and 306 mm in the case of using a cover. Air volume of blast was 100 m/min and compressed air of 2 kg/cm^2 and liquid of 2 kg/cm^2 were used for atomization in nozzles.

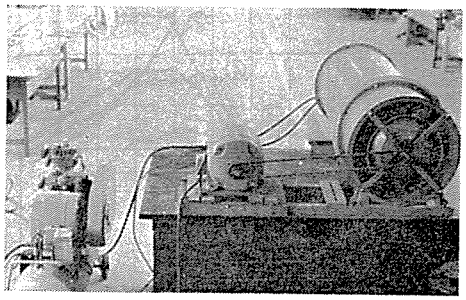


Fig. 1 Experimental apparatus.

2) Test nozzles.

The test nozzles made by way of trial are shown in Fig. 2 and Fig. 3 and its classification is given in Table 1 too. As shown in Table 1, the nozzles of the speedsprayer type which have been used in general in farming are of 4 kinds, and the nozzles of the speedmister type which were made by the authors are of 5 kinds. The nozzles wich were made in U. S. A. are of 2 different kinds of nozzle bodies (i.e., No. 40100 and No. 60100) and 3 kinds of nozzle heads, when those nozzle bedies and nozzle heads are combined 6 kinds of spraying patterns are obtained.

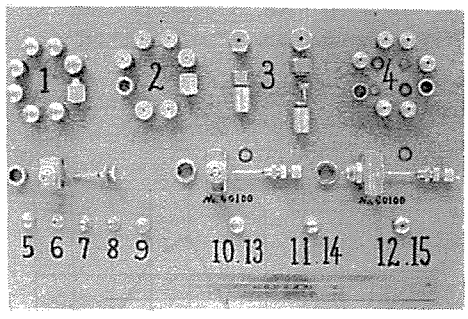


Fig. 2 Each kinds of test nozzles.

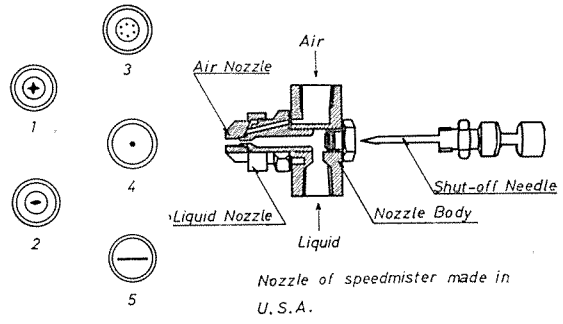


Fig. 3 Each kinds of test nozzles.
1 : closs notch spray nozzle
2 : single notch spray nozzle
3 : wide angle round spray nozzle
4 : round spray nozzle
5 : flat spray nozzle.

3) Measuring the range of deposit.

Glass beakers were set at intervals of 0.5m on the straight line from the nozzle to 10m and after the spray the catched liquids were measured with messcylinder.

4) Measuring the mean diameter of particle by taking microphotographs and calculating the anal-

ysis of particle diameter. Paraffin had been painted on the preparate glass and the particles were caught on this glass at each points 1, 3, 5, 7, 10 m from the nozzle and microphotographs of them were enlarged fifty times. From these photographs, we calculated the mean diameter of particle and the analysis of particle diameter was calculated and analyzed.

Results and Discussions of the Experiments

1) Arriving performance of particles.

The results of these kinds of experiments are shown in Fig. 4, Fig. 5, Fig. 6, and Fig. 7.

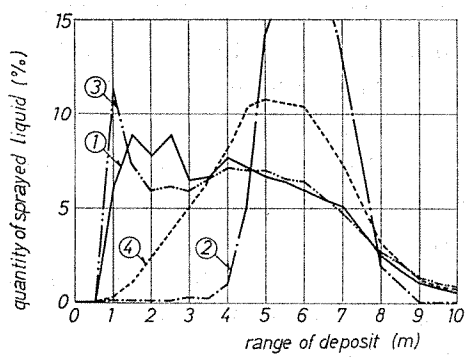


Fig. 4 Quantity of sprayed liquid to the range of deposit. (nozzle of speed-sprayer used)
① : No. 1
② : No. 2
③ : No. 3
④ : No. 4

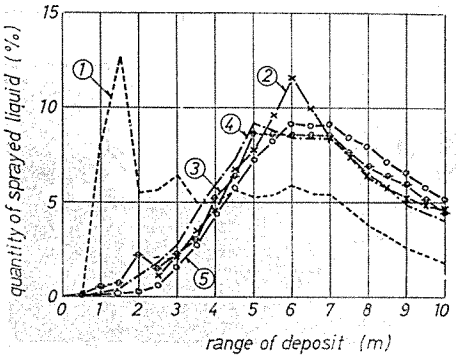
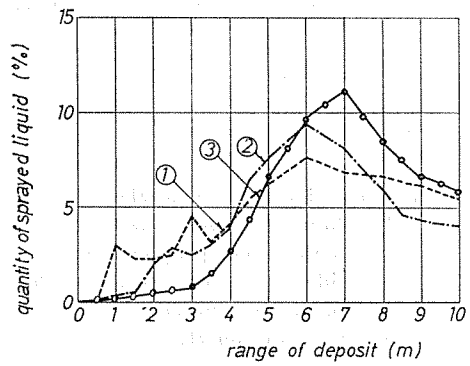


Fig. 5 Quantity of sprayed liquid to the range of deposit. (nozzle of speed-mister used)
① : No. 5
② : No. 6
③ : No. 7
④ : No. 8
⑤ : No. 9



Fg. 6 Quantity of sprayed liquid to the range of deposit. (nozzle of speed-mister made in U. S. A. used)
(No. 40100)
① : No. 10
② : No. 11
③ : No. 12

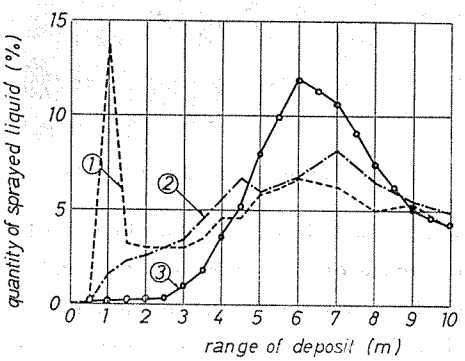


Fig. 7 Quantity of sprayed liquid to the range of deposit. (nozzle of speed-mister made in U. S. A. used)
(No. 60100)
① : No. 13
② : No. 14
③ : No. 15

In Fig.4, the speedsprayers nozzles were used and nozzle No. 1 and No. 3 are diffusion type and

nozzle No. 2 and No. 4 are arriving type nozzles. Diffusion type nozzles formed a flat spray pattern within 6m from nozzle position.

Arriving type nozzles made the particles fall at the maximum distance of 5～6m from the nozzle, therefore the range of deposit is 7～8m and the particle could not go as fas as 10m.

In Fig.5, the speedmisters nozzles made by way of trial were used. Nozzle No.6, No.7, No.8 and No. 9 are all arriving types and the maximum falling position was 5～7m from the nozzle and arriving particles that went as far as 10m from the nozzle were 4～5%. Nozzle No. 5 is diffusion type and makes flat spray pattern within 2～7m from the nozzle.

In Fig. 6 and Fig. 7, the speedmister nozzles made in U. S. A. were used. These nozzles are able to adjust the shut-off needle and this type nozzle can be used both as diffusion type and arriving type. Nozzle No. 12 and No. 15 made arriving type spray pattern and the maximum falling position 6～7m from the nozzle was shown. Nozzle No. 13 is diffusion type spray pattern and maximum falling position is within 1m from nozzle. Nozzle No. 10, No. 11 and No. 14 made also arriving type spray pattern, but maximum falling quantity was less than in the case of No. 15.

2) Analysis of particle diameter for each kind of nozzles.

Fig. 8, Fig. 9, Fig. 10 and Fig. 11 show the relative frequency of particle diameter for each test nozzle. The distribution of particle diameter formed L-type Poisson distribution and the

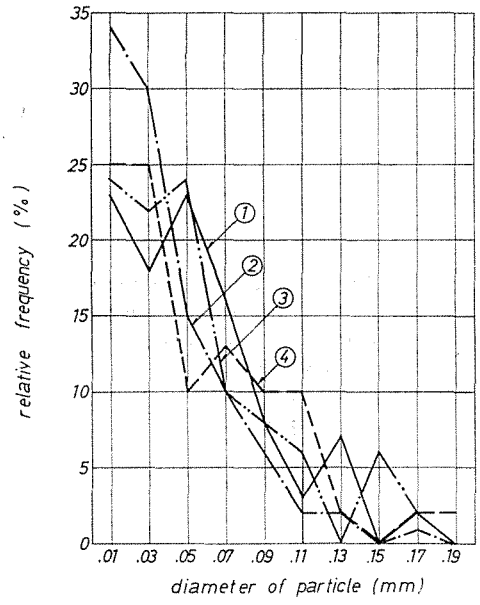


Fig. 8 Relative frequency of the particle diameter. (nozzle of speedsprayer used)

① : No. 1
② : No. 2
③ : No. 3
④ : No. 4

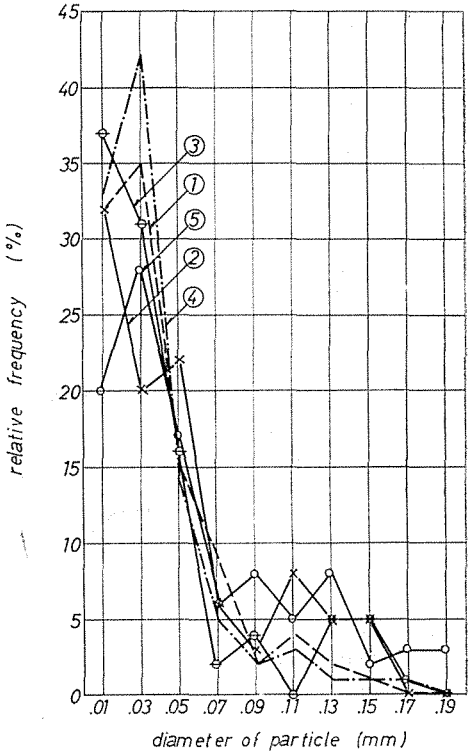


Fig. 9 Relative frequency of the article diameter. (nozzle of speedmister used)

① : No. 5
② : No. 6
③ : No. 7
④ : No. 8
⑤ : No. 9

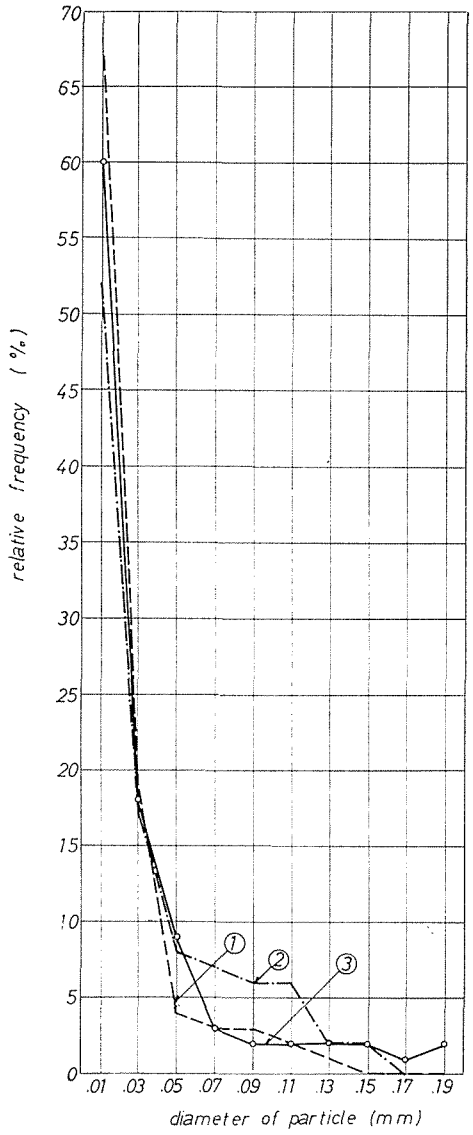


Fig. 10 Relative frequency of the particle diameter. (nozzle of speedmister made in U. S. A. used)
(No. 40100)
① : No. 10
② : No. 11
③ : No. 12

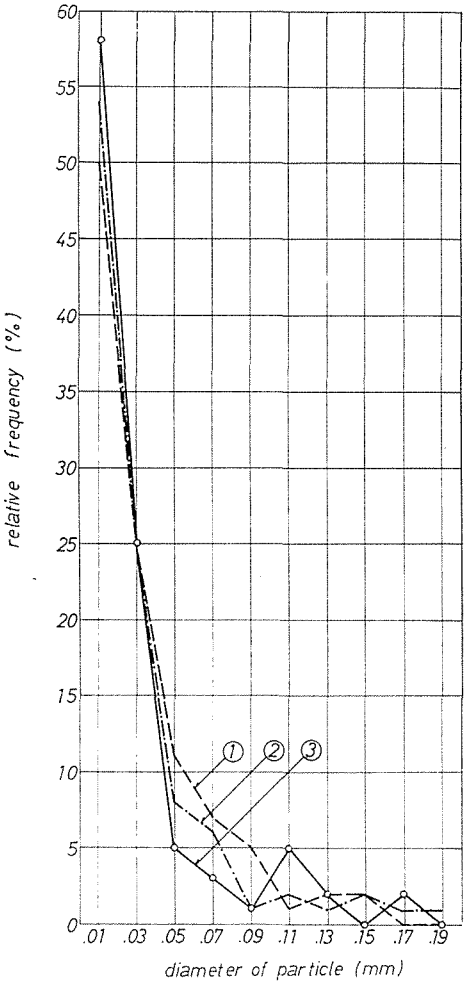


Fig. 11 Relative frequency of the particle diameter. (nozzle of speedmister made in U. S. A. used)
(No. 60100)
① : No. 13
② : No. 14
③ : No. 15

frequency was connected with the small particles. In regard to the relative frequency of particle diameter, the frequency of small particles become high in the following order, i.e., speedsprayer type, speedmister type and speedmister type made in U. S. A. and also in this order containing rough particles decreased. The relative frequency of particle diameter of $50\sim100\mu$ was higher in

the case of diffusion type nozzle than in the case of arriving type nozzle.

At the position of 1m from the nozzle, the particles were analyzed for each kind of nozzles and those results are given in Table 2.

Table 2

Nozzle head	Type	Classification	Mean diameter of particle	Standard deviation S	Measure of skewness a_3	Kurtosis a_4	Discharge rate (1/min) (with 8 nozzle head)
Round spray	Nozzle of speedsprayer	No. 2	0.039	0.032	1.44	5.10	3.47
	Nozzle of speedmister	No. 9	0.059	0.049	1.13	3.33	4.53
	Nozzle of speedmister made in U. S. A. No. 40100	No.12	0.032	0.041	2.44	8.60	3.26
	Nozzle of speedmister made in U. S. A. No. 60100	No.15	0.029	0.035	2.39	8.24	4.56
Round spray (with net core)	Nozzle of speedsprayer	No. 4	0.055	0.044	1.06	3.75	1.92
Flat spray	Nozzle of speedmister	No. 8	0.034	0.027	2.07	8.51	6.08
	Nozzle of speedmister made in U. S. A. No. 40100	No.11	0.037	0.038	1.35	3.76	2.70
	Nozzle of speedmister made in U. S. A. No. 60100	No.14	0.031	0.036	2.47	9.18	3.55
Closs notch spray	Nozzle of speedmister	No. 6	0.048	0.041	1.10	3.16	4.56
Single notch spray	Nozzle of speedmister	No. 7	0.042	0.042	11.65	4.77	4.00
Wide angle round spray	Nozzle of speedsprayer	No. 1	0.053	0.038	0.89	3.38	3.33
	Nozzle of speedmister	No. 5	0.038	0.031	1.52	5.28	5.28
	Nozzle of speedmister made in U. S. A. No. 40100	No.10	0.024	0.027	2.38	8.23	2.43
	Nozzle of speedmisser made in U. S. A. No. 60100	No.13	0.033	0.033	1.81	6.18	3.14
Whirl nozzle	Nozzle of speedsprayer	No. 3	0.053	0.041	1.14	3.70	3.31

The calculating formula are as follows,

$$m_2 = \frac{1}{n}\sum_{i=1}^{k} f_i\,(d_i - d_a)^2 \quad \cdots\cdots\text{moment of the second order}$$

$$m_3 = \frac{1}{n}\sum_{i=1}^{k} f_i\,(d_i - d_a)^3 \quad \cdots\cdots\text{moment of the third order}$$

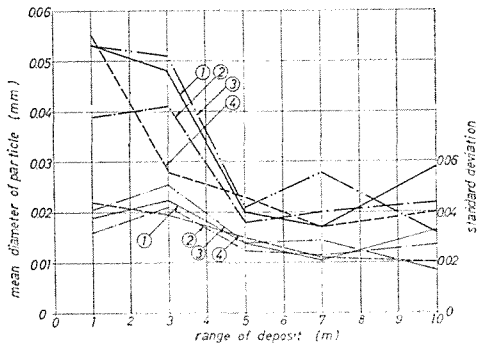
$$m_4 = \frac{1}{n}\sum_{i=1}^{k} f_i\,(d_i - d_a)^4 \quad \cdots\cdots\text{moment of the fourth order}$$

by use of the above formula,

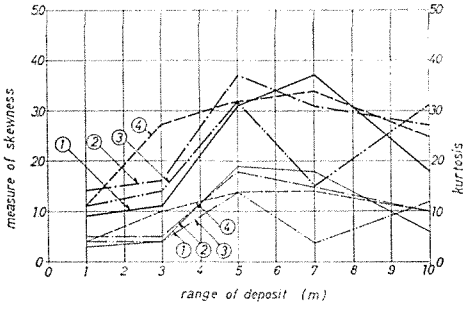
$$S = \sqrt{m_2} \quad \cdots\cdots\text{standard deviation}$$

$$a_3 = \frac{m_3}{S^3} \quad \cdots\cdots\text{measure of skewness}$$

$$a_4 = \frac{m_4}{m_2^2} \quad \cdots\cdots\text{kurtosis}$$

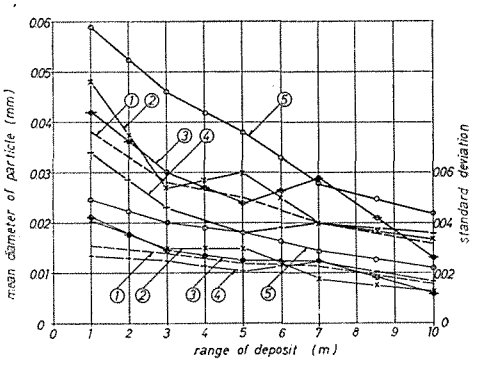


(a)



(b)

Fig. 12 Analysis of particle diameter.
(nozzle of speedsprayer used)
① : No. 1
② : No. 2
③ : No. 3
④ : No. 4



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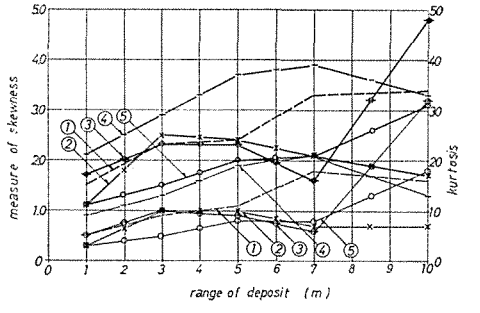


(b)

Fig. 13 Analysis of particle diameter.
(nozzle of speedmister used)
① : No. 5
② : No. 6
③ : No. 7
④ : No. 8
⑤ : No. 9

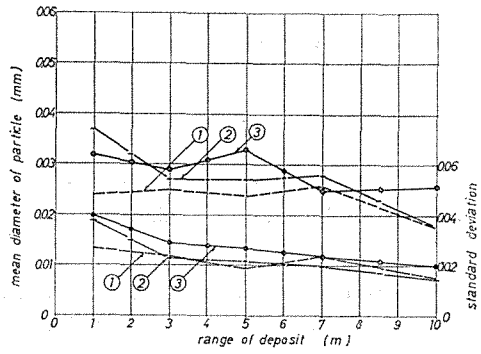
In general, speedsprayer type contained large particles of 50～60μ diameter speedmister type came next and speedmister type made in U. S. A. contained smallest particles of 30～50μ diameter.

Mean diameter of particles was calculated by using the following formula,

$$d_a = \frac{1}{n} \sum_{i=1}^{k} f \, d_i$$

3) Analysis of particle diameter for each distance from the nozzle.

In Fig. 12, Fig. 13, Fig. 14 and Fig. 15, the relationship the rang of deposit and the mean diameter of particles are shown with the standard deviation S, the measure of skewness a_3, the kurtosis a_4. When speedsprayers nozzles were used, the mean diameter of particles changed rapidly within 5m from the nozzle but at a distance of more than 5m the particle diameter was uniformly about 20μ. So, standard deviation is low, measure of skewness and kurtosis are high.



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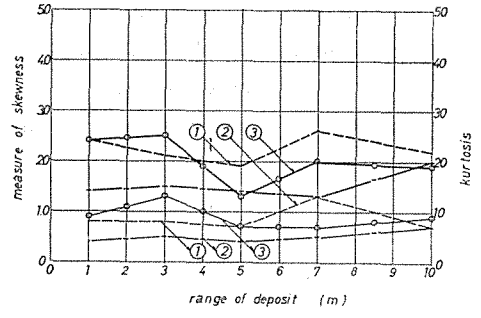
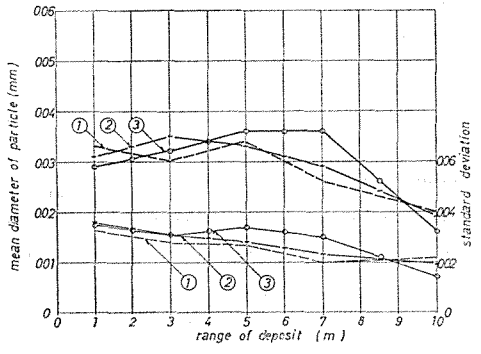


(b)

Fig. 14 Analysis of particle diameter. (nozzle of speedmister made in U. S. A. used)
(No. 40100)
① : No. 10
② : No. 11
③ : No. 12



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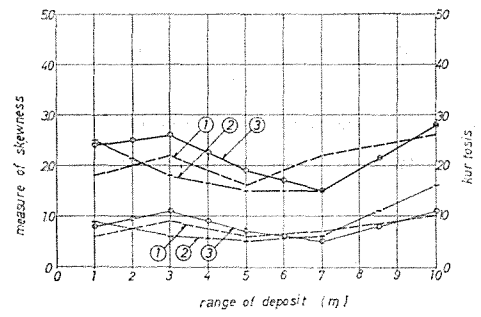

(b)

Fig. 15 Analysis of particle diameter. (nozzle of speedmister made in U. S. A. used)
(No. 60100)
① : No. 13
② : No. 14
③ : No. 15

When speedmister nozzles except No. 9 were used, the mean diameter decreased slowly at a distance of more than 3m. Standard deviation is lower at the position of 1～5m than in the case of speedsprayer and the particles are uniform. But at a distance of more than 5m, measure of skewness and kurtosis became low value and the particle distribution was rough. When speedmister nozzles made in U. S. A. were used, standard deviation S, measure of skewness a_3 and kurtosis a_4 were all low values and the mean diameter was almost constant as far as 7m from the nozzle, therefore the arriving performance of particles was very good. From the above mentioned experiments, the authors reached the following conclusions,

(1) For diffusion type nozzles, there is need to decrease a falling of particle at the position of 1～2m.

(2) For speedsprayers nozzles, the effective range of deposit is about 7～8m.

(3) In the case of speedsprayer and speedmister nozzles, many particles of a diameter larger than 50μ were contained.

In the case of speedmister made in U. S. A. the particles are smaller.

(4) Particles that went as far as 10m from the nozzle have a diameter of less than 20μ.

Conclusions

Some nozzles for speedmister were made by way of trial by the authors. There were 4 kinds of nozzles for the speedsprayer, 5 kinds of nozzles for the speedmister and 6 kinds of nozzles made in U. S. A. which were applied for the experiments.

Nozzles were fixed to the nozzle head of the 1/10 model speedmister, and each nozzle was experienced in comparison with its mutual characteristics in regard to the range of deposit of particles, the mean diameter of particles, the relative frequency and the analysis of particle diameter etc..

Those experiments were carried out with the following results. For speedsprayers nozzles, the effective range of deposit is about 7～8 m. In the case of speedsprayer and speedmister nozzles, many particles of a diameter larger than 50μ were contained. However, in the case of speedmister made in U. S. A., the particles are smaller. Judging from these results we may say that these test nozzles were not yet perfect, but a few favorable type nozzles for speedmister were found out in those test nozzles made by way of trial.