EPA-540/9-77-015

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JUNE 1977

U.S. Environmental Protection Agency
Washington, D. C. 20460

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ABSTRACT

Nineteen different commercial home and garden pesticide formulations containing fungicides from 17 manufacturers were evaluated for particle size by wet- and dry-sieve methods. Significantly different results were obtained by each method. The wet-sieved method showed that at least 90% of the particles were smaller than 75 µm in 17 formulations, while the dry-sieved method indicated that 70% of the particles were smaller than 75 µm in only seven formulations. The dry sieving method was found to be most appropriate for the evaluation of dusts. The mean particle size of most currently marketed commercial pesticide dusts for home and garden use is 149 µm or smaller.

The relationship between particle size and pesticide effectiveness is well known (4, 5, 6, 7, 8, 9, 10). Pesticide manufacturers frequently specify the portion of their product that will pass a 325-mesh sieve (i.e. 44 µm). Methods for particle size determination vary among manufacturers, but wet and dry sieving are most common (1, 2).

The work reported here was undertaken to determine the particle size of commercially available home and garden pesticide dusts containing fungicides and to compare the two methods used for determining size.

MATERIALS AND METHODS

Home and garden pesticide formulations often contain both fungicides and insecticides. Fungicidal components involved in this study were: Folpet, Folpet plus sulfur, Chlorothalonil plus Karathane, zinc salts, and a copper zinc chromate complex. A sulfur compound and a copper zinc chromate complex were the only products that did not contain insecticides in their formulation.

Both dry- and wet-sieving (1, 2) methods were evaluated in this study. Nineteen pesticide dust formulations registered for domestic use, including 60 different samples collected from 17 distributors, were sieved using both methods.

Dry sieving: Three aliquots containing 10 g each of each pesticide formulation were independently dry sieved through a nest of Tyler standard sieves consisting of 149, 74, and 44 μm openings (100, 200, and 325-meshes per inch). The samples were placed on the top sieve (149 μm) and the nest was shaken for 10 minutes on a model R202 Tyler Portable Sieve Shaker. Dust remaining on each sieve and in the bottom pan was weighed at the conclusion of the shake cycle and the mean percent weight of the material on each sieve was calculated.

Wet sieving: Three aliquots containing 10 g each of each pesticide formulation were independently wet sieved through a nest of Tyler standard sieves consisting of 149, 74, and 44 μm openings (100, 200, and 325-meshes per inch). The sieves were thoroughly wet with tap water before the sample was placed on the upper sieve of the nest. Then the sample was washed through the sieves with a continuous stream of tap water (about 1100-1200 ml/minute). Samples were considered completely sieved when the water passing the 44 μm sieve was clear. Material retained on each sieve was individually washed into a separate petri dish and the uncovered dishes were placed in a drying oven at 27 C for 24 hours. After cooling, weights of the pesticide formulation were determined and the mean percent weight of material on each sieve was calculated.

RESULTS AND DISCUSSION

The percentage of each dust retained on 100, 200, and 325-mesh sieves and the percentage that passed the 325-mesh sieve were expressed as particle size groups based on sieving behavior (Table 1). More than 70% of the particles in formulations A, B, C (Folpet), H (Folpet plus sulfur), J (Captan), P (sulfur), and Q (Karathane plus Chlorothalonil) were smaller than 75 μm as determined by the dry-sieve method. However, more than 90% of the particles of 17 wet-sieved formulations contained particles smaller than 75 μm. Formulations L (Captan), R (copper zinc chromate), and S (zinc salts) contained the majority of particles larger than 149 μm by the dry-sieve method. Eighty percent of the particles from Folpet (A), Captan (J and L), and sulfur (P) formulations measured less than 45 μm in size when tested by the wet-sieve technique.

The particle size distribution of similar dry-sieved formulations was often distinctly different. For example, in one Captan formulation (J) less than 1% of the particles were greater than 150 μm but in a similar formulation (L) over 74% of the particles were larger than 150 μm. A similar disparity of particle size distribution occurred with two similar Folpet formulations (A vs. G).

Smaller particles may cause over-application when used in plastic squeeze dusters (3). It is difficult to achieve uniform coverage with these dusters when the dust formulation is principally composed of small particle sizes. For example, with formulation A approximately 2.8 times as much dust was applied as when plants were dusted with similar formulation G. Formulations which contain smaller particles may result in over application and reduce photosynthesis of the leaves

unless the excess dust is removed following application. Larger particles applied with plastic squeeze dusters may result in poor distribution of the dust on the leaf surface if the duster orifice becomes clogged.

Particle size affects applicator effectiveness. This work demonstrates that the method by which particle size is determined is an important factor in achieving desired results. Because dusts are applied dry, the most appropriate method of evaluation is dry sieving. Both the wet- and dry-sieving methods are necessary to determine particle size of products which may be used as dusts or sprays.

Significant differences between aliquots did not exist and consistent results were obtained using both methods.

The amount of pesticide formulation to be sieved is important. Ten grams of material can be sieved without overloading the sieves. Therefore, 10 gram aliquots were used.

Material may be effectively sieved in 10 minutes provided that only three sieves are used.

Samples containing Folpet as the only fungicide ingredient were from different manufacturers (except E and F). All other samples containing the same fungicide components were from different manufacturers. The results illustrate that various manufacturers strive for different particle size ranges or have poor quality control. Some manufacturers may blend fungicides and insecticides of different particle sizes to prepare combination products.

Particle size is not regulated unless specified on the product label but can be an important factor in product effectiveness.

Table 1. Particle size distribution of pesticide dusts determined by dry and wet sieving.

Pesticide			Percentage of pesticide in various particle size groups							
Sample designation	No. of samples tested	Fungicide content	> 150 µm		75-149 µm		45-74 µm		< 44 µm	
			Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
A	4	Folpet 5%	1.3	0.3	3.0	9.3	12.3	45.0	83.2	45.3
B	6	Folpet 5%	1.6	0.3	12.5	1.8	30.5	13.1	54.7	84.6
C	3	Folpet 6.5%	2.3	0.1	15.1	2.2	33.5	14.9	45.7	82.8
D	2	Folpet 5%	3.6	0.1	36.0	3.1	29.4	6.8	31.0	90.1
E	3	Folpet 5%	5.5	0.6	30.0	1.2	50.0	5.7	14.6	92.5
F	3	Folpet 7.5%	22.4	0.3	52.9	2.4	17.8	5.2	7.0	92.1
G	1	Folpet 5%	14.2	0.1	33.7	1.5	47.0	5.2	5.1	93.2
H	1	Folpet 7.5% Sulfur 10%	6.1	2.7	16.5	2.3	56.6	8.5	20.8	86.5
I	11	Folpet 7.5% Sulfur 30%	26.2	0.1	56.4	2.9	10.6	7.0	5.0	90.0
J	2	Captan 5%	0.7	0.2	6.1	4.1	26.9	25.1	66.3	70.7
K	2	Captan 4%	39.5	0.2	41.7	2.1	12.2	16.5	6.7	82.2
L	3	Captan 5%	74.6	13.7	3.2	10.1	19.3	9.3	2.9	66.8
M	4	Captan 5% Sulfur 20%	15.2	2.3	42.1	2.3	24.2	7.5	18.5	87.9
N	2	Captan 4% Sulfur 25%	37.8	0.4	39.2	2.8	17.1	11.3	5.9	85.5
O	5	Captan 10% Sulfur 25%	12.3	1.0	70.2	4.0	12.1	20.0	5.3	75.0
P	2	Sulfur	0.7	17.2	3.2	6.1	19.3	16.7	76.9	60.1
Q	3	Karathane 0.9% Chlorothalonil 5%	1.4	0.1	15.0	1.0	33.5	6.6	50.2	92.3
R	2	Copper Zinc Chromate 89%	53.8	0.4	34.4	1.2	3.5	1.6	8.3	96.8
S	1	Zinc 3.9%	76.6	0.1	16.9	2.3	2.5	5.3	3.9	92.3

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