

## IMPROVED METHODS OF FORMULATING GRANULAR PARIS GREEN LARVICIDE<sup>1</sup>

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A previous report described a granular paris green-vermiculite formulation for use against culicine and anopheline larvae (Rogers and Rathburn, 1958). This formulation is made by coating the outer surface of vermiculite granules with paris green powder by use of a water-miscible sticker. When applied to water the granules float for several hours, during which time the paris green is released through action of a wetting agent in the sticker. The powder settles slowly through the water where it is consumed by subsurface-feeding larvae either as it settles or after it comes to rest on the soil, grass stems, debris, etc. Some of the released paris green floats at the surface for considerable time where it is available to anopheline larvae. Thus, the granular formulation seems to meet the requirements of an all-purpose mosquito larvicide.

The original formulation was made with a 60 percent motor oil emulsion as the sticker. The emulsion had two disadvantages: it was difficult to apply as a fine spray to the vermiculite and it contained water which had to be removed from the formulation. This required extra handling and a large amount of floor space for processing.

Research in 1958 resulted in replacement of the emulsion sticker by an emulsifiable oil, which is easy to apply as a spray and requires no drying of the formulation. The emulsifiable oil is made by adding an emulsifier to a horticultural-type spray oil.

**OIL.** Oils tested were Standard Oil Company's No. 341 and No. 345 spray oils, and Gulf Oil Company's No. 361 and No. 562 spray oils. In laboratory tests,

all of these oils performed about equally as stickers for the paris green.

These oils, with 10 percent by volume of Triton N-101,<sup>2</sup> were further tested in identical formulations against larvae of *Aedes taeniorhynchus* in randomized and replicated field tests. (All tests reported in this paper were in plots 200 square feet in size.) Oils No. 345 and 562 were compared in the same test in a pickleweed salt marsh. Oils No. 341 and 361 were tested together in a mangrove salt marsh. All dosages were 0.6 pound per acre of paris green, applied by hand as six pounds per acre of a 10 percent paris green formulation. Results are shown in Table 1. There were three replications of each treatment.

TABLE 1.—Field tests comparing four spray oils as stickers in a vermiculite-paris green formulation against larvae of *Aedes taeniorhynchus* Wied.

Oil No.	Avg. no. larvae/dip		Percent reduction	Type Marsh
	Pre treatment	Post treatment		
345	22.1	1.5 <sup>1</sup>	93	Pickleweed
562	19.4	1.1 <sup>1</sup>	94	
341	93.4	0.0 <sup>2</sup>	100	Mangrove
361	100.0	2.0 <sup>2</sup>	98	

<sup>1</sup> 24 hours.

<sup>2</sup> 18 hours.

**EMULSIFIERS.** Rapid and complete water solubility appear to be important requirements for the emulsifier-wetting agent in this formulation. Viscosity and other physical factors, as well as chemical factors, may also play a part both in helping

<sup>1</sup> A paper from the Proceedings of the 15th annual meeting of the AMCA, Salt Lake City, April, 1959.

<sup>2</sup> Rohm & Haas Co.

to stick the paris green on the granules and in releasing the toxicant at the proper rate, but no detailed studies have been made to determine the effects of all these factors. Laboratory tests indicated, however, that oil-soluble emulsifiers do not perform as well as water-soluble emulsifiers.

Only Triton N-101 and Tween 20<sup>3</sup> emulsifiers were field-tested against larvae of *Aedes taeniorhynchus* in these studies. These were compared at concentrations of 5 percent and 10 percent by volume in 10 percent paris green formulations, using No. 345 oil as the sticker. Dosage was six pounds per acre gross applied in a pickleweed salt marsh. Results are shown in Table 2. There were three replications of each treatment, except the check.

TABLE 2.—Field tests comparing two emulsifiers in a vermiculite-paris green formulation against larvae of *Aedes taeniorhynchus* Wied.

Treatment	Avg. No. larvae/dip		% Reduction
	Pre treatment	24 hours	
Triton 5%	30.5	1.4	95
Tween 5%	28.4	8.7	69
Triton 10%	21.3	0.0	100
Tween 10%	37.0	10.3	72
Check <sup>1</sup>	13.8	14.0	—

<sup>1</sup> Two replications.

Judged only by the results shown in Table 1, it might appear that oils No. 341 and No. 361 were slightly superior in these tests. However, other tests (see Table 3) and use experience have shown that granular paris green using the No. 345 or No. 562 oil will give excellent larval kills in mangrove marshes. Pools in these marshes are free of weeds and the bottom is covered with mangrove leaves. These physical conditions permit complete coverage and the broad, flat mangrove leaves on the soil apparently form an ideal substrate upon which the paris green powder may settle and remain available to subsurface-

feeding larvae. Therefore, any apparent differences in the performance of the oils that may be indicated in Table 1 probably reflect differences in marsh conditions rather than in the oils. Cost would seem to be the most important factor in selecting one of these oils. Other spray oils probably could be used, but they should first be tested to ascertain their performance in the formulation.

Data in Table 2 show that Triton N-101 was superior in these tests, but a good explanation for these results is not apparent. There probably are a number of other emulsifiers or wetting agents that would work well in this formulation, but these data show that they should be selected only after adequate testing.

The data also indicate that Triton N-101 at 5 percent by volume was only slightly less effective than the 10 percent volume. But again, use experience and the slight difference in costs seem to justify using the 10 percent volume.

**VERMICULITE.** For application by hand-casting, a No. 4 Zonolite or Institute grade of vermiculite of which at least 90 to 95 percent by weight is retained on a No. 30 U. S. Standard Sieve appears to be satisfactory as the granular base. However, for aerial application, and probably for ground application by mechanical equipment, a more uniform grade of vermiculite is necessary to ensure uniform distribution and dosage. Good progress has been made toward the production of a suitable grade of vermiculite for aerial or other mechanical applications of this formulation but final specifications have not been determined.

**FORMULATING PROCEDURE.** The procedure for formulating granular paris green with emulsifiable oil basically is the same as previously described (Rogers and Rathburn, 1958). The vermiculite is placed in a rotating drum (cement-type mixer) and with the drum rotating the oil-emulsifier mixture is sprayed over the vermiculite as a fine spray of mist. The emulsifier is not soluble in the oil and tends to settle to the bottom of the spray tank

<sup>3</sup> Atlas Powder Co.

rather rapidly. Therefore it is essential that frequent or constant agitation be applied to the sticker as it is being sprayed. After the emulsifiable oil is thoroughly mixed with the vermiculite, the paris green powder is added in small quantities and mixing is continued until the formulation appears uniformly green in color. This formulation may be bagged directly from the mixer and is ready for use; no drying is necessary.

**STANDARD FORMULA.** For uniform weight and quality it seems desirable to standardize the formulation. The recommended standard formula contains by weight 53 pounds of vermiculite, 17 pounds of powder, and 30 pounds of emulsifier-oil sticker per 100-pound batch. Using commercial 90 percent paris green powder, this formula makes 100 pounds of 15 percent paris green by weight.

To make a finished product on the standard formula containing less than 15 percent paris green, the 90 percent paris green is first diluted with a heavy dust, like calcium carbonate (marble dust). For example, to make 100 pounds of 10 percent granular paris green on the standard formula, use 17 pounds of a calcium carbonate-paris green blend which contains 60 percent by weight of paris green.

**DOSAGE RECOMMENDATIONS.** Numerous field tests in 1958 showed the improved, standard formulation to be as effective as the original formulation against larvae of *Aedes taeniorhynchus*. Typical data from tests conducted in a mangrove marsh are shown in Table 3. Some of the treatments were replicated in time during September, 1958. Formulations were made either with No. 345 or No. 562 oil, as indicated.

Two years of experience in testing granular paris green by ground application against larvae of *Aedes taeniorhynchus* have shown that a dosage of 0.6 pound per acre of toxicant is adequate to control this species where physical conditions in the breeding area permit good coverage, and where the larvae are well dispersed. There are situations and conditions, however, where this dosage rate is not adequate.

In breeding areas overgrown with thick vegetation, and in any situation where larvae become concentrated in large numbers in small areas of water, as in wheel ruts or in holes left by a receding water level, the dosage rate should be doubled or tripled to ensure good results. Presumably, this is due to the fact that paris green acts only as a stomach poison and under these conditions of concentrated larval populations not enough toxicant is available per larva at low dosage rates. Spot-treating with larger dosage rates under these conditions should not increase the cost per acre, because considerably less area is treated than when larvae are more widely dispersed. In the case of *Aedes taeniorhynchus* and *Aedes sollicitans*, concentrations of larvae occur from normal behavior of the third and fourth instar larvae, even in well-flooded marshes. Since spot-treating of these "balls" of larvae cannot be accomplished by aerial application, this might prove to be an important dosage factor for aerial treatment of these species.

Since conditions vary so widely in different areas, dosage rates can probably best be determined by use experience in any given area. As a starting point, it is suggested that a 10 percent formulation be

TABLE 3.—Dosage and volume tests against larvae of *Aedes taeniorhynchus* Wied. using improved, standard formulation of granular paris green

Formulation (percent paris green)	Dosage lbs./acre (gross)	Avg. No. larvae/dip		Number replications	Percent reduction
		Pre treatment	Post treatment		
7.5	8	71.3	0.03	3	99.95
10.0	6	80.3	0.10	3	99.87
10.0 <sup>1</sup>	6	16.7	0.00	1	100.00

<sup>1</sup> Formulation made with No. 562 oil.

tried at a rate of 10 pounds per acre. The 10-pound rate will ensure better coverage, which is very important with this larvicide, and the required amount of toxicant can be determined by varying the paris green content of the formulation.

Although a number of highly successful tests have been made with aerial applications of granular paris green, this work is

not sufficiently advanced to permit general recommendations for airplane application at this time.

#### References

ROGERS, ANDREW J. and CARLISLE B. RATHBURN, JR. 1958. Tests with a new granular paris green formulation against *Aedes*, *Anopheles*, and *Psorophora* larvae. Mosquito News 18(2):89-93.