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Studies On The Vapor-Toxicity Of Dibrom^{*}

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ABSTRACT

Dibrom as in Dibrom 8 Emulsive, Dibrom 4 Emulsive, as in Fly Killer D has given excellent mite control with the sequence of 3 applications 3 days apart applied to hot steam pipes. Satisfactory results have also been obtained when applied to cold steam pipes previous to turning on the steam. Control is also possible with Dibrom when applied to hot water pipes or to cold water pipes previous to turning on the heat. Steam pipes require 6 to 8 lbs. pressure per pipe, for satisfactory vaporization of Dibrom. In the case of hot water pipes, water temperature of 160-190°F. has successfully vaporized Dibrom to give satisfactory mite control. Dibrom has been used commercially in a wide range of rose greenhouses and applied to some 20 different rose varieties. Some injury has occurred on the foliage of certain varieties especially young succulent plants and reports have been given on possibility of reduction of bud size in Golden Rapture. These reports have not proven consistent from one rose range to another. Rose Growers have not considered injury serious enough to discontinue Dibrom fumigation. Dibrom in addition to mite control has afforded excellent control of aphids, leafroller's orange tortrix, whitefly, and mealy bugs. In laboratory experiments, at Cornell University, xylene has a narcotic effect on mites and is synergistic with Dibrom. The Dibrom toxicity to mites is a function of both relative humidity and exposure. Percent mortality increases with time but decreases with humidity.

INTRODUCTION

It has long been known that the vapors of organophosphates were toxic to insects and mites. Studies were undertaken to investigate the fumigant effectiveness of Dibrom under laboratory and field conditions to the two-spotted mites, *Tetranychus telarius* L., and certain other insects infesting greenhouse roses.

Mites breathe by exposing two openings of the trachea or air tubes. Recent microscopical investigations at Blauvelt Laboratory, Cornell University, show the brain area of the mite is supplied with a number of these tracheae. The objective is to get the vapors into the tracheae to the brain. Recent information indicates that the mite exposes the

tracheal openings under conditions of high humidity. Knowledge of this fact turned our interest to the influences of humidity on vapor toxicity. Information found in the laboratory was utilized for commercial applications in the attempt to control the mite. *Tetranychus telarius* L. and certain other rose pests.

LABORATORY RESULTS

The procedure employed in this first study consisted of exposing mites to the vapors of Xylene alone, Dibrom technical alone, and the combinations of vapors of Xylene and Dibrom.

The results indicate that both the Xylene and the Dibrom effects are functions of both the relative humidity and the exposure time; the percent mortality to both increases with time but decreases with humidity. Of particular interest is the effects of the combination vapors. In all cases except one, the kill approaches 100% and this kill is not as drastically effected by humidity. Experiments show that mites exposed to Xylene for 5 minutes are immobilized for at least 1 hour. Xylene has little effect on mortality except when used for long periods of time. The synergistic action of Xylene with Dibrom is apparently associated with the narcotic action of Xylene.

FIELD RESULTS

Regular control programs in cooperation with several commercial rose growers were established. Field programs were set up using both high and low humidities. Eighty percent relative humidity was considered high which was obtained by misting for 15 minutes overhead or wetting down the walks and beds 1 to 2 hours previous to treatment. Dibrom was applied by dribbling Dibrom 8 Emulsive, 1 oz. per 10,000 cu. ft. undiluted onto the hot steam pipes. The hot pipes caused immediate vaporization of the Dibrom. The same procedure was followed when applications were made to cold steam and hot water pipes. Application devices included plastic squeeze bottles, glass bottles with rubber corks with appropriate holes to allow the Dibrom to escape, trigger oil cans, and specially devised applicators with a copper tube.

Special precautions were taken to limit the flow so that the material could be evenly distributed over the entire length of the pipes. Rubber gloves and respirators were used as the vapors of Dibrom tend to be irritating. All treatments were carried out, usually in the late afternoon, when the temperature was approximately 75°F. After the treatment, the steam was turned off and the houses ventilated one to four hours, depending on the temperature.

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^{*}Trademark California Chemical Company, ORTHO Division, Richmond, California for Dimethyl 1,2-dibromo-2,2-dichloroethyl phosphate insecticide.

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DIBROM

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Schedules were set up for Dibrom application, one— to use 3 applications four days apart during the colder part of the season, another to use 3 applications 3 days apart in the late spring and the early summer when the house temperatures tended to be high. This type of scheduling was necessary to catch all stages of the mite species as Dibrom, in the vapor phase, does not have any residual action. This was an attempt to control mites which emerged from the quiescent stage.

The rating system for evaluation of control was as follows:

RATE	POPULATION/LEAF
0 =	no mites alive
1 =	1 to 2 mites alive
2 =	3 to 10 mites alive
3 =	11 to 100 mites alive
4 =	100+ mites alive

Leaf samples, composed of 5 leaflets, were selected at random from areas known to be seriously infested. The rating system included all motel forms.

RESULTS AND DISCUSSION

Tables 1 and 2 show the results obtained with Dibrom 8 Emulsive used alone and in combination with another miticide at low humidity. In general, the combination treatments gave better results because of the residual afforded by the spray applications. In all cases, except one, the two types of treatments provided effective spider mite control. Data under conditions of low humidity are presented in tables 3 and 4. The Dibrom in this case was put on steam pipes at 5 am and the steam was turned on and the houses ventilated two hours later. When no attempt

was made to raise the humidity, the control was equal to and in some cases better than when the humidity was elevated. Generally the relative humidity in houses at the time of the Dibrom treatments was in the range 50 to 60%.

Additional tests, table 5, demonstrated that 5 applications of Dibrom 4 Emulsive (Fly Killer D) at 2 oz. per 10,000 cu. ft. reduced the mite population from a rating of 4 (100+ mites per leaf,) to a rating of 0. In this series of treatments no attempt was made to raise the humidity and the house was left closed for 3 to 4 hours. In another test Dibrom was applied to cold hot water pipes. The hot water (160°-190°F) was then circulated for 2½ hours with the house closed for 2½ hours. The results in table 6 show excellent control of a high mite population.

OTHER INSECTS CONTROLLED

In addition to control of spider mites, Dibrom gave complete clean-up of green fly, (aphids) whitefly, leaf-roller complex, (including leafrollers and orange tortrix) and mealy bug. Observations indicate that thrip are also controlled in the bloom but due to lack of residual with Dibrom frequent applications are necessary. Table 7 indicates that complete clean-up of aphids was obtained on roses with 1 application of Dibrom 8 Emulsive vaporized from hot water pipes. This application was made to cold, hot water pipes and the hot water allowed to circulate for two and one half hours.

Table 8 shows the aphid control obtained with Dibrom 4 Emulsive (Fly Killer D) at 2 oz. per 10,000 cu. ft. Similar results have been reported from many other growers using the same treatment. Table 9 indicates the excellent control of the leafroller complex, including orange tortrix

TABLE 1—Some typical results using Dibrom-8-Emulsive at High Humidity

House No.	Variety	Initial Rating ¹	Final Rating	Mites/leaf ²	
				Before	After
1	Better Times	1.29	.20	2.8	.3
3	Golden Rapture	1.45	.16	3.5	.2
17	Red Bird	.47	.03	.7	.05
18	White Butterfly	1.31	1.41	2.9	3.4

¹ All ratings are given as means of 6 benches.
² Mites per leaf calculated from field ratings.

TABLE 2—Some typical results using a combination of spray and Dibrom-8-Emulsive at high humidity.

House No.	Variety	Combination Dibrom and	Initial Rating	Final Rating	Mites/Leaf ⁴	
					Initial	Final
5	Jingles	Chlorobenzilate and Tedion	.82 ⁽¹⁾	.10	1.2	.2
14	Pink Garnette	Chlorobenzilate and Tedion	.62 ⁽²⁾	.03	.9	.05
22	Better Times	Pentac ⁽⁵⁾	.07 ⁽²⁾	0.0	.1	0.0
28	Topper Garnette	Chlorobenzilate and Tedion	.47 ⁽³⁾	.09	.7	.1

(1) Based on means of 8 benches.
 (2) Based on means of 3 benches.
 (3) Based on means of 8 benches.
 (4) Mites per leaf calculated from field ratings.
 (5) Hooker Chemical Co.

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TABLE 3—Dibrom used alone at a low humidity.

House No.	No. of Benches Treated	Variety	Initial Rating*	Final Rating*	Mites/Leaf	
					Initial	Final
1	6	Better Times	.66	0.0	1.0	0
2	6	Velvet Times	.45	.08	.7	.1
3	3	Golden Rapture	.80	.20	1.2	.3
13	3	Better Times	.43	.23	.7	.3
14	3	Better Times	.20	.03	.3	.05
16	3	Briarcliff	.1	.03	.2	.05
26	6	Better Times	.86	.13	1.3	.2

*Based on average of 6 benches.

TABLE 4—Dibrom-8-Emulsive used at low humidity in combination with Pentac.¹

House No.	No. of Benches Treated	Variety	Initial Rating	Final Rating	Mites/leaf	
					Initial	Final
15	3	Carol Amling Pink Garnette Garnette	2.0	0	6.	0
27	6	Pink Sensation Garnette	.13	0	.2	0

¹ Pentac supplied by The Hooker Chemical Co.

TABLE 5—Mite Control when Dibrom-4-Emulsive (Fly Killer D) (2 ozs./10,000 cu. ft.) is Vaporized from Hot Steam Pipes (6-8 psi) at 3 day intervals.

Date Treated	Date Mites Counted	Mite Rating	Mites/leaf
	4/21/61	4.0	100
4/21/61	4/24/61	2.5	25.5
4/24/61	4/25/61	2.0	6.0
4/27/61	5/1/61	0.5	.8
5/1/61	5/3/61	0.0	0.0
5/4/61	5/8/61	0.0	0.0

Note: House left closed for 3-4 hours.

TABLE 6—Mite Control When Dibrom-8-Emulsive (1 oz./10,000 cu. ft.) is applied to Cold Hot Water Pipes

Dates Applied	Relative Humidity	Temperature		Mite Rating		Mites/leaf	
		Outside	Inside	Before	After	Before	After
6/8/61	55-60%	85-75	90-95°F	4.0	2.0	100+	6.0
6/12/61	59-62%	90-85	90-100°F	3.0	2.5	25	25.5
6/15/61	55-72%	72-70	72-83°F	2.0	0.3	6.0	.5

Material applied to cold pipes then hot water (190°F) circulated thru pipes for 2 hours. House left closed 2½ hours.

TABLE 7—Aphid Control when Dibrom-8-Emulsive (1 oz./10,000 cu. ft.) applied to Hot Water pipes, Kennett Square, Pa.

Date Applied & Counted	Rate of Application	Relative Humidity	Temperature Range	Aphid Count*	
				Before	After
6/8/61	1 oz./10,000 cu. ft.	55-60%	90-95°F	895	0
6/12/61	"	59-62%	90-100°F	0	0
6/15/61	"	55-72%	72-83°F	0	0

NOTE: House left closed for 2½ hours.
*Number of Aphids found on 10 terminals in 3 locations in greenhouse

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TABLE 8—Aphid Control when Dibrom-4-Emulsive (Fly Killer D 2 oz./10,000 cu. ft.) Applied to Hot Steam Pipes, Kennett Square, Pa.

Material	Rate Applied	Date Applied	Aphid Count*	
			Before	After
Dibrom Fly Killer D	2 oz./10,000 cu. ft.	4/21/61	164+	0
"	"	5/1/61	52	0
"	"	5/22/61	28	0

*Counts made by counting number of aphids on 10 terminals in 3 house locations. Figures indicate average no. per terminal.

TABLE 9—Leafroller Complex control when Dibrom-4-Emulsive (Fly Killer D 2 ozs./10,000 cu. ft.) is vaporized from Hot Steam Pipes.

Date House Treated	Days between Applications	Date Counts Made	Leafroller* per 50 roses observed	
			Larvae	Pupae
4/21/61		4/18/61	38	14
4/24/61	3			
4/27/61	3	4/27/61	7	4
5/1/61	3			
5/4/61	3	5/17/61	0	0

*Infested areas marked and each count made from same area on each date.

and the Mexican leafroller. Immediate control is obtained of the adults, however, several applications are necessary to control the larvae. In this instance a heavy infestation was controlled with 5 applications made to hot steam pipes. Table 10 shows the excellent results obtained on whitefly infesting Oxalis plants in the rose house. The data demonstrates the effectiveness of Dibrom against the adults and that 3 applications of Dibrom 8 Emulsive at 1 oz. per 10,000 cu. ft. cleaned up the infestation.

Data was also taken on mealy bug control which is presented in Table 11. Counts were not made until after the third application which indicated complete kill with the exception of one adult. The data demonstrates that Dibrom when applied in 3 successive applications, 3 days apart, will give control of mealy bugs but that it is effective on only the motel forms.

Dibrom has been applied to the following rose varieties: Carol Amling, Pink Garnette, Garnette, Pink Sensation, Better Times, Velvet Times, Golden Rapture, Briarcliff, Tam Tam, Topper, White Butterfly, Red Bird, Jingles, J & P #7515, J & P #57-11891, J & P Red American Beauty, May Day, White Jewel, Fashionette, Tiara, Castanet, and Golden Garnette, Demure, Happiness, Yuletide and certain other varieties. Reports on injury were inconsistent. Injury to Golden Rapture, manifested as a smaller bud, to Castanet as burning of the outer petals, to Yuletide crinkling of the foliage, to Happiness and Better Times as a bleaching of the outer petals. We can not overlook the possibility that factors such as nutrition, light intensity, humidity, moisture, etc, may contribute to injury.

The economics associated with Dibrom fumigation of rose houses are encouraging. One grower reported that 3

Dibrom applications cost him 10 cents per 1000 plants; whereas a spray program would cost him \$2.35 for the same 1000 plants. Another grower indicated that where they have over a million cubic foot of greenhouse space it required six men 3 days to spray this area, while Dibrom could be applied by 12 men in 20 to 30 minutes. This is a noticeable saving in labor costs.

SUMMARY AND CONCLUSIONS

The use of Dibrom as a fumigant shows excellent promise as a control of spider in commercial rose ranges. The data we have collected shows that it can reduce high mite populations and the reduction depends on dosage and scheduling. Proper scheduling is one of the utmost importance due to the lack of residual afforded by Dibrom vapors and the necessity of applying a material when the eggs hatch or when the mites emerge from quiescent stages. Only the active forms of the mites are effected by the vapors of Dibrom. A schedule of 3 applications, 3 days apart with follow-up treatments as required is best. Data is also presented to substantiate control afforded by Dibrom for aphids, whitefly, mealy bugs and leafroller complex.

Dibrom may be vaporized from hot steam pipes where the pressure ranges from 6 to 8 lbs. per sq. in. It may also be applied to cold steam pipes before turning the steam on for a minimum of 30 minutes. Successful control is also obtained from applications to hot water pipes where the water temperature in the pipes is maintained between 160°F and 190°F. It is important that the temperature be maintained at this level for at least 2 hours. Dibrom may be applied to cold hot water pipes and vapo-

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TABLE 10—Whitefly Control when Dibrom-8-Emulsive (1 oz./10,000 cu. ft.) is applied to Cold Hot Water Pipes.

Date Applied	Rate of Application per 10,000 cu. ft.	Relative Humidity	Temperature Range	White Fly Rating*	
				Before	After
6/8/61	1 oz.	55-60%	90-95°F	7	0
6/12/61	1 oz.	59-62%	90-100°F	3	0
6/15/61	1 oz.	55-72%	72-83°F	1	0

NOTE: House left closed for 2½ hours.

*Whitefly population rated 0-10. 0=no flies. 10=high population. Infestation on weeds, chiefly oxalis.

TABLE 11—Mealy Bug Control when Dibrom-8-Emulsive (1 oz./10,000 cu. ft.) applied to Cold Hot Water Pipes.

Date Applied	Rate of Application per 10,000 cu. ft.	Relative Humidity	Temperature Range	Mealy Bugs*	
				Alive	Dead
6/8/61	1 oz.	55-60%	90-95°F
6/12/61	1 oz.	59-62%	90-100°F
6/15/61	1 oz.	55-72%	72-83°F	99	1

NOTE: House left closed for 2½ hours.

*Counts made with a binocular microscope. Dead and alive forms (adults & immature) were counted on 25 leaves taken at random.

rized when hot water (160-190°F) is circulated for at least 2 hours. Dibrom as in Dibrom 8 Emulsive or Dibrom 4 Emulsive (Fly Killer D) has proven safe for use as a fumigant on a wide range of rose varieties. Reports on injury have been inconsistent, but are as follows: small bud size of Golden Rapture, injury to blooms of Castanet and crinkling of foliage on Yuletide and certain of the other varieties. However, growers have not considered the injury serious enough to discontinue the use of Dibrom. No serious leaf ripening or defoliation, except on Orange Delight, has occurred with successive treatments of Dibrom. Dibrom vaporized from steam on hot water pipes is an economical control measure technique and reduces labor costs.

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