Combination Azobenzene—HETP Fumigation

by
W. E. Blauvelt, Department of Entomology, and Julius Hoffman
Roses Incorporated Research Fellow, Cornell University

Fumigation with a combination of azobenzene and hexaethyl tetraphosphate has shown greater effectiveness against all stages of red spider mite from a single treatment than either material used alone by any method yet reported. Like the "combined operations" used so successfully in World War II, this new method strikes at the enemy simultaneously with two different and powerful forces acting together for the greatest combined effects.

By markedly increasing the effectiveness of azobenzene fumigation the combination treatment promises to reduce considerably the number of fumigations required. This would be particularly valuable on roses, where the mites are most resistant and where frequent fumigations are objectionable because of loss of color in the buds.

The combination fumigant, like the use of HETP itself, is still in the experimental stage. Much additional research and large scale testing will have to be done before we can recommend it with assurance for general grower use. However, the results to date are promising both as to effectiveness and plant safety on a wide range of florist crops. Since no new method can be kept secret until fully developed and tested, we are giving here the experience to date so that growers who wish to experiment with it will have the benefit of this information.

COMBINATION GIVES FASTER KILL

Azobenzene fumigation alone under proper conditions has given kills of better than 99 per cent of all stages of the red spider mite including active mites of all ages, the inactive molting stages, and eggs in all stages of development. These results have been obtained not only in many large and small scale experimental fumigations but in many routine fumigations by growers. The weak point in control has been that many of the mites died so slowly that they were able to lay quite a few eggs before dying. Although some of these eggs are affected so that they do not develop, enough hatch to carry on the infestation. So great is the rapidity of mite development that small numbers of survivors soon increase to a large population, particularly at high temperature. There was a need for some effective material that could be added to insure an immediate high kill of older mites to prevent this egg laying. HETP appears to fill this need best, giving 100 per cent kill of active stages in twelve hours or less.

The question will be raised, If HETP is so effective, why not use it alone and avoid the loss of color in roses from azobenzene? The reason is that HETP, while remarkably effective against the active stages has little effect against the eggs and also fails to kill many of the inactive molting stages. Thus it is weak where azobenzene is strong, and the maximum effectiveness is obtained by using the two materials together. The eggs and molting stages make up from one half to three fourths of the total population; and three carefully timed treatments with HETP alone are usually required to give the same degree of control as is obtained with one combination fumigation.

EXPERIMENTS SHOW VALUE AS A FUMIGANT

Hexaethyl tetraphosphate was discovered and developed in Germany during the war to replace nicotine for control of aphids or plant lice. Information on the formula and method of manufacture was uncovered by the United States government science teams who entered Germany immediately after fighting ceased. Tests in this country showed that it was highly effective against mites as well as aphids and large amounts are now being manufactured and used as sprays on various crops.

The writers were particularly interested in determining whether HETP could be used as a greenhouse fumigant, since fumigation saves much time and labor and is more thorough than spraying. The chances of using HETP as a fumigant were not considered promising since the material was known to vaporize only slightly at normal temperatures and chemists reported that it could not be distilled or vaporized by heating without "breaking down". Experiments were first made by bubbling air through a flask of HETP and into a chamber in which mite-infested leaves were exposed. A complete kill of active stages of the mites was obtained, proving that the material was volatile enough to be effective as a fumigant.

HETP was also found completely effective against active stages of the mites when distributed through the air of a greenhouse in very fine mist or fog-like particles by means of the now familiar liquified gas aerosol bomb. There were strong indications that the effect of HETP aerosol was also due largely to fumigation, through vaporization of the tiny particles of HETP in the air. The first and most extensive work on use of HETP as an aerosol has been done by Dr. Floyd F. Smith and his co-workers in the United States Bureau of Entomology. Their investigations have been reported in detail in the

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cont'd. from pg. 11-New Azobenzene Fumigants and may go out before completely burned. To avoid this they should be stored in a warm, dry place.

For best results with Azofume Candles, follow the recommendations for proper Conditions for Fumigation as discussed in the preceding article.

florist trade journals.

Next, experiments were made to determine whether HETP could be vaporized by means of the steampipes as with azobenzene. Practically complete kills of active stages of the mites were obtained by dosages of 3 to 5 grams of HETP per 1000 cubic feet, either applied undiluted or mixed to a paste with water and celite powder and painted on the pipes. Although some of the material is probably broken down by this method, enough is vaporized to give good results at economical cost. Steam pipe vaporization is a particularly good method for vaporizing HETP by heat since the temperature is automatically controlled well below the point (300°F.) where HETP is known to break down rapidly and may give off ethylene gas harmful to plants.

TESTS ON MIXED CROPS

The first commercial scale trial of combination azobenzene-HETP fumigation was made December 26, 1946 in a 30,000 cubic foot greenhouse of the Floriculture Department at Ithaca. Seventy per cent azobenzene powder was used at the standard rate of 1 pound per 40,000 cubic feet and HETP was added at the rate of 5 grams per 1000 cubic feet. The HETP was mixed in with the azobenzene paste and painted on the pipes in the usual manner.

The house contained 20 different florists crops in addition to potted rose plants of Better Times variety moved in for the test. The plants were as follows: Carnations-mature plants of King Cardinal, Virginia Rose, Olivette, 3 benches; Chrysanthemums - 26 varieties as listed in article on Azobenzene Developments, 400 plants 2 to 6 weeks old in flats; Snapdragon - Cheviot Maid Supreme, 1/2 bench in crop; Geraniums - Madame Landry, 90 plants in 4-inch pots; Cineraria - Siter's Rainbow strain and Cremers Strain, 150 plants in 6-inch pots; Calceolaria - multiflora nana, 20 plants in 5-inch pots and many hybrid seedlings; Tulips - 50 pans, tops about 3"; Myosotis - Blue Bird, 60 plants in 4-inch pots; Camellia - 2 plants, pink and white, in bloom; together with 10 to 25 plants each of Asters, Stocks, Larkspur, Easter Lilies, Lupine, Kalanchoe, Begonia, Saintpaulia, Calendula, Narcissus, and Sweet Peas.

Due to a rapid drop in outside temperature from around 20 degrees at 4:30 p.m. when fumigation was started to 8 degrees during the night, the house temperature was held barely at 70 degrees and the house could not be ventilated until 10 a.m. In spite of the unfavorable conditions the only injury of any importance was to Myosotis, which developed numerous burned spots in the leaves. These plants had just been repotted and sprayed with water to reduce wilting, and the injury was apparently greatest where the foliage was wet. Occasional leaves of lupines and larkspurs developed some marginal burn. Carnation and camellia blooms showed no noticeable bleaching or other injury, and snapdragon flowers were not noticeably damaged.

The treatment gave a 100 per cent kill of active stages of red spider mite on both roses and carnations. Counts at intervals up to 10 days showed a 99.98 per cent kill of all stages including eggs and molting stages on carnations and 98 per cent on roses. In addition, there was a nearly 100 per cent kill of the pink and green rose aphid.

COMMERCIAL TESTS ON ROSES

On roses, the first commercial scale test of the combination fumigation was made in cooperation with Mr. Harold Koenig at the United States Cut Flower Company, Elmira, N.Y. on January 31, 1947. Three connecting ridge and furrow houses of 65,250 cubic feet each were treated. The varieties were Better Times, Briarcliff, and Talisman. The standard dosage of 70 per cent azobenzene powder was used but the dosage of HETP was cut to three grams per 1000 cubic feet. Unfortunately, a rather high wind developed which caused rapid leakage in the narrow, rather loose houses. The kill of active stages the following morning was high but the kill of eggs and molting stages was unsatisfactory. There was no foliage injury, tipburn or bleaching of mature leaves.

In mid-February, Harold Koenig made a second combination fumigation in these same houses under more favorable conditions on a sunny day, with a house temperature around 80 degrees, and a 6-hour fumigation period. Vapotone, which contains 50 per cent of HETP, was used at the rate of 8 fluid ounces for each pound of 70 per cent azobenzene powder (equal to 5 grams HETP per 1000 cubic feet). The results were excellent. Practically 100 per cent of active stages of the mites were found dead the following morning, and a very high kill of eggs and molting stages was obtained. There was no foliage injury in the form of bleaching and only very slight tipburn. A few buds showed a purple discoloration of the margins of outer petals the following morning, but there was very little loss of color in the buds. Whether this result could be expected generally, and whether HETP acts in some way to reduce the bleaching effect of azobenzene on buds is not known. A number of other growers have tried the combination fumigation but detailed reports of results have not yet been received.

SUGGESTIONS ON TREATMENT

Much additional research and large-scale testing will have to be done before the combination fumigation can be recommended. For those who wish to experiment with it at the present stage we suggest using 4 fluid ounces of straight HETP or 8 fluid ounces of Vapotone (50 per cent HETP) for each pound of 70 per cent azobenzene powder. Simply mix it with the water used in making the paste for painting on the pipes. All other operations and conditions for fumigation are the same as with the 70 per cent azobenzene powder alone.

HETP is not suggested for lamp vaporization with azobenzene crystals because of the danger of breaking down the material by the high temperature, with loss of effectiveness and possible production of ethylene. If a

combination treatment is desired with lamp vaporization or with azofume candles it can be accomplished by using an HETP aerosol during the fumigation period.

PRECAUTIONS-

HETP is a highly poisonous material,- as poisonous as pure nicotine, and all necessary precautions as given on the containers should be strictly observed. Rubber gloves should be worn in handling and applying the concentrated material. Operators should wear a chemical cartridge respirator or a gas mask when exposed to the vapors during fumigation. We have used the Comfo Chemical Cartridge Respirator with G. M. C. cartridges, made by the Mines Safety Appliance Co., Pittsburg, Penna., and believe that this is probably satisfactory for the concentration of vapor used. The price has been $5.50. For greater assurance of safety the Full Vision Gas Mask, with G. M. C. cannister, may be used as suggested by Dr. Floyd Smith for use with HETP aerosols. This is made by the same company and costs about $22.50.