

INTRODUCTION

Dan A. Wolfenbarger
55 Calle Cenizo Brownsville, TX 78520

Cotton producers have been at war against the boll weevil, *Anthonomus grandis* Boheman, in the United States since the turn of the 20th century and will be fighting this war into this century. The toxicity of malathion to the boll weevil, its ease of application, relatively low cost, and low mammalian toxicity make it the insecticide of choice for current eradication programs against the boll weevil. Although this insecticide like all others has its disadvantages (e.g., toxicity to beneficial insects), the eradication effort as we know it would not be possible without it. All other insecticides effective against the boll weevil are too expensive to be feasible. The effectiveness of the boll weevil eradication program (BWEP) using ULV malathion is indicated by the experience in Georgia, where the number of insecticide applications made in cotton were reduced from about 12 to 15 before eradication, to about three per year after eradication (Herzog et al. 2000). There was also a concurrent increase in yield in Georgia after eradication because the "top crop" was salvaged in the absence of the boll weevil (Herzog et al. 2000).

Technical (96+ %) malathion, an alkyl phosphorodithioate, is a clear amber-colored liquid with a specific gravity of 1.23 and a familiar but disagreeable odor. It has an oral LD₅₀ of 1,000 to 1,375 mg/kg for rats. The dermal LD₅₀ on rabbits is 4,100 mg/kg (Anonymous 1990). Inhalation LC₅₀ of malathion to rats is >5.2 mg/liter of air space.

Technical malathion is also registered for use on cotton in a boll weevil Attract and Kill device. Two other organophosphorus insecticides, azinphosmethyl and methyl parathion, are registered for use as sprays on cotton and are effective against the boll weevil, but are less desirable from an environmental standpoint and also are more toxic to humans than malathion. The usefulness of other compounds in boll weevil eradication programs is limited by lesser effectiveness against the boll weevil compared to malathion and label restrictions on the number of applications. Other factors are higher costs of the insecticide and greater costs of application of emulsifiable concentrates compared with ULV malathion.

So far there has been no documented boll weevil resistance to this insecticide in the United States. Bioassays in Texas and Louisiana, and eradication successes in the southeastern states and far West have discounted any suggestions of resistance in these areas.

Malathion has desirable physical properties for application. It can be easily applied with ground equipment at 16 oz/A undiluted or at 16 oz/A in a 1:1 mixture with cottonseed oil. Its viscosity allows it to flow easily through the nozzles of an airplane at its 10 -12 oz/A use rate. When technical malathion is applied at 12 oz/A, droplets about 100 to 200 microns in diameter deposited on the plant surfaces. These droplets are distributed 100 to 5,000 microns apart from each other. The specific gravity of malathion helps to insure that more droplets will reach the target area than other insecticides applied as ULV or in water. The majority of droplets from technical malathion applications are found on the surfaces of the upper third of the plant. In addition, the surface tension of droplets of malathion which impinge on boll weevils or leaf surfaces will not allow them to spread extensively.

Technical malathion can be encapsulated or formulated into an emulsifiable concentrate and wettable powder. These formulations are not used in the program because they do not have the efficacy of ULV applications and also are more expensive to apply.

Perhaps the greatest disadvantage of using malathion is its toxicity to the myriad of beneficial insects and arachnids. In cotton, beneficials include both predators and parasites of Homoptera, Hemiptera and Lepidoptera. Following multiple applications of malathion by the program, the reduction of beneficial insects is evident. However, attempts should be made to minimize the harm to beneficial insects. Proper timing of insecticide applications is a logical approach. One paper in this Supplement presents some recent research on the effect of malathion of beneficial insects.

Koivistoinen (1961) concluded that ultraviolet radiation had little to no effect on rate of loss of malathion by plants. He also found that higher air temperatures (18.9 versus 8.9°C) and pH (9-11 versus 5-6) increased the degradation rate somewhat. Aqueous formulations of malathion provide better coverage of the leaf surface than technical. This is because in each droplet of aqueous formulations of malathion molecules of malathion are mixed with molecules of emulsifiers and solvents, which increase spread over the plant surface. However, with increased spread comes increased contact with plant tissues containing enzymes in and on plant cells, thus hastening degradation of malathion (Koivistoinen 1961). In plant tissue, Koivistoinen (1961) found that the most common degradation products of malathion are the O,O-dimethyl phosphorodithioate and monoacid of mono ethyl succinate. Phosphatase and carboxyl esterase enzymes were responsible for the degradation of malathion. It is assumed that similar enzymes would be responsible for degradation of malathion in the boll weevil, but no information on in vivo degradation is available.

The use of malathion is not limited to the boll weevil. It is the insecticide of choice against mosquitoes in urban areas, and when used in liquid baits is the insecticide of choice against Mexican and Mediterranean fruit flies in tropical countries. ULV malathion is toxic to various hemipteran species of *Lygus*; ULV malathion diluted in cottonseed oil killed 100% of nymphs and adults within 24h in a laboratory test (Mulrooney, unpublished data). ULV malathion is presumed to be toxic to another hemipteran pest, the cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter), which is an important pest in Texas. The toxicity of malathion to hemipteran species is an added advantage in the BWEP.

Malathion is not always effective against lepidopteran pests of cotton. Multiple applications of ULV malathion are toxic to adults of the pink bollworm, *Pectinophora gossypiella* (Sanders). Malathion was not highly toxic to susceptible strains of the third-instar of the bollworm or tobacco budworm, except on the day of application. At a rate three fold greater than that used by the program in Texas, mortalities on 1-7d were <50% (Wolfenbarger and McGarr 1970). Malathion is not toxic to *Tetranychus* mite spp, the cotton aphid, *Aphis gossypii* Glover, and the whitefly, *Bemisia* spp. With the information on toxicity of technical malathion to the boll weevil, the pink bollworm, *Pectinophora gossypiella*, hemipteran pests, and its lack of toxicity to mammals, mites, lepidopterous and homopterous pests, the insecticide could be considered to be selective.

The latest information on technical malathion applied as a ULV spray against the boll weevil in area-wide programs across the cotton belt in the United States is offered in this Supplement. More information is needed on toxicity of this insecticide against other pests of cotton that are encountered in the programs across the United States.

Literature Cited

- Anonymous. 1990. Farm Chemicals Handbook. 76th edition. Meister Publishing Co.
- Koivistoinen, Perra. 1961. Studies on the disappearance of malathion from plant materials. *Suomalaisen Tiedeac. Toimituksissa Annales Academiae Scieniarus Feffecae. Series A. IV Biologia.* 1-91 pp.
- Herzog, G. A., W. R. Lambert, III, and P. M. Roberts. 2000. Malathion use in the Southeast boll weevil eradication program: A bumpy ride but the destination is what counts. *Proc. Beltwide Cotton Conferences.* Vol. 2:1069.
- Jones, R. G., and D. A. Wolfenbarger. 1999. Effect of lepidopteran damage and weather to cotton in ten irrigated field fields following malathion ULV applications: Lower Rio Grande Valley, Texas-1995. *Proc. Beltwide Cotton Conferences.* Vol. 2:1152-1155.
- Wolfenbarger, D. A., and R. L. McGarr. 1970. Low-volume and ultra-low volume sprays of malathion and methyl parathion for control of three lepidopterous cotton pests. USDA Production Research Report No. 126:1-14 pp.