

What you  
Always wanted  
To know  
About DDT  
(in Arizona)  
But were  
Afraid to  
Ask

*by George W. Ware\**

DDT is 101 years old this year. It was first synthesized by a German graduate student at the University of Strassburg, who had no idea of its tremendous insecticidal value and, after synthesis, it was thrown out and forgotten. In September of 1939, Dr. Paul Müller, an entomologist, working for the Geigy Chemical Co. in Switzerland, rediscovered DDT while searching for a better insecticide against the clothes moth. It was extremely effective against blow flies, mosquitoes and the Colorado potato beetle. Dr. Müller received the Nobel Prize for Medicine in 1948 for his life-saving discovery.

DDT first appeared in Arizona in very small quantity in September 1943 and for purely agricultural experiments at the U of A Experimental Farm at Mesa. The first person to work with it was W. A. Stevenson, an entomologist with the U.S.D.A.

Bureau of Entomology and Plant Quarantine, who tested a 2 percent DDT dust on caged cotton plants against stink bugs and lygus. In the spring of 1944, larger field plot tests were conducted using 2 percent DDT in pyrophyllite and 4 percent DDT plus 60 percent sulfur in pyrophyllite, applied with a hand duster. The DDT-sulfur gave Stevenson better yields than ever with sulfur-arsenical mixes. In July and August of 1944, an 18-acre field of short-staple cotton at Litchfield Park received the first aerial applications of DDT in Arizona, involving a total of 6 treatments of the dusts at 1.0 pound actual DDT per acre. Lygus bugs were the most abundant injurious insects. The field was picked in January 1945, with a gain of 920 pounds per acre over the untreated check.

In 1944, Orin Hills, another U.S.D.A. entomologist, experimented with DDT dust on seed sugar beets for lygus control and reported, "it looked too good to be true. One application seems

*\*Head, Department of Entomology, U of A.*

to give us control of lygus, and we always figured we needed at least two applications of pyrethrum and sulfur.”

The commercial use of DDT in Arizona began on a very small scale in late summer of 1945 when the first dusts were sold to cotton growers by the Arizona Pest Control Co., White Chemical Co., Arizona Fertilizer, Inc., and Stauffer Chemical Co.

In 1945, Professors Charles T. Vorhies and Lawrence P. Wehrle, entomologists from the University of Arizona, experimented with DDT applied with a U. S. Navy “secret fog-generating apparatus being used for the production of smoke screens.” The Navy loaned the fogging machines, the 5 percent DDT in kerosene was purchased from the Shell Oil Co., and the project was sponsored by an old friend of the University, Colonel Dale Bumstead, owner of the Tal-wi-wi

risers to heights far greater than required.” They predicted that this aerosol method was destined to rank high as a method of insecticide application in agricultural pest control.

DDT was generally used by cotton growers in 1946 as a result of its outstanding success against cotton pests and increased yields. In 1946 outbreaks of beet armyworm and bollworm over several thousand acres of cotton in the State, were brought under control with one treatment of 5 percent DDT, with sulfur applied at 15-25 pounds per acre.

The first 10 percent DDT dust in sulfur was applied to cotton in 1946. This formulation was described as “very lumpy and gritty and almost impossible to apply efficiently.” In that year the insect control literature became filled with reports of the astonishing effectiveness of this new “miracle insecticide.”

In 1947, S. E. McGregor, a U.S.D.A. apiculturist assigned to work in cooperation with the University of Arizona, made extensive studies of effects of DDT on honeybees in cooperation with C. T. Vorhies. They concluded that dust or oil spray air applications of DDT to large cotton acreages were not hazardous to commercial beekeeping. DDT was considered a bee-safe insecticide and greatly welcomed after many years of bee losses from heavy applications of arsenicals to cotton.

More than 4 billion pounds of DDT have been used throughout the world for insect control since 1940, of which 80 percent was used in agriculture. Production peaked out in the U.S. in 1961 with the manufacture of 160 million pounds. The greatest agricultural benefits from DDT have been in the control of the Colorado potato beetle and several other potato insects, the codling moth on apples, corn earworm, cotton bollworm, cotton budworm, pink bollworm on cotton, and the worm complex on vegetables. It has been most useful against the gypsy moth and the spruce budworm in forests. Medically it has been most successful against mosquitoes that transmit malaria and yellow fever, body lice that transmit typhus, and fleas that transmit plague.

One of the amazing features of this marvelous insecticide was its low cost. Most of that sold to the World Health Organization cost less than 22 cents per pound! Without question it was

the most economical insecticide ever sold.

Because of DDT's low cost and high effectiveness it was used in Arizona on most crops against various pests at rates of 1 to 3 pounds per acre, but mostly against pests of cotton and lettuce. The actual amounts of DDT used in the State are known only for the years 1965-1969, when the sales-usage information was collected by the Arizona Community Pesticide Studies Project, Department of Entomology. In Table I is shown the estimated use of DDT since 1945. These estimates are based only on the cotton and lettuce acreage in central and western Arizona.

As a direct result of the heavy use of insecticides and large number of aerial applicators, the Arizona Board of Pest Control Applicators was appointed in 1953 by Governor Howard Pyle. Its purpose was to license aerial

Table 1. DDT Use Estimates for Arizona, 1945-1968.

Year	Technical DDT (1000's Lbs.)
1945	8
1946	804
1947	1,162
1948	1,400
1949	1,849
1950	1,412
1951	2,730
1952	3,162
1953	3,072
1954	2,900
1955	2,640
1956	2,689
1957	2,689
1958	3,803
1959	3,714
1960	4,142
1961	3,861
1962	3,977
1963	3,895
1964	3,739
1965	545 <sup>1</sup>
1966	1,072 <sup>1</sup>
1967	2,520 <sup>1</sup>
1968	528 <sup>1</sup>

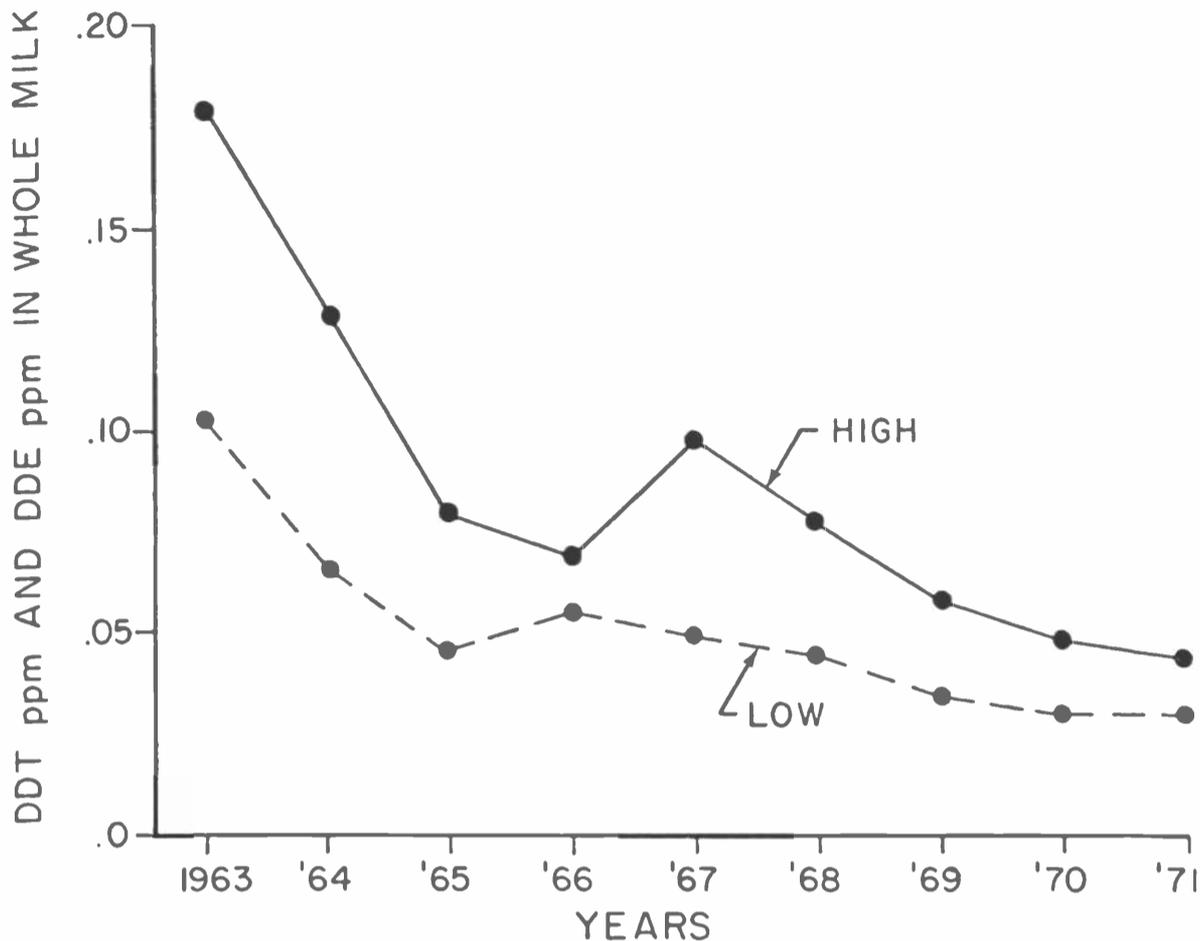
<sup>1</sup> Arizona Community Pesticides Studies sales information.

Ranch at Litchfield Park. Targets of these experiments were the grape leafhopper, citrus thrips on oranges and a beef herd. All were treated with some degree of success. The scientists reported that the fog “is too fine and light for best results in insecticide applications in the field. It billows and

Table 2. Condensed Rules of the Arizona Board of Pesticide Control Leading to the DDT Moratorium in 1969.

- 1953 The Board of Pest Control Applicators was established by the Arizona State Legislature in the Arizona Applicators Act of 1953.
- 1953 Board of Pest Control Applicators was appointed by Governor Howard Pyle.
- 1961 Act expanded to include Rule 17, Section B, Safety Rules, No. 14. “All persons and livestock must be removed from the area to be treated and drift onto adjacent dwellings, fields where livestock are feeding, or onto other crops, must be avoided.”
- 1964 Act expanded to include Rule 18, “No applicator may apply insecticide of any type or on any location in violation of a regulatory order . . .”
- 1965 Rule 21, required all commercial growers to obtain a growers' permit annually from the Board, and sellers permits of those selling insecticides to growers.  
Rule 23, provided for the Board to hold public hearings when making changes in rules.  
Rule 26, restricted the application of DDT to liquid spray only. Special permits to apply DDT dust to cotton could be obtained for the period July 15-September 15 if no forage crop, other than feed grains, were located within 5 miles of the treated field.
- 1968 The Board was restructured and renamed the Board of Pesticide Control, increased from 5 to 9 members.

Figure 1. High and low DDT-DDE residues in whole milk from Maricopa County, Arizona.



Rule 20, prohibited use of DDT other than as specified on the label, or in any form other than spray or with air blast equipment. DDT was to be applied at boom pressures not to exceed 40 psi and not less than 5 gallons of spray per acre. In normal application of DDT, the nozzles on aircraft were to be directed toward the rear with wind velocities not exceeding 5 mph with application to take place, during the period one hour before sunset to 3 hours after sunrise. For the first time rigid distances were established. DDT could not be applied within 1 mile of a dairy without written permission of the owner, or within ½ mile of animal feed crops other than his own, without written permission from the owner.

- 1969 Rule 20 totally restricted the use of DDT for agricultural purposes for a period of one year — the historic DDT moratorium.
- 1970 Rule 20 continued the moratorium for another year.
- 1971 Rule 20 repeated the moratorium for a third year.
- 1972 Rule 20 extended the moratorium through its fourth year.
- 1973 Jan. 1 began the Environmental Protection Agency's restriction of DDT use. All registrations for DDT were cancelled, resulting in a complete ban for the United States.

applicators and establish safe use patterns for pesticides on food, fiber and feed crops. The rules established by the board over the intervening years are condensed in Table 2.

Because of the wide use of DDT in the irrigated areas of Arizona the milk supply became contaminated from residues of DDT on alfalfa hay and other feeds. In 1963 the milk supply in Maricopa County reached 0.18 ppm DDT and DDE. In Figure I are shown the annual high-low average ppm of DDT found by the State Dept. of Health through monthly milk sampling from 1963 through 1971.

In 1964, as a direct result of the milk contamination and its economic threat to milk and feed producers, the Arizona Legislature expanded the responsibilities of the Board of Pest Control Applicators to work toward correcting this situation. In 1965 the first restrictions on DDT use were published by the Board as Rule 26 (see Table 2).

In 1968, the U. S. Food and Drug Administration placed an embargo on 50,000 pounds of butter shipped from Arizona to California because of DDT residues present in amounts over the legal tolerance. The Board, now called the Board of Pesticide Control, was

confronted with a deepening of the DDT contamination problem. In 1968, the University of Arizona Department of Entomology, with substantial supporting research information, removed DDT from all of its agricultural pest control recommendations. The sole objective was to reduce DDT residues in food and feed crops. This action by the University was persuasive in nature but did not have the force of law. The agricultural chemicals industry accepted the decision and began to phase out their supplies of DDT which had been stockpiled before the decision to remove DDT from State recommendations was announced.

In the fall of 1969 the Board was presented overwhelming evidence that feed and milk residues could be reduced no further without legal action to halt the use of DDT. The U.S. Food & Drug Administration in the meantime had proposed that the tolerance for DDT in beef fat be reduced from 7.0 ppm to 1.0 ppm. This raised problems for the Arizona beef producers since beef fat at that time was running 0.4 to 3.6 ppm.

The United Dairymen's Association approached the Board of Pesticide Control with a petition supported by the Arizona Cattle Feeders Association, to place a one-year moratorium on the agricultural use of DDT. The Board announced a public hearing to be held in Phoenix to discuss the proposed 1-year ban.

The hearing took place in January of 1969, and for the first time since 1964 the United Dairymen's Association had abundant supporters. The general consensus was, "Try the moratorium for 1 year." The Board made the courageous decision to let agriculture go one year without its friend and foe, DDT.

With little or no resistance, based on reports of the reduction of DDT residues in alfalfa, the moratorium was repeated in 1970, again in 1971 and, for the final time, in January 1972. A Federal ban on the use of DDT was declared by the Environmental Protection Agency, effective January 1, 1973, and DDT can no longer be used on agricultural crops, nation-wide.

DDT enjoyed 18 years of unrestricted use in Arizona, 4 more or less unsuccessful years of restricted use, followed by 4 years of prohibition under a State moratorium, with all use final-

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# All the things You wanted to know about DDT...

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ly terminated by a Federal ban (see Table 2).

The environmental picture for DDT in Arizona has changed little after four years of State and Federal moratoriums as evidenced by the residue data from green alfalfa, crop soils and native desert soils, as shown in Tables

which is increasing in amount.

DDT residue problems are not yet past. The United Dairymen's Association occasionally receives "hot" milk samples with slightly greater than 0.05 ppm tolerance for DDT in whole milk, but these grow fewer and residues smaller.

Table 3. Average DDTR Residues (ppm) in Green Alfalfa.

Sampling Area	1967 Aug.	1969 Jan.	1969 Sept.	1970 Sept.	1971 Sept.	1972 Sept.
Baseline Rd.	.404	.102	.037	.045	.032	.026
Salt River Valley	—	.117	.051	.063	.036	.039
Pinal County	—	.088	.086	.050	.049	.031
Yuma County	—	.046	.210	.058	.162	.123
State average		.088	.096	.054	.069	.055

3, 4, and 5. The alfalfa residues appear to have leveled off at about 0.03 ppm. The residues in soils have declined negligibly, only in that DDT is declining by being converted to DDE

At the time of the moratorium DDT was losing its effectiveness against the pests which were of greatest economic importance. Laboratory tests showed that the bollworm had become 9-fold

## The Mini: an Audio-Tutorial Technique

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phasize that all experimental insect-resistant entries are evaluated using cultural practices identical to those used by alfalfa growers in Arizona and that seeding rate, cutting interval and harvest management are identical for all of the 3,000 replicated plots tested each year. This is the end of the Mini, but the lecture continues.

The Mini is so named because the actual length of this entire presentation is eight minutes. This technique is extremely useful in our Introductory Agronomy course because such topics as "High Lysine in Sorghum," "Growing Close-Spaced Cotton," "Hybrid Barley" and "Hybrid Cotton" are not yet available in textbooks and yet students must be exposed to these new principles of Agronomy.

The Mini technique accomplishes more than just the exposure to new research. It serves as a natural avenue to introduce students to scientists who are currently involved with research on specific crops. Thus, students in a sense know these people and feel free to visit or write to them to obtain ad-

ditional information. The Mini also allows the student first-hand observation of how textbook techniques and concepts are applied in real life situations. When students see and hear the application of basic principles they start to think and may actually apply this knowledge beyond the videotaped interview. This audio-tutorial technique is extremely convenient for classroom situations and is a time-saver for the instructor and student.

The Mini, "Breeding for Insect Resistance in Alfalfa," illustrated and discussed on these pages has been duplicated and sent by request to nine other universities. In turn these Universities are reciprocating and providing 5 to 10 minute cassette tapes and 3 to 5 slides on new frontiers of Agronomy in their respective areas. This technique has greatly stimulated our students in learning more about the various research projects and current technology in agriculture. Broader, newer knowledge can be the only end result for Agronomy majors with this type of a teaching tool.

Table 4. Average DDTR Residues (ppm) in Soils From Alfalfa Fields Taken at 2-Year Intervals.

Sampling Area	1969 Jan.	1970 Sept.	1972 Sept.
Salt River Valley	1.58	1.82	1.64
Pinal County	1.69	1.62	1.55
Yuma County	0.82	0.75	0.78
State Average	1.36	1.39	1.32

as tolerant to DDT in Maricopa County as in the generally untreated area of Cochise County. In 1972 field experiments, the bollworm-budworm complex was scarcely affected by applications of 1.0 pound of DDT used alone per acre while Lygus bugs were

Table 5. Average DDTR Residues (ppm) in Desert Soils Adjacent to Agricultural Areas Taken at 2-Year Intervals.

Sampling Area	1969 Jan.	1970 Sept.	1972 Sept.
Salt River Valley	0.89	0.86	0.60
Pinal County	0.40	0.57	0.44
Yuma County	0.13	0.13	0.13
State Average	0.48	0.52	0.39

also difficult to control at that rate. To achieve control it was necessary to apply DDT in combination with other materials.

What is the future of DDT in Arizona? Doubtful. DDT will probably not be used in Arizona agriculture during the next decade. When and if it is again available its use will be permitted only on cotton, on a tightly controlled prescription basis, applied only by ground equipment, under prescribed weather conditions, and for only a limited number of applications per season.