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EVALUATION OF CANDIDATE CHEMOSTERILANTS FOR THE BOLL WEEVIL

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EVALUATION OF CANDIDATE CHEMOSTERILANTS FOR THE BOLL WEEVIL

By JACK W. HAYNES, NORMAN MITLIN, T. B. DAVICH, and C. E. SLOAN, *Entomology
Research Division, Agricultural Research Service*

The Boll Weevil Research Laboratory at State College, Miss., has evaluated over 200 potential chemosterilants against the boll weevil (*Anthonomus grandis* Boheman). Generally the materials chosen for evaluation had shown activity against some biological system or had belonged to a class of closely related compounds. They included many alkylating agents and anti-metabolites, types of compounds that already have been reported to be effective chemosterilants (Borkovec 1).¹

Several materials were tested in conjunction with the alkylating agent apholate, which has been the most effective sterilant of the boll weevil (Haynes and others 7). Unfortunately it destroys the mitotic tissue of the midgut, materially affecting the vigor of the insect

(Riemann and Flint 10). It was hoped that the concentration of apholate could thereby be reduced, along with the consequent ill effects, should potentiation or augmentation occur. Since the damaging effects of the alkylating agent are identical to those caused by radiation, it was reasoned that the conjunctive use of chemical radioprotective agents might prevent or decrease these debilitating effects.

Several 3,4-(methylenedioxy)phenyl compounds were evaluated, which had been reported to be effective growth inhibitors and female sterilants (Mitlin 8, Mitlin and Baroody 9). More recently these compounds have been shown to work well in combination with insect hormone-type compounds (Bowers 2).

METHODS AND MATERIALS

All compounds were tested by dipping, feeding, or topical application. All tests were made with 20–50 newly emerged laboratory-reared weevils, generally of mixed sexes. If the chemical was promising, it was retested against sexed weevils. All chemical solutions were prepared daily on a weight-to-volume basis just before use.

In dipping tests the five solvents used in order of preference were water (H₂O), ethanol, methanol, dimethylformamide (DMF), and dimethyl sulfoxide (DMSO). If water was used, the weevils received a single 15-second dip. A single 5-second dip was made when any of the other solvents were used, since they were

undiluted and high mortality resulted with longer dips.

Prior to dipping, the weevils were anesthetized with carbon dioxide. The anesthetized weevils were easier to handle and mortality was not a factor. After they were dipped, they were allowed to dry and then put into containers.

Feeding tests were conducted by incorporating the desired candidate chemosterilant in a 10-percent sucrose solution. The insects were placed in pint ice cream cartons with screen tops. Pieces of absorbent cotton were placed on top of the carton and saturated with the sucrose solution containing the chemosterilant, and the weevils were allowed to feed for 48 hours.

Topical treatments were made with a micro-applicator equipped with a No. 31 gage needle. Each insect received 1.4 ml. of liquid applied to

¹ Italic numbers in parentheses refer to Literature Cited, p. 24.

the dorsal abdominal region. Acetone was the solvent used.

After the treatment all insects were mated and placed in pint ice cream cartons provided with screen tops and held at 25.6°–26.6° C. They were fed adult diet pellets (Gast 6) or cotton squares if available. Eggs were collected and placed on wet filter paper. They were observed daily up to 7 days and hatch was recorded. Mortality was noted at the end of

the first and second week after treatment. If it was excessive after the first week, the test usually was discontinued.

When insects were treated with the 3,4-(methylenedioxy)phenyl compounds, the eggs were surface sterilized with 0.5 percent sodium hypochlorite for 1 hour, drawn up into a syringe, spread over the diet plates, and checked for hatch and development for 2 weeks in an incubator at 29.5° C.

RESULTS

The following candidate chemosterilants screened alone effectively sterilized 75 percent or more of the eggs collected (table 1) :

Entomology No. (ENT-)	Chemical name
50173	1-aziridinecarboxamide, <i>N,N'</i> -(4-methyl- <i>m</i> -phenylene) bis-
50664	1-aziridinecarboxamide, <i>N,N'</i> -1,5-naphthylenebis-
50987	1-aziridinecarboxamide, <i>N,N'</i> -vinylenebis-, <i>trans</i> -
50825	porfirromycin
50451	carbamic acid, [bis(1-aziridinyl)-phosphinyl]-, benzyl ester
50450	carbamic acid, [bis(1-aziridinyl)-phosphinyl]-, ethyl ester
51134	cobalt, dichlorobis[tris(1-aziridinyl)-phosphine oxide]-
61461	methanetrisulfonic acid, trimethyl ester
24915	tapa
50003	metepa
50004	methiotepa
50981	phosphinothioic amide, <i>P,P</i> ,-bis(1-aziridinyl)- <i>N</i> -(3-methoxypropyl)
50882	hempa
28009	triphenyltin hydroxide
50123	methylapholate
25296	tretamine
50055	methyl tretamine
50781	urea, 1-[bis(1-aziridinyl)phosphinyl]-3-(3,4-dichlorophenyl)-

Mortality of the adult weevils treated with these chemosterilants ranged from 30 to 100 percent with three exceptions. Eggs collected from weevils dipped in a 12-percent solution of 1-aziridinecarboxamide, *N,N'*-1,5-naphthylenebis- proved to be 91-percent nonviable, and adult mortality was 12 percent after 14 days. A 1.5-percent concentration of tretamine sterilized 93 percent of the eggs collected during the test, and mortality of the treated insects was 11 percent after 14 days. Eggs collected from weevils dipped in a 10-percent concentration

of urea, 1-[bis(1-aziridinyl)phosphinyl]-3-(3,4-dichlorophenyl)- proved to be 100-percent sterile, and mortality of treated adults ranged from 14 to 60 percent after 14 days.

The following chemical combinations sterilized 75 percent or more of the eggs collected (table 2) :

apholate + piperonyl butoxide
 apholate + propyl isome
 apholate + sesamex
 apholate + Bucarpolate
 apholate + carbazole
 carbazole + tretamine
 piperonyl butoxide + 1-[bis(1-aziridinyl)-phosphinyl]-3-(3,4-dichlorophenyl)urea
 piperonyl butoxide + methiotepa
 6-thioguanine + apholate

Mortality was higher than 30 percent with all these combinations tested except with 1-percent apholate plus 1-percent piperonyl butoxide, 1-percent apholate plus 1-percent Bucarpolate, and 1-percent apholate plus 2-percent carbazole, which sterilized 100, 86, and 94 percent of the eggs collected, respectively, but killed only 30, 15, and 10 percent of the adult weevils, respectively, 14 days after treatment.

Three derivatives of 3,4-(methylenedioxy)phenyl proved to be the most effective of those screened topically (table 3) ; di-2-propynyl (6-propylpiperonyl) phosphonate when tested against males reduced egg hatch to about 56 percent at 1, 5, and 10 mg. per milliliter; 4,5-(methylenedioxy)-2-propyl-*a*-(2-propynyloxy)-toluene when tested against both sexes reduced egg hatch to about 38 percent at 10 mg. per milliliter; and sesamex at 1 mg. per milliliter reduced egg hatch to about 6 percent when both sexes were treated. Emergence also was generally lower than that of the control group.

TABLE 1.—*Results of general chemosterilant screening against adult boll weevils by dipping, feeding, and topical treatment. (1 replication of 20–50 weevils per test)*

Chemical name	Entomology No. (ENT-)	Concentration	Solvent	Method applied	Sterile eggs	Mortality after 7–14 days
		Percent			Percent	Percent
Acetamide, 2 amidino-2-(phenylazo)-, hydrochloride	51982	1	H ₂ O	Dip ¹	8	0
Acetamide, <i>N,N'</i> -(tetramethyl- <i>p</i> -phenylene)bis[2-chloro- <i>N</i> -cyclohexyl]-	51188	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	Ethanol	Dip	2	4
				Fed ²	10	6
Acetanilide, <i>N,N'</i> -trimethylenebis-[2-chloro-	51176	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	DMF	Dip	2	42
				Fed	4	18
Acetic acid, mercaptophenyl-, ethyl ester, <i>S</i> -ester with <i>O,O</i> -dimethyl phosphorodithioate	27386	$\left\{ \begin{array}{l} 1.25 \\ 2.5 \\ 5 \end{array} \right.$	Ethanol	Dip	(³)	100
			do	Dip	(³)	100
			do	Dip	(³)	100
Acetohydroxamic acid, <i>N</i> -fluoren-2-yl-	50466	$\left\{ \begin{array}{l} 1 \\ 1 \end{array} \right.$	DMSO	Dip ¹	10	50
			DMSO	Dip ⁴	0	40
Acetonitrile, (purin-6-ylthio)-	50856	$\left\{ \begin{array}{l} 10 \\ 2 \end{array} \right.$	DMSO	Dip	3	44
				Fed	0	54
Acrylamide, <i>N,N'</i> -methylenebis-	8643	$\left\{ \begin{array}{l} 10 \\ .1 \end{array} \right.$	DMSO	Dip	0	58
				Fed	0	94
Adenine, <i>N,N</i> -diethyl-	51952	$\left\{ \begin{array}{l} .0012 \\ .0012 \\ .0025 \\ .0025 \\ .005 \\ .005 \\ .010 \\ .010 \end{array} \right.$	Ethanol	Topical ¹	13	0
			do	do. ⁴	5	30
			do	do. ¹	11	10
			do	do. ⁴	5	0
			do	do. ¹	0	20
			do	do. ⁴	9	10
			do	do. ¹	0	0
			do	do. ⁴	4	10
Alanine, 3-[<i>p</i> -[bis(2-chloroethyl)-amino]phenyl]-, DL-	25298	$\left\{ \begin{array}{l} 2 \\ 1 \end{array} \right.$	H ₂ O	Dip	11	14
				Fed	67	65
Ammonium, hexadecyltrimethyl- — — — bromide	12209	$\left\{ \begin{array}{l} 2 \\ 10 \\ .5 \\ 2 \end{array} \right.$	H ₂ O	Dip	1	20
			H ₂ O	Dip	18	28
				Fed	4	20
				Fed	1	20
Aniline, <i>N,N</i> -diethyl- <i>p</i> -nitroso-	15392	1	H ₂ O	Dip ¹	8	0
Aziridine, 1,1'-adipoylbis-	50610	$\left\{ \begin{array}{l} 1 \\ 2 \\ .5 \end{array} \right.$	H ₂ O	Dip ¹	8	12
			H ₂ O	Dip	0	85
				Fed	0	30

See footnotes at end of table.

TABLE 1.—*Results of general chemosterilant screening against adult boll weevils by dipping, feeding, and topical treatment. (1 replication of 20–50 weevils per test)*—Continued

Chemical name	Entomology No. (ENT-)	Concentration	Solvent	Method applied	Sterile eggs	Mortality after 7–14 days
		Percent			Percent	Percent
Aziridine, 1,1'-azelaoylbis-.....	50611	{ 1	H ₂ O.....	Dip.....	0	10
		{ 2	H ₂ O.....	Dip.....	0	85
		{ 10	H ₂ O.....	Dip.....	5	0
		{ .5	.....	Fed.....	2	4
Aziridine, 1-(<i>p</i> -chlorobenzoyl)-.....	50407	{ 10	DMF.....	Dip.....	1	28
		{ 2	.....	Fed.....	1	16
Aziridine, 1,1'-fumaroylbis-.....	50616	{ 1	H ₂ O.....	Dip.....	4	9
		{ 2	H ₂ O.....	Dip.....	0	75
		{ 10	H ₂ O.....	Dip.....	26	8
Aziridine, 2-methyl-.....	50325	{ 10	H ₂ O.....	Dip.....	1	8
		{ .5	.....	Fed.....	6	4
Aziridine, 1,1'-oxalylbis-.....	50888	{ 10	H ₂ O.....	Dip.....	6	10
		{ .5	.....	Fed.....	2	0
Aziridine, 1-propionyl-.....	50890	{ 10	H ₂ O.....	Dip.....	1	3
		{ .5	.....	Fed.....	4	12
Aziridine, 1,1'-sebacoylbis-.....	50612	{ 10	H ₂ O.....	Dip.....	7	20
		{ .5	.....	Fed.....	1	0
Aziridine, 1,1'-suberoylbis-.....	50889	{ 10	H ₂ O.....	Dip.....	9	2
		{ .5	.....	Fed.....	2	4
Aziridine, 1,1'-sulfinylbis[2-methyl-.....	50358	{ 10	H ₂ O.....	Dip.....	0	96
		{ .5	.....	Fed.....	0	92
Aziridine, 1,1'-terephthaloylbis-.....	50526	{ 10	DMF.....	Dip.....	8	44
		{ .5	.....	Fed.....	0	4
Aziridine, 1-1, <i>o</i> -toluoyl.....	50550	{ 2	DMSO.....	Dip.....	4	20
		{ .5	.....	Fed.....	8	10
1-Aziridinecarboxamide, <i>N,N'</i> -hexamethylenebis-.....	50172	{ .5	H ₂ O.....	Dip.....	0	11
		{ 2	H ₂ O.....	Dip.....	41	38
		{ 1	.....	Fed.....	50	100
1-Aziridinecarboxamide, <i>N,N'</i> -hexamethylenebis[2-methyl-.....	50885	2	H ₂ O.....	Dip.....	21	36
1-Aziridinecarboxamide, <i>N,N'</i> -(methylenedi- <i>p</i> -phenylene)bis-.....	50175	{ 10	DMSO.....	Dip.....	6	2
		{ .5	.....	Fed.....	12	2
		{ 2	.....	Fed.....	17	74

TABLE 1.—Results of general chemosterilant screening against adult boll weevils by dipping, feeding, and topical treatment. (1 replication of 20–50 weevils per test)—Continued

Chemical name	Entomology No. (ENT-)	Concentration	Solvent	Method applied	Sterile eggs	Mortality after 7–14 days
		Percent			Percent	Percent
1-Aziridinecarboxamide, <i>N,N'</i> -(4-methyl- <i>m</i> -phenylene)bis-	50173	1	H ₂ O	Dip	4	15
		2	H ₂ O	Dip	58	50
		1		Fed	87	92
1-Aziridinecarboxamide, <i>N,N'</i> -(4-methyl- <i>m</i> -phenylene)bis[2-methyl-	50887	2	H ₂ O	Dip	22	24
1-Aziridinecarboxamide, <i>N,N'</i> -1,5-naphthylenebis-	50664	2	H ₂ O	Dip	13	2
		10	H ₂ O	Dip	58	5
		12	H ₂ O	Dip	91	12
		15	H ₂ O	Dip	100	32
		.5		Fed	8	4
1-Aziridinecarboxamide, <i>N</i> -octadecyl-	50169	10	Ethanol	Dip	4	24
		.5		Fed	8	10
1-Aziridinecarboxamide, <i>N,N'</i> -(<i>o</i> -phenylenedimethylene)bis-	50174	2	H ₂ O	Dip	31	11
		1		Fed	33	83
1-Aziridinecarboxamide, <i>N</i> -propyl-	50170	6	H ₂ O	Dip	9	6
		.5		Fed	15	10
1-Aziridinecarboxamide, <i>N,N</i> -tetramethylenebis-	50838	5	H ₂ O	Dip	(³)	82
		10	H ₂ O	Dip	(³)	100
		2		Fed	(³)	100
1-Aziridinecarboxamide, <i>N,N'</i> -vinylenebis-, <i>trans</i> -	50987	.312	Ethanol	Dip	10	4
		1.25	. . . do	Dip	67	58
		2.5	. . . do	Dip	89	66
		3.0	. . . do	Dip	100	36
		4.0	. . . do	Dip	100	50
		5.0	. . . do	Dip	100	30
		10.0	. . . do	Dip	100	74
		.25		Fed	(³)	100
		.5		Fed	93	75
		1.0		Fed	(³)	100
		2.0		Fed	100	36
		5.0		Fed	62	4
1-Aziridinecarboxanilide	50171	10	Ethanol	Dip	4	38
		.5		Fed	16	6
1-Aziridinecarboxanilide, 4',4''',4''''-methylidynetris-	50176	10	DMF	Dip	0	6
		.5		Fed	10	6
2-Aziridineethanol, polymer (50-percent aqueous solution)	50177	1	H ₂ O	Dip	6	15
		2	H ₂ O	Dip	1	28
		.5		Fed	10	6

See footnotes at end of table.

TABLE 1.—*Results of general chemosterilant screening against adult boll weevils by dipping, feeding, and topical treatment. (1 replication of 20–50 weevils per test)*—Continued

Chemical name	Entomology No. (ENT-)	Concentration	Solvent	Method applied	Sterile eggs	Mortality after 7–14 days
		Percent			Percent	Percent
1-Aziridinethanol, α -(trichloromethyl)-	50891	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	H ₂ O	Dip.....	2	6
			.....	Fed.....	2	6
Azirino[2',3':3,4]pyrrolo[1,2- <i>a</i>]indole-4,7-dione, 6-amino-1,1a,2,8,8a,8b,8-(hydroxymethyl)-8a-methoxy-1,5-dimethyl-, carbamate (porfiromycin)...	50825	$\left\{ \begin{array}{l} 10 \\ .1 \end{array} \right.$	DMSO.....	Dip.....	29	24
			.....	Fed.....	94	60
Benzene, 4-[(6,7-epoxy-3,7-dimethyl-2-octenyl)oxy]-1,2-(methylenedioxy)-, <i>trans</i> -.....	70033	$\left\{ \begin{array}{l} .001 \\ .001 \end{array} \right.$	Acetone.....	Topical ¹	3	20
			do.....	do. ⁴	3	0
Benzeneearsonous acid, <i>p</i> -[(4,6-diamino- <i>s</i> -triazin-2-yl)amino]dithio-, diester with mercaptoacetic acid, disodium salt.....	51157	$\left\{ \begin{array}{l} 2 \\ 10 \end{array} \right.$	H ₂ O.....	Dip.....	8	4
			H ₂ O.....	Dip.....	10	22
<i>p</i> -Benzoquinone, 2,5-bis(dimethylamino)-	50904	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	Ethanol.....	Dip.....	2	2
			.....	Fed.....	4	0
1 <i>H</i> -Benzotriazole-1-methanol, 5,6-dimethyl-.....	52182	$\left\{ \begin{array}{l} 1 \\ 1 \end{array} \right.$	DMF.....	Dip ¹	8	20
			DMF.....	Dip ⁴	10	30
Biguanide, 1-(<i>p</i> -chlorophenyl)-.....	52174	$\left\{ \begin{array}{l} 1 \\ 1 \end{array} \right.$	DMF.....	Dip ¹	18	10
			DMF.....	Dip ⁴	8	10
1,4-Butanediol, dimethanesulfonate (busulfan).....	25012	$\left\{ \begin{array}{l} .25 \\ .5 \\ 1 \\ 2 \\ 2 \\ 1 \end{array} \right.$	H ₂ O.....	Dip.....	0	18
			H ₂ O.....	Dip ¹	4	28
			H ₂ O.....	Dip.....	0	32
			H ₂ O.....	Dip.....	0	28
			DMSO.....	Dip ¹	60	85
			.....	Fed.....	8	15
Butyric acid, 4-[<i>p</i> -[bis(2-chloroethyl)amino]phenyl]- (chlorambucil).....	26083	$\left\{ \begin{array}{l} 2 \\ 1 \end{array} \right.$	H ₂ O.....	Dip.....	0	63
			.....	Fed.....	49	65
Butyric acid, 4-hydroxy-2-mercapto-, γ -lactone, <i>S</i> -ester with <i>O,O</i> -diethyl phosphorothioate.....	27333	10	Ethanol.....	Dip.....	0	100
Carbamic acid, phenyl ester.....	50866	10	do.....	Dip.....	(³)	100
Carbamic acid, [bis(1-aziridinyl)-phosphinyl]-, benzyl ester.....	50451	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	do.....	Dip.....	3	72
			.....	Fed.....	85	54
Carbamic acid, [bis(1-aziridinyl)-phosphinyl]-, ethyl ester.....	50450	$\left\{ \begin{array}{l} 8 \\ 10 \\ .5 \end{array} \right.$	H ₂ O.....	Dip.....	0	80
			.....	Fed.....	90	74
			.....	Fed.....	0	84

See footnotes at end of table.

TABLE 1.—*Results of general chemosterilant screening against adult boll weevils by dipping, feeding, and topical treatment. (1 replication of 20–50 weevils per test)—Continued*

Chemical name	Ento- mology No. (ENT-)	Concen- tration	Solvent	Method applied	Sterile eggs	Mor- tality after 7–14 days
		<i>Percent</i>			<i>Percent</i>	<i>Percent</i>
Carbamic acid, ethylenebis[ethyl-, diethyl ester.....	52171	$\begin{cases} 1 \\ 1 \end{cases}$	Methanol..... .....do.....	Dip ¹ Dip ⁴	0 6	0 10
Carbamic acid, [2-hydroxy-1- (hydroxymethyl)ethyl]-, 2-chloro-1- (chloromethyl) ethyl ester.....	28271	$\begin{cases} 10 \\ 2 \end{cases}$	H ₂ O.....	Dip..... Fed.....	1 6	24 16
Carbamic acid, (2,2,3-trichloro-1- hydroxybutyl-, butyl) ester.....	22675	10	H ₂ O.....	Dip.....	6	12
Carbanilic acid, isopropyl ester.....	14879	$\begin{cases} 1 \\ 1 \end{cases}$	DMF..... DMF.....	Dip ¹ Dip ⁴	16 4	50 30
5 β -Cholest-7-en-6-one, 2 β ,3 β ,14,20,22,25- hexahydroxy-, (22 <i>R</i>)- (ecdysterone)....	44727	.001	Acetone.....	Topical ¹	3	0
5 β -Cholest-7-en-6-one, 2 β ,3 β ,14- trihydroxy-.....	70034	$\begin{cases} .001 \\ .001 \end{cases}$	do..... .....do.....	do. ¹..........do. ⁴	9 19	7 0
5 β ,20-Cholest-7-en-6-one, 2 β ,3 β ,14,20,22,26-hexahydroxy- (inokosterone).....		$\begin{cases} .001 \\ .001 \end{cases}$	do..... .....do.....	do. ¹..........do. ⁴	3 3	7 7
Choline, acetyl-, bromide.....	18298	$\begin{cases} 10 \\ 2 \end{cases}$	H ₂ O.....	Dip..... Fed.....	6 2	8 30
Chromium, dichlorotetrakis(ethylenimine) — — —chloride, <i>trans</i> -.....	50873	$\begin{cases} 10 \\ .5 \end{cases}$	H ₂ O.....	Dip..... Fed.....	2 2	28 4
Cobalt, bis(dimethylglyoximate)bis- (ethylenimine)— — —chloride.....	50872	$\begin{cases} 10 \\ .5 \end{cases}$	H ₂ O.....	Dip..... Fed.....	9 2	8 28
Cobalt, bis(ethylenediamine)bis- (ethylenimine)— — —tribromide.....	50874	$\begin{cases} 10 \\ .5 \end{cases}$	H ₂ O.....	Dip..... Fed.....	9 2	2 4
Cobalt, dichlorobis[tris(1-aziridinyl)- phosphine oxide]-.....	51134	$\begin{cases} 10 \\ 15 \\ 2 \end{cases}$	H ₂ O.....	Dip..... Fed..... Fed.....	41 25 100	44 42 82
1,2,4-Dithiazolium, 3,5-bis- (dimethylamino)— — —chloride.....	51160	$\begin{cases} 5 \\ 10 \\ .5 \end{cases}$	H ₂ O..... H ₂ O.....	Dip..... Dip..... Fed.....	(³) (³) (³)	98 84 98
Ethanol, 1,1'-[(6-amino-s-triazine-2,4-diyl) diimino]bis[2,2,2-trichloro-.....	51121	$\begin{cases} 10 \\ .5 \end{cases}$	DMF.....	Dip..... Fed.....	3 7	58 18
Ethylenimine.....	50324	$\begin{cases} 10 \\ .5 \end{cases}$	H ₂ O.....	Dip..... Fed.....	0 4	8 0

See footnotes at end of table.

TABLE 1.—*Results of general chemosterilant screening against adult boll weevils by dipping, feeding, and topical treatment. (1 replication of 20–50 weevils per test)—Continued*

Chemical name	Entomology No. (ENT-)	Concentration	Solvent	Method applied	Sterile eggs	Mortality after 7–14 days
		Percent			Percent	Percent
Flavanone, 3,3',4',5,7-pentahydroxy-(dihydroquercetin).....	52769	10	H ₂ O.....	Dip.....	3	4
		25	H ₂ O.....	Dip.....	6	8
		2	.....	Fed.....	(³)	100
		2	.....	Fed.....	6	12
Fluorene-2,7-diamine.....	50463	10	H ₂ O.....	Dip.....	0	8
		.5	.....	Fed.....	4	0
Glucaric acid, dipotassium salt.....	50366	2	H ₂ O.....	Dip.....	5	0
		1	.....	Fed.....	4	28
Glycerol, trimethanesulfonate.....	61169	2	DMSO.....	Dip ¹	50	70
Guanazole.....	51272	10	H ₂ O.....	Dip.....	10	20
		.5	.....	Fed.....	8	4
Guanidine, (benzylideneamino)-, nitrate.....	52004	2	Ethanol.....	Dip.....	28	10
		1	.....	Fed.....	0	10
Guanidine, methyl-, hydrochloride.....	51270	10	H ₂ O.....	Dip.....	4	18
		.5	.....	Fed.....	3	46
2-Imidazolidinone.....	22151	1	H ₂ O.....	Dip.....	5	0
		2	H ₂ O.....	Dip.....	1	0
		5	H ₂ O.....	Dip.....	5	0
		1	H ₂ O.....	Dip.....	0	0
		1	.....	Fed.....	0	0
Isothiocyanic acid, s-triazine-2,4,6-triyl ester.....	51101	10	DMF.....	Dip.....	4	8
		.5	.....	Fed.....	16	16
Ketone, methyl 3-pyridyl.....	50031	10	H ₂ O.....	Dip.....	6	6
		.5	.....	Fed.....	13	8
Mannitol, 1,6-bis[(2-chloroethyl)amino]-1,6-dideoxy-, dihydrochloride, D-(mannitol nitrogen mustard).....	50454	1	H ₂ O.....	Dip.....	0	25
		2	H ₂ O.....	Dip.....	5	0
		.25	.....	Fed.....	(³)	100
		.5	.....	Fed.....	68	52
Melamine, N ² -butyl-N ⁴ -octyl-N ⁶ -propyl...	51169	10	Ethanol.....	Dip.....	0	42
		.5	.....	Fed.....	16	18
Melamine, N ² ,N ² -diethyl-N ⁴ ,N ⁴ -dimethyl-N ⁶ ,N ⁶ -dipropyl.....	51227	10	Ethanol.....	Dip.....	(³)	96
Melamine, N ² ,N ⁴ -dimethyl.....	51237	10	H ₂ O.....	Dip.....	4	16
		2	.....	Fed.....	2	18

See footnotes at end of table.

TABLE 1.—*Results of general chemosterilant screening against adult boll weevils by dipping, feeding, and topical treatment. (1 replication of 20–50 weevils per test)*—Continued

Chemical name	Ento- mology No. (ENT-)	Concen- tration	Solvent	Method applied	Sterile eggs	Mor- tality after 7–14 days
		Percent			Percent	Percent
Melamine, (dodecylphenyl)-.....	51167	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	DMF.....	Dip.....	2	50
				Fed.....	8	8
Melamine, ethyl-.....	51196	$\left\{ \begin{array}{l} 2 \\ 10 \\ 10 \\ 2 \end{array} \right.$	H ₂ O.....	Dip.....	5	4
			H ₂ O.....	Dip.....	5	42
			Ethanol.....	Dip.....	7	30
				Fed.....	6	22
Melamine, hexamethyl-.....	50852	$\left\{ \begin{array}{l} 2 \\ .5 \end{array} \right.$	Ethanol.....	Dip.....	4	4
				Fed.....	8	2
Melamine, isopropyl-.....	51195	$\left\{ \begin{array}{l} 10 \\ 2 \end{array} \right.$	Ethanol.....	Dip.....	1	12
				Fed.....	6	10
Melamine, methyl-, hydrochloride.....	51216	$\left\{ \begin{array}{l} 2 \\ 10 \\ .5 \end{array} \right.$	H ₂ O.....	Dip.....	0	0
			H ₂ O.....	Dip.....	7	20
				Fed.....	20	18
Melamine, octadecyl-.....	51095	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	DMF.....	Dip.....	2	48
				Fed.....	10	12
Melamine, pentamethyl-.....	51239	$\left\{ \begin{array}{l} 10 \\ 2 \end{array} \right.$	Ethanol.....	Dip.....	7	22
				Fed.....	13	18
Melamine, pentamethyl-, hydrochloride...	51240	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	H ₂ O.....	Dip.....	7	16
				Fed.....	6	12
Melamine, propyl-.....	51197	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	H ₂ O.....	Dip.....	17	18
				Fed.....	5	29
Melamine, N ² ,N ² ,N ⁴ ,N ⁴ -tetramethyl-, hydrochloride.....	51146	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	H ₂ O.....	Dip.....	2	30
				Fed.....	2	32
Melamine, N ² ,N ² ,N ⁴ ,N ⁶ -tetramethyl-.....	51243	$\left\{ \begin{array}{l} 10 \\ 2 \end{array} \right.$	Ethanol.....	Dip.....	7	60
				Fed.....	6	18
Melamine, N ² ,N ² ,N ⁴ ,N ⁶ -tetramethyl-, hydrochloride.....	51244	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	H ₂ O.....	Dip.....	3	18
				Fed.....	27	28
Melamine, (1,1,3,3-trimethylbutyl)-.....	51126	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	Ethanol.....	Dip.....	1	16
				Fed.....	6	14
Melamine, N ² ,N ⁴ ,N ⁶ -tri- <i>tert</i> -butyl-.....	51165	10	Ethanol.....	Dip.....	4	58
Melamine, N ² ,N ⁴ ,N ⁶ -tributyl-N ² ,N ⁴ ,N ⁶ - trimethyl-.....	51228	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	...do.....	Dip.....	9	90
				Fed.....	23	8

TABLE 1.—Results of general chemosterilant screening against adult boll weevils by dipping, feeding, and topical treatment. (1 replication of 20–50 weevils per test)—Continued

Chemical name	Entomology No. (ENT-)	Concentration	Solvent	Method applied	Sterile eggs	Mortality after 7–14 days
		Percent			Percent	Percent
Melamine, N^2, N^2, N^4 -trimethyl-.....	60020	$\left\{ \begin{array}{l} 2 \\ 5 \\ 10 \\ 2 \end{array} \right.$	$\left\{ \begin{array}{l} \text{Ethanol} \\ \text{do} \\ \text{do} \\ \text{do} \end{array} \right.$	$\left\{ \begin{array}{l} \text{Dip} \\ \text{Dip} \\ \text{Dip} \\ \text{Fed} \end{array} \right.$	$\left\{ \begin{array}{l} 0 \\ 0 \\ 1 \\ 5 \end{array} \right.$	$\left\{ \begin{array}{l} 12 \\ 16 \\ 16 \\ 6 \end{array} \right.$
Melamine, N^2, N^2, N^4 -trimethyl-, hydrochloride.....	60021	$\left\{ \begin{array}{l} 2 \\ 5 \\ 10 \end{array} \right.$	$\left\{ \begin{array}{l} \text{H}_2\text{O} \\ \text{H}_2\text{O} \\ \text{H}_2\text{O} \end{array} \right.$	$\left\{ \begin{array}{l} \text{Dip} \\ \text{Dip} \\ \text{Dip} \end{array} \right.$	$\left\{ \begin{array}{l} 5 \\ 6 \\ 5 \end{array} \right.$	$\left\{ \begin{array}{l} 4 \\ 8 \\ 16 \end{array} \right.$
Melamine, N^2, N^4, N^6 -trimethyl-.....	51035	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	$\left\{ \begin{array}{l} \text{H}_2\text{O} \\ \text{do} \end{array} \right.$	$\left\{ \begin{array}{l} \text{Dip} \\ \text{Fed} \end{array} \right.$	$\left\{ \begin{array}{l} 36 \\ 14 \end{array} \right.$	$\left\{ \begin{array}{l} 30 \\ 30 \end{array} \right.$
Melamine, N^2, N^4, N^6 -trimethyl-, hydrochloride.....	51242	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	$\left\{ \begin{array}{l} \text{H}_2\text{O} \\ \text{do} \end{array} \right.$	$\left\{ \begin{array}{l} \text{Dip} \\ \text{Fed} \end{array} \right.$	$\left\{ \begin{array}{l} 21 \\ 3 \end{array} \right.$	$\left\{ \begin{array}{l} 10 \\ 18 \end{array} \right.$
Mercury, acetoxyphenyl-.....	14668	$\left\{ \begin{array}{l} 10 \\ 2 \end{array} \right.$	$\left\{ \begin{array}{l} \text{DMF} \\ \text{do} \end{array} \right.$	$\left\{ \begin{array}{l} \text{Dip} \\ \text{Fed} \end{array} \right.$	$\left\{ \begin{array}{l} ^{(3)} \\ 4 \end{array} \right.$	$\left\{ \begin{array}{l} 100 \\ 92 \end{array} \right.$
Methanediol, dimethanesulfonate.....	51799	2	DMSO.....	Dip ¹	68	65
Methanesulfonamide, N, N -bis(2-hydroxyethyl)-, dimethanesulfonate....	61174	2	DMSO.....	Dip ¹	58	55
Methanetrissulfonic acid, trimethyl ester..	61461	2	DMSO.....	Dip ¹	100	95
Nickel, bis(dimethyldithiocarbamate)-....	50831	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	$\left\{ \begin{array}{l} \text{Mineral oil} \\ \text{do} \end{array} \right.$	$\left\{ \begin{array}{l} \text{Dip} \\ \text{Fed} \end{array} \right.$	$\left\{ \begin{array}{l} ^{(3)} \\ 1 \end{array} \right.$	$\left\{ \begin{array}{l} 100 \\ 38 \end{array} \right.$
Orotic acid, 5-fluoro-.....	26398	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	$\left\{ \begin{array}{l} \text{DMSO} \\ \text{do} \end{array} \right.$	$\left\{ \begin{array}{l} \text{Dip} \\ \text{Fed} \end{array} \right.$	$\left\{ \begin{array}{l} 2 \\ 4 \end{array} \right.$	$\left\{ \begin{array}{l} 24 \\ 14 \end{array} \right.$
2 <i>H</i> -1,3,2-Oxazaphosphorine, 2-[bis(2-chloroethyl)amino]tetrahydro-, 2-oxide (endoxan).....	26198	$\left\{ \begin{array}{l} 2 \\ .5 \end{array} \right.$	$\left\{ \begin{array}{l} \text{H}_2\text{O} \\ \text{do} \end{array} \right.$	$\left\{ \begin{array}{l} \text{Dip} \\ \text{Fed} \end{array} \right.$	$\left\{ \begin{array}{l} 8 \\ 4 \end{array} \right.$	$\left\{ \begin{array}{l} 25 \\ 40 \end{array} \right.$
Pactamycin (from <i>Streptomyces pactum</i> var. <i>pactum</i>).....	51038	$\left\{ \begin{array}{l} 1 \\ 2 \\ 5 \\ 10 \\ .5 \\ 1 \end{array} \right.$	$\left\{ \begin{array}{l} \text{Ethanol} \\ \text{do} \\ \text{do} \\ \text{do} \\ \text{do} \\ \text{do} \end{array} \right.$	$\left\{ \begin{array}{l} \text{Dip} \\ \text{Dip} \\ \text{Dip} \\ \text{Dip} \\ \text{Fed} \\ \text{Fed} \end{array} \right.$	$\left\{ \begin{array}{l} 1 \\ 2 \\ 3 \\ 2 \\ ^{(3)} \\ ^{(3)} \end{array} \right.$	$\left\{ \begin{array}{l} 2 \\ 28 \\ 70 \\ 86 \\ 100 \\ 100 \end{array} \right.$
Pentaerythritol, tetramethanesulfonate...	61236	2	DMSO.....	Dip ¹	38	35
Peroxy carbamic acid, dimethyltrithio-, <i>tert</i> -butyl ester.....	25031	$\left\{ \begin{array}{l} 2 \\ .5 \end{array} \right.$	$\left\{ \begin{array}{l} \text{H}_2\text{O} \\ \text{do} \end{array} \right.$	$\left\{ \begin{array}{l} \text{Dip} \\ \text{Fed} \end{array} \right.$	$\left\{ \begin{array}{l} 2 \\ 6 \end{array} \right.$	$\left\{ \begin{array}{l} 46 \\ 4 \end{array} \right.$

See footnotes at end of table.

TABLE 1.—*Results of general chemosterilant screening against adult boll weevils by dipping, feeding, and topical treatment. (1 replication of 20–50 weevils per test)—Continued*

Chemical name	Entomology No. (ENT-)	Concentration	Solvent	Method applied	Sterile eggs	Mortality after 7–14 days
		Percent			Percent	Percent
Phenol, <i>o</i> -[(<i>m</i> -nitrobenzylidene)amino]-...	51257	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	DMSO.....	Dip.....	11	18
			.....	Fed.....	1	14
Phosphine oxide, bis(2-methyl-1-aziridinyl)- (phenyl MAPO).....	50005	$\left\{ \begin{array}{l} 1 \\ 1 \end{array} \right.$	H ₂ O.....	Dip.....	9	18
			.....	Fed.....	60	90
Phosphine oxide, tris(1-aziridinyl)- (tepa).....	24915	$\left\{ \begin{array}{l} .5 \\ 1 \\ 2 \\ 1 \end{array} \right.$	H ₂ O.....	Dip.....	65	20
			H ₂ O.....	Dip.....	72	16
			H ₂ O.....	Dip.....	88	69
			.....	Fed.....	50	90
Phosphine oxide, tris(2-methyl-1-aziridinyl)- (metepa).....	50003	$\left\{ \begin{array}{l} .5 \\ 2 \\ .25 \\ .5 \end{array} \right.$	H ₂ O.....	Dip.....	20	43
			H ₂ O.....	Dip.....	9	37
			.....	Fed.....	(³)	100
			.....	Fed.....	80	78
Phosphine sulfide, tris(2-methyl-1-aziridinyl)- (methiotepa).....	50004	$\left\{ \begin{array}{l} 1 \\ 2 \end{array} \right.$	H ₂ O.....	Dip.....	55	43
			H ₂ O.....	Dip.....	98	82
Phosphinothioic amide, <i>P,P</i> -bis(1-aziridinyl)- <i>N</i> -(3-methoxypropyl)-.....	50981	$\left\{ \begin{array}{l} 2 \\ 5 \\ 10 \\ 2 \end{array} \right.$	Ethanol.....	Dip.....	100	88
			do.....	Dip.....	(³)	100
			do.....	Dip.....	(³)	100
			.....	Fed.....	(³)	100
Phosphonic acid, phenyl-, propyl 2-propynyl ester.....	28923	$\left\{ \begin{array}{l} .001 \\ .001 \end{array} \right.$	Acetone.....	Topical ¹	12	0
			do.....	do. ⁴	5	13
Phosphonic amide, <i>P,P</i> -bis(1-aziridinyl)- <i>N</i> -isopropyl-.....	51256	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	H ₂ O.....	Dip.....	(³)	86
			.....	Fed.....	(³)	100
Phosphonic amide, <i>P,P</i> -bis(1-aziridinyl)- <i>N</i> -methyl-.....	51254	$\left\{ \begin{array}{l} 5 \\ 10 \\ .5 \end{array} \right.$	H ₂ O.....	Dip.....	(³)	88
			H ₂ O.....	Dip.....	(³)	100
			.....	Fed.....	(³)	100
Phosphonic amide, <i>P,P</i> -bis(1-aziridinyl)- <i>N</i> -propyl-.....	51253	$\left\{ \begin{array}{l} 2 \\ 10 \\ 2 \end{array} \right.$	H ₂ O.....	Dip.....	(³)	96
			H ₂ O.....	Dip.....	(³)	100
			.....	Fed.....	(³)	96
Phosphonothioic acid, methyl-, <i>O</i> -(2-chloroethyl) <i>O</i> -(α,α,α -trifluoro-4-nitro- <i>m</i> -tolyl) ester.....	51098	$\left\{ \begin{array}{l} 5 \\ 10 \end{array} \right.$	Ethanol.....	Dip.....	(³)	100
			do.....	Dip.....	(³)	100
Phosphoric triamide, <i>N,N'</i> -ethyl- <i>N,N,N',N'</i> -tetramethyl-.....	51199	$\left\{ \begin{array}{l} 2 \\ 10 \\ .5 \end{array} \right.$	H ₂ O.....	Dip.....	4	2
			H ₂ O.....	Dip.....	10	50
			.....	Fed.....	10	14

See footnotes at end of table.

TABLE 1.—*Results of general chemosterilant screening against adult boll weevils by dipping, feeding, and topical treatment. (1 replication of 20–50 weevils per test)*—Continued

Chemical name	Ento- mology No. (ENT-)	Concen- tration	Solvent	Method applied	Sterile eggs	Mor- tality after 7-14 days
		<i>Percent</i>			<i>Percent</i>	<i>Percent</i>
Phosphoric triamide, hexamethyl- (hempa).....	50882	$\left\{ \begin{array}{l} 5 \\ 10 \\ 25 \\ 50 \\ 10 \\ .5 \\ 2 \end{array} \right.$	H ₂ O.....	Dip.....	62	12
			H ₂ O.....	Dip.....	69	40
			H ₂ O.....	Dip.....	88	49
			H ₂ O.....	Dip.....	70	77
			H ₂ O.....	Dip.....	11	10
			.....	Fed.....	30	2
.....	Fed.....	(³)	96			
Phosphoric triamide, N''-isopropyl- N,N,N',N'-tetramethyl-.....	51163	$\left\{ \begin{array}{l} 2 \\ 10 \\ .5 \end{array} \right.$	H ₂ O.....	Dip.....	5	4
			H ₂ O.....	Dip.....	9	48
			.....	Fed.....	12	14
Phosphorodiamidic acid, N,N'-dimethyl-, phenyl ester.....	27222	$\left\{ \begin{array}{l} 2 \\ 5 \\ 10 \end{array} \right.$	H ₂ O.....	Dip.....	8	10
			H ₂ O.....	Dip.....	1	14
			.....	Fed.....	4	20
Phthalimide, N-hydroxy.....	52074	2	Ethanol.....	Dip.....	32	10
Piperazine.....	26675	$\left\{ \begin{array}{l} 10 \\ 5 \end{array} \right.$	H ₂ O.....	Dip.....	6	12
			.....	Fed.....		96
1,4-Piperazinedicarboxylic acid, bis[2- chloro-1-(chloromethyl)ethyl] ester.....	51085	$\left\{ \begin{array}{l} 2 \\ 10 \\ .5 \end{array} \right.$	DMF.....	Dip.....	7	12
			DMF.....	Dip.....	3	52
			.....	Fed.....	7	16
1,3-Propanediol, dimethanesulfonate.....	51904	$\left\{ \begin{array}{l} 1 \\ 1 \\ 1 \end{array} \right.$	DMSO.....	Dip ¹	8	10
			DMSO.....	Dip ⁴	20	50
			H ₂ O.....	Fed.....	0	26
Purine, 2,6-diamino-.....	25010	$\left\{ \begin{array}{l} 1 \\ 1 \end{array} \right.$	DMSO.....	Dip ¹	16	30
			DMSO.....	Dip ⁴	10	30
Purine, 2,6-dichloro-.....	51950	$\left\{ \begin{array}{l} 2 \\ 1 \end{array} \right.$	Ethanol.....	Dip.....	31	20
			.....	Fed.....	9	8
Purine, 6-(phenylthio)-.....	52068	$\left\{ \begin{array}{l} 1 \\ 1 \end{array} \right.$	Methanol.....	Dip ¹	6	0
			...do.....	Dip ⁴	6	0
Pyrazole-3-acetic acid, 5-amino-4- carbamoyl-.....	50980	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	Ethanol.....	Dip.....	3	4
			.....	Fed.....	6	8
3,6-Pyridazinedione, 1,2-dihydro-1- methyl-2-phenyl-.....	60049	$\left\{ \begin{array}{l} 2 \\ 5 \\ 10 \\ 2 \end{array} \right.$	DMSO.....	Dip.....	0	26
			DMSO.....	Dip.....	1	26
			DMSO.....	Dip.....	2	24
			.....	Fed.....	4	42

See footnotes at end of table.

TABLE 1.—*Results of general chemosterilant screening against adult boll weevils by dipping, feeding, and topical treatment. (1 replication of 20–50 weevils per test)*—Continued

Chemical name	Entomology No. (ENT-)	Concentration	Solvent	Method applied	Sterile eggs	Mortality after 7–14 days
		Percent			Percent	Percent
Pyridinium, 1-methyl- — — iodide.....	15031	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	H ₂ O.....	Dip.....	24	28
			.....	Fed.....	7	42
4,6-Pyrimidinediol, 5-nitro-.....	50455	$\left\{ \begin{array}{l} 1 \\ 1 \end{array} \right.$	DMSO.....	Dip ¹	0	50
			DMSO.....	Dip ⁴	12	30
Quinaldonitrile, 1-benzoyl-1,2-dihydro-...	16856	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	DMF.....	Dip.....	1	14
			.....	Fed.....	18	18
Streptomycin, dihydro-, sulfate.....	50133	$\left\{ \begin{array}{l} .5 \\ .5 \end{array} \right.$	H ₂ O.....	Dip.....	10	18
			.....	Fed.....	10	18
Sulfamide, tetramethyl-.....	22946	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	Ethanol.....	Dip.....	2	6
			.....	Fed.....	4	4
Tin, acetoxytriphenyl- (triphenyltin acetate).....	25208	$\left\{ \begin{array}{l} .1 \\ .5 \\ 2 \\ .5 \end{array} \right.$	Ethanol.....	Dip.....	(³)	100
			...do.....	Dip.....	(³)	100
			...do.....	Dip.....	(³)	100
			...do.....	Fed.....	(³)	100
Tin, allyltriphenyl-.....	50909	$\left\{ \begin{array}{l} .006 \\ .08 \\ .31 \\ 1 \\ 2.5 \\ 5 \\ 10 \\ .5 \end{array} \right.$	Ethanol.....	Dip.....	2	24
			...do.....	Dip.....	1	82
			...do.....	Dip.....	(³)	100
			...do.....	Dip.....	(³)	100
			...do.....	Dip.....	(³)	100
			...do.....	Dip.....	(³)	100
			...do.....	Dip.....	(³)	100
			...do.....	Fed.....	0	96
Tin, chlorotriphenyl-.....	25207	$\left\{ \begin{array}{l} .5 \\ 2 \\ .5 \end{array} \right.$	Ethanol.....	Dip.....	(³)	100
			...do.....	Dip.....	(³)	100
			.....	Fed.....	0	98
Tin, hydroxytriphenyl- (triphenyltin hydroxide).....	28009	$\left\{ \begin{array}{l} 1 \\ .5 \end{array} \right.$	Ethanol.....	Dip.....	100	100
			.....	Fed.....	(³)	100
Tin, thiobis(triphenyl-.....	50910	$\left\{ \begin{array}{l} 10 \\ .5 \end{array} \right.$	DMF.....	Dip.....	5	96
			.....	Fed.....	2	4
1,3,5,2,4,6-Triazatriphosphorine, 2,4,6-tris(1-aziridinyl)-2,2,4,4,6,6- hexahydro-2,4,6-triphenyl-.....	50877	$\left\{ \begin{array}{l} 10 \\ 2 \\ 1 \end{array} \right.$	DMF.....	Dip.....	17	46
			.....	Fed.....	2	16
			.....	Fed.....	47	60
1,3,5,2,4,6-Triazatriphosphorine, 2,2,4,4,6,6-hexahydro-2,2,4,4,6,6- hexakis(2-methyl-1-aziridinyl)- (methylapholate).....	50123	$\left\{ \begin{array}{l} 1 \\ 2 \\ 1 \end{array} \right.$	H ₂ O.....	Dip.....	31	14
			H ₂ O.....	Dip.....	30	33
			.....	Fed.....	98	100

See footnotes at end of table.

TABLE 1.—*Results of general chemosterilant screening against adult boll weevils by dipping, feeding, and topical treatment. (1 replication of 20–50 weevils per test)—Continued*

Chemical name	Entomology No. (ENT-)	Concentration	Solvent	Method applied	Sterile eggs	Mortality after 7–14 days
		Percent			Percent	Percent
1,3,5,2,6-Triazatriphosphorine, 2,2,4,4,6,6-hexakis(dimethylamino)- 2,2,4,4,6,6-hexahydro-, hydrochloride . .	51346	{ 10 .5	H ₂ O	Dip	4	50
				Fed	2	18
s-Triazine, 2,4-diamino-6-chloro-	50982	{ 6 10 1.2	H ₂ O	Dip	0	98
			H ₂ O	Dip	0	50
				Fed	7	12
s-Triazine, 2,4-diamino-6-(2-furyl)-	22641	{ 10 2	DMF	Dip	7	70
				Fed	12	54
s-Triazine, 2,4-diamino-6-morpholino-, hydrochloride	51143	{ 10 .5	H ₂ O	Dip	12	20
				Fed	21	20
s-Triazine, 2,4,6-tris(1-aziridinyl)- (tretamine)	25296	{ .5 1 1.5 2 1	H ₂ O	Dip	54	18
			H ₂ O	Dip	95	40
			H ₂ O	Dip	93	11
			H ₂ O	Dip	100	74
				Fed	83	100
s-Triazine, 2,4,6-tris(2-methyl-1- aziridinyl)- (methyl tretamine)	50055	{ .5 1 1.5 1	H ₂ O	Dip	15	16
			H ₂ O	Dip	27	23
			H ₂ O	Dip	3	16
				Fed	95	69
s-Triazine-3,5(2 <i>H</i> ,4 <i>H</i>)-dione, 2-ribofuranosyl-	50104	{ 2 .5	H ₂ O	Dip	0	11
				Fed	8	0
v-Triazolo[4,5- <i>d</i>]pyrimidin-7-ol, 5-amino- (8-azaguanine)	25015	{ 2 .5	H ₂ O	Dip	0	11
				Fed	2	0
2,6-Tridecadienoic acid, 10,11-epoxy-7- ethyl-3,11-dimethyl-, methyl ester (mixed isomers synthetic juvenile hormone)	33972	{ .001 .001	Acetone	Topical ¹	2	7
			do	do. ⁴	2	7
Uracil, 5,6-diamino-1,3-dimethyl-, hydrochloride	52131	{ 2 1	H ₂ O	Dip	32	0
				Fed	19	40
Uracil, 5-fluoro-	25297	{ 1 1 1 2 5 10 1 2	Methanol	Dip ¹	7	10
			do	Dip ⁴	2	10
			H ₂ O	Dip	1	18
			DMSO	Dip	3	26
			DMSO	Dip	8	16
			DMSO	Dip	7	44
				Fed	(³)	58
				Fed	0	70

See footnotes at end of table.

TABLE 1.—Results of general chemosterilant screening against adult boll weevils by dipping, feeding, and topical treatment. (1 replication of 20–50 weevils per test)—Continued

Chemical name	Ento- mology No. (ENT-)	Concen- tration	Solvent	Method applied	Sterile eggs	Mor- tality after 7–14 days
		Percent			Percent	Percent
Urea, 1-acetyl-2-thio-.....	24935	10	H ₂ O.....	Dip.....	12	16
Urea, 1-[bis(1-aziridiny)phosphinyl]-3- (3,4-dichlorophenyl)-.....	50781	10	H ₂ O.....	Dip.....	100	14
		10	H ₂ O.....	Dip.....	100	56
		10	H ₂ O.....	Dip.....	100	60
		5	H ₂ O.....	Dip.....	93	32
		.25	.....	Fed.....	100	67
Urea, hydroxy-.....	51139	1	H ₂ O.....	Dip ¹	12	20
		1	H ₂ O.....	Dip ⁴	2	0
		1	H ₂ O.....	Dip.....	6	4
		3	H ₂ O.....	Dip.....	0	8
		10	H ₂ O.....	Dip.....	4	6
		1	.....	Fed.....	(³)	100
Check.....			H ₂ O.....	Dip ⁵	5	16
			Ethanol.....	Dip ⁶	4	15
			DMSO.....	Dip ⁷	5	28
			DMF.....	Dip ⁸	4	15
			Mineral oil.....	Dip ⁹	(³)	98
			Acetone.....	Topical ¹⁰	8	8
			Methanol.....	Dip ¹⁰	6	0
Confidential.....			.....	Fed ^{2 6}	5	19
			Ethanol.....	Dip.....	0	100
			.....	Fed.....	3	38
			H ₂ O.....	Dip.....	3	34
			.....	Fed.....	(³)	98
			H ₂ O.....	Dip.....	6	40
			Ethanol.....	Dip.....	0	100
			...do.....	Dip.....	11	20

¹ Treated male × normal female.² 10 percent sugar water.³ No eggs laid.⁴ Treated female × normal male.⁵ 34 replications.⁶ 23 replications.⁷ 16 replications.⁸ 12 replications.⁹ 1 replication.¹⁰ 2 replications.

TABLE 2.—*Additive effects of various chemical combinations at substerilizing doses on boll weevils by dipping. (1 replication of 20–50 weevils per test)*

Compound	Concentration		Solvent	Sterile eggs	Mortality after 7–14 days
	Chemo-sterilant	Adjunct			
	Percent	Percent		Percent	Percent
SERIES 1.—APHOLATE PLUS ANTIMETABOLITES, SYNERGISTS, HORMONES, AND OTHER AGENTS					
Apholate.....	1	.....	H ₂ O.....	28	16
Do.....	1	.....	Methanol.....	62	5
Do. ¹	1	.....	do.....	51	3
Do. ²	1	.....	do.....	9	2
Apholate plus—					
Piperonyl butoxide.....	1	1	do.....	100	30
Do. ¹	1	.....	do.....	59	11
Do. ².....	.....	.....	do.....	15	6
Propyl isome.....	1	1	do.....	100	40
Do. ¹	1	1	do.....	43	1
Do. ²	1	1	do.....	13	4
Sesamex.....	1	1	do.....	100	40
Do. ¹	1	1	do.....	66	3
Do. ²	1	1	do.....	17	6
2-(Butoxyethoxy)ethyl piperonylate				86	15
(Bucarpolate) ²	1	1	do.....	64	4
Aminopterin (<i>N</i> -[<i>p</i> -[[2,4-diamino-6-pteridiny]methyl]amino]benzoyl]glutamic acid.....	1	1	H ₂ O.....	15	10
Sulfanilamide.....	1	1	H ₂ O.....	66	15
8-Bromoguanine.....	1	1	H ₂ O.....	22	30
Methotrexate.....	1	1	H ₂ O.....	25	15
8-Azaguanine (5-amino- <i>v</i> -triazolo[4,5- <i>d</i>]pyrimidin-7-ol).....	1	1	H ₂ O.....	24	30
6-Mercaptopurine (purine-6-thiol).....	1	1	H ₂ O.....	21	45
5-Amino-4-imidazolecarboxamide.....	1	1	H ₂ O.....	52	30
Hydroxyurea.....	1	1	H ₂ O.....	14	40
Abscisic acid ((<i>E,E</i>)-5-(1-hydroxy-2,6,6-trimethyl-4-oxo-2-cyclohexen-1-yl)-3-methyl-2,4-pentadienoic acid).....	1	.004	H ₂ O.....	30	0
Check.....	.....	.....	Methanol.....	9	10
			H ₂ O.....	11	14
			H ₂ O.....	14	12
SERIES 2.—APHOLATE PLUS RADIOPROTECTIVE AGENTS					
Apholate plus—					
<i>N</i> -Acetylcysteine.....	1	1	H ₂ O.....	2	0
DL-penicillamine (3-mercaptovaline).....	1	1	H ₂ O.....	18	0
Glutathione.....	1	1	H ₂ O.....	8	5
L-cysteine.....	1	1	H ₂ O.....	28	0
2-Mercaptoethylamine hydrochloride.....	1	1	H ₂ O.....	16	10
2-Aminoethanediol hydrochloride.....	1	1	H ₂ O.....	51	10

See footnotes at end of table.

TABLE 2.—*Additive effects of various chemical combinations at substerilizing doses on boll weevils by dipping. (1 replication of 20–50 weevils per test)—Continued*

Compound	Concentration		Solvent	Sterile eggs	Mortality after 7–14 days
	Chemo-sterilant	Adjunct			
	Percent	Percent		Percent	Percent
Cystamine dihydrochloride (2,2'-dithiobis (ethylamine) dihydrochloride).....	1	1	H ₂ O.....	52	10
Carbazole.....	1	1	Methanol.....	78	15
	1	1	DMSO.....	88	70
	1	2	Methanol.....	94	10
	1	2	DMSO.....	84	90
			H ₂ O ³	2	12
Check.....			Methanol ³	9	8
			DMSO.....	8	65

SERIES 3.—CARBAZOLE PLUS SOME ALKYLATING AGENTS

Carbazole.....		2	Methanol.....	10	5
Carbazole plus—					
1-[bis(1-Aziridinyl)phosphinyl]-3-(3,4-dichlorophenyl)urea.....	2	2	...do.....	55	20
Methiotepa (tris(2-methyl-1-aziridinyl) phosphine sulfide).....	1	2	...do.....	69	10
Tretamine.....	1	2	...do.....	75	55
<i>trans</i> -N,N'-Vinylenebis(1-aziridinecarboxamide) ..	1	2	...do.....	22	20
Porfiromycin.....	2	2	...do.....	34	10
Check.....			...do.....	24	0

SERIES 4.—PIPERONYL BUTOXIDE PLUS SOME ALKYLATING AGENTS

Piperonyl butoxide.....		1	Methanol.....	20	45
Piperonyl butoxide plus—					
1-[bis(1-Aziridinyl)phosphinyl]-3-(3,4-dichlorophenyl)urea.....	2	1	...do.....	98	90
Methiotepa.....	1	1	...do.....	93	80
Tretamine.....	1	1	...do.....	(⁴) 72	100
<i>trans</i> -N,N'-Vinylenebis(1-aziridinecarboxamide) ..	1	1	...do.....	72	45
Porfiromycin.....	2	1	...do.....	56	60
Check.....			...do.....	21	5

SERIES 5.—THIOUREA PLUS SOME ALKYLATING AGENTS

Thiourea.....		2	Methanol.....	38	10
Thiourea plus—					
1-[bis(1-Aziridinyl)phosphinyl]-3-(3,4-dichlorophenyl)urea ¹	1	2	...do.....	24	10
Methiotepa.....	.5	2	...do.....	28	25
Tretamine.....	.5	2	...do.....	30	0
1-Aziridinecarboxamide, N,N'- <i>trans</i> -N,N'-vinylenebis(1-aziridinecarboxamide) vinylenebis-, <i>trans</i>	.5	2	...do.....	35	5
Porfiromycin.....	1	2	...do.....	54	15
Check.....			...do.....	17	5

See footnotes at end of table.

TABLE 2.—*Additive effects of various chemical combinations at substerilizing doses on boll weevils by dipping. (1 replication of 20–50 weevils per test)—Continued*

Compound	Concentration		Solvent	Sterile eggs	Mortality after 7–14 days
	Chemo-sterilant	Adjunct			
	Percent	Percent		Percent	Percent
SERIES 6.—6-THIOGUANINE (2-AMINOPURINE-6-THIOL) PLUS SOME ALKYLATING AGENTS					
6-Thioguanine.....		.5	H ₂ O.....	32	10
6-Thioguanine plus—					
Apholate.....	1.0	1.0	H ₂ O.....	83	45
Tretamine.....	.5	.5	H ₂ O.....	39	20
1-[bis(1-Aziridinyl)phosphinyl]-3-(3,4-dichlorophenyl)urea.....	1	.5	Methanol.....	34	15
"Queen substance" ((E)-9-oxo-2-decenoic acid) ..	1	.5	H ₂ O.....	28	15
Check.....			{ Methanol.....	19	25
			{ H ₂ O.....	3	0

¹ Treated male × normal female.² Treated female × normal male.³ 3 replications.⁴ No eggs laid.TABLE 3.—*Effects of 3,4-(methylenedioxy)phenyl derivatives against boll weevils treated topically. (10 pairs of weevils per test; acetone solvent)*

Chemical name	Entomology No. (ENT-)	NIA ¹ No.	Concentration	Mortality after 7–14 days	Average egg hatch	Average emerged adults
			Mg. per ml.	Percent	Percent	Percent
3-Acetyldihydro-5-piperonyl-2(3H)-furanone.....	52737-a	{ ² 10385 ³ 10385	{ 1 5	{ 30 0	{ 80 84	{ 36 20
5-Acetyldihydro-5-(6-propylpiperonyl)-2(3H)-furanone.....	52726-a	{ ² 39 ³ 39	{ { 1 5 1 5 10	{ { 0 0 0 10 0	{ { 80 88 84 100 84	{ { 20 44 32 28 (4)
2-Chloro-3',4'-(methylenedioxy)acetanilide.....	52741	{ ² 11167 ³ 11167	{ { 1 5 10 1 5 10	{ { 40 50 20 0 0 0	{ { 97 71 85 97 6 89	{ { 33 29 27 7 7 17

See footnotes at end of table.

TABLE 3.—*Effects of 3,4-(methylenedioxy)phenyl derivatives against boll weevils treated topically. (10 pairs of weevils per test; acetone solvent)*—Continued

Chemical name	Ento- mology No. (ENT-)	NIA ¹ No.	Concen- tration	Mortality after 7-14 days	Average egg hatch	Average emerged adults
			<i>Mg. per ml.</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
2-Chloropiperonyl acetate.....	52727	² 232	1	0	84	32
			5	0	98	28
			10	0	44	24
		³ 232	1	0	94	28
			5	0	94	34
			10	0	90	24
2-Chloropiperonyl 10-undecenoate.....	52728	² 233	1	40	85	41
			5	20	97	30
			10	30	91	24
		³ 233	1	0	89	21
			5	0	93	19
			10	0	97	14
α -[(Dibutylamino)methyl]-3,4-(methylenedioxy) phenethyl alcohol.....	52736	² 10374	1	30	89	29
			5	40	81	29
			10	10	81	25
		³ 10374	1	0	87	17
			5	0	67	7
			10	0	90	3
Diethyl piperonylphosphonate.....	52739-a	² 11003	1	0	80	8
			5	20	73	21
			10	20	78	34
		³ 11003	1	20	78	25
			5	20	59	7
			10	20	80	13
Diethyl (6-propylpiperonyl)phosphonate.....	52740	² 11005	1	40	91	34
			5	30	82	33
			10	40	95	35
		³ 11005	1	10	90	10
			5	10	93	17
			10	0	83	10
7,11-Dimethyl-1-[3,4-(methylenedioxy)phenyl]- 1,4,6,10-dodecatetraen-3-one.....	52734-a	² 10138	1	0	66	16
			5	0	70	0
			10	0	88	0
		³ 10138	1	0	80	12
			5	0	69	20
			10	0	74	16
Di-2-propynyl (6-propylpiperonyl)phosphonate.....	52742	² 11507	1	0	57	12
			5	20	58	18
			10	20	54	16
		³ 11507	1	10	57	14
			5	10	68	18
			10	20	73	16

See footnotes at end of table.

TABLE 3.—*Effects of 3,4-(methylenedioxy)phenyl derivatives against boll weevils treated topically. (10 pairs of weevils per test; acetone solvent)*—Continued

Chemical name	Ento- mology No. (ENT-)	NIA ¹ No.	Concen- tration	Mortality after 7-14 days	Average egg hatch	Average emerged adults
			<i>Mg. per ml.</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
Ethyl 2-[3,4-(methylenedioxy)phenyl]-4,6-dioxocyclohexanecarboxylate.....	52729-a	² 8936	1	0	100	(⁴)
			5	5	92	(⁴)
			10	0	82	(⁴)
		³ 8936	1	10	85	(⁴)
			5	0	92	(⁴)
			10	0	88	(⁴)
α -(Ethylsulfonyl)-4,5-(methylenedioxy)-2-propyltoluene.....	14722	² 46	1	0	96	28
			5	0	95	25
			10	0	90	(⁴)
		³ 46	1	0	76	16
			5	0	100	16
			10	10	88	30
<i>N</i> -[2-Hydroxy-3-[3,4-(methylenedioxy)phenyl]propyl]acetamide acetate.....	52738-a	² 10908	1	0	68	(⁴)
			5	0	81	(⁴)
			10	0	78	20
		³ 10908	1	0	68	24
			5	0	76	32
			10	10	63	24
Methylcarbamic acid ester with 3,4-(methylenedioxy)mandelonitrile.....	52732-a	² 10240	1	0	95	18
			5	0	94	12
			10	0	100	20
		³ 10240	1	10	86	6
			5	0	98	18
			10	0	92	12
1,2-(Methylenedioxy)-4-[2-(octylsulfinyl)propyl]benzene.....	16634	² 1769	1	10	66	22
			5	0	54	30
			10	0	74	24
		³ 1769	1	0	53	24
			5	0	66	20
			10	0	66	24
4,5-(Methylenedioxy)- α -(phenylsulfonyl)-2-propyltoluene.....	16015	² 78	1	10	77	23
			5	30	85	31
			10	20	99	34
		³ 78	1	0	93	13
			5	0	90	20
			10	0	92	23

See footnotes at end of table.

TABLE 3.—*Effects of 3,4-(methylenedioxy)phenyl derivatives against boll weevils treated topically. (10 pairs of weevils per test; acetone solvent)*—Continued

Chemical name	Ento- mology No. (ENT-)	NIA ¹ No.	Concen- tration	Mortality after 7-14 days	Average egg hatch	Average emerged adults
			Mg. per ml.	Percent	Percent	Percent
1,2-(Methylenedioxy)-4-(2-propynyloxy)benzene. . . .	52730	² 10060	{ 1	0	45	13
			{ 5	0	82	20
			{ 10	20	84	26
		³ 10060	{ 1	0	85	(⁴)
			{ 5	0	81	30
			{ 10	0	72	16
4,5-(Methylenedioxy)-2-propyl- α -(2-propynyloxy)toluene.	52731-a	² 10081	{ 1	20	80	22
			{ 5	10	82	15
			{ 10	20	42	10
		³ 10081	{ 1	20	71	12
			{ 5	10	65	6
			{ 10	40	34	6
5-Methyl-4-[3,4-(methylenedioxy)phenyl]- <i>m</i> -dioxane.	5535	² 202	{ 1	0	84	16
			{ 5	20	90	24
			{ 10	0	88	12
		³ 202	{ 1	0	88	(⁴)
			{ 5	0	72	20
			{ 10	20	80	30
<i>cis</i> -2-Phenyl-5-[(6-propylpiperonyl)oxy]- <i>m</i> -dioxane.	52743-a	² 16094	{ 1	0	98	16
			{ 5	0	90	12
			{ 10	0	100	16
		³ 16094	{ 1	0	94	18
			{ 5	0	94	28
			{ 10	0	88	12
6-Propylpiperonyl <i>o</i> -benzoylbenzoate.	16014	² 77	{ 1	0	76	20
			{ 5	0	50	19
			{ 10	0	68	32
		³ 77	{ 1	0	70	28
			{ 5	0	66	20
			{ 10	0	74	44
6-Propylpiperonyl <i>p</i> -ethoxybenzoate.	16020	² 98	{ 1	0	96	(⁴)
			{ 5	0	90	16
			{ 10	10	97	52
		³ 98	{ 1	0	100	4
			{ 5	10	92	22
			{ 10	0	92	20

See footnotes at end of table.

TABLE 3.—*Effects of 3,4-(methylenedioxy)phenyl derivatives against boll weevils treated topically. (10 pairs of weevils per test; acetone solvent)*—Continued

Chemical name	Entomology No. (ENT-)	NIA ¹ No.	Concentration	Mortality after 7-14 days	Average egg hatch	Average emerged adults
			Mg. per ml.	Percent	Percent	Percent
6-Propylpiperonyl laurate.....	16013	² 23	1	20	83	30
			5	20	67	31
			10	0	74	25
		³ 23	1	0	90	20
			5	0	90	10
			10	0	100	7
6-Propylpiperonyl phenylacetate.....	16016	² 79	1	20	93	32
			5	40	96	24
			10	10	80	31
		³ 79	1	0	89	14
			5	0	85	26
			10	0	93	20
Sesamex.....	² 20871	.....	1	0	12	(⁴)
		³ 20871	.....	1	7	0 (⁴)
1,2,3,4-Tetrahydro-3-methyl-6,7-(methylenedioxy)- 1,2-naphthalenedicarboximide.....	52735-a	² 10365	1	10	76	24
			5	0	83	30
			10	0	91	20
		³ 10365	1	0	93	20
			5	0	96	20
			10	0	93	(⁴)
Check ⁵				10	83	24

¹ Niagara Chemical Co. number.² Treated male × normal female.³ Treated female × normal male.⁴ Discarded plate due to contamination.⁵ 10 replications.

DISCUSSION

The aziridines were the most effective materials screened. However, none of them were more effective than apholate, which unfortunately decreases the vigor of the insect. This is partly due to damage done to the midgut epithelial cells.

Dame and Schmidt (⁴) sterilized two species of mosquitoes—*Aedes aegypti* (L.) and *Anopheles quadrimaculatus* Say—and the house fly (*Musca domestica* L.) by allowing these insects to crawl over metepa-treated surfaces. However, they reported general vigor was greatly re-

duced. Metepa by dipping proved to be ineffective against boll weevils. When tested by feeding, it was highly effective, but high mortality, reduced vigor, or both resulted.

Tretamine when applied topically sterilized either sex of the screw-worm (*Cochliomyia hominivorax* (Coquerel)) with low toxic effects (Crystal ³). It was tested against the boll weevil by dipping and feeding and was found to be highly effective as a sterilant, but again toxicity was high. In one test high sterility was

attained with little mortality; however, this could not be explained.

In addition to tretamine, two other aziridinyl compounds showed good sterilizing ability with little mortality to the weevil. They were 1-aziridinecarboxamide, *N,N'*-1,5-naphthylenebis- and urea, 1-[bis(1-aziridinyl)phosphinyl]-3-(3,4-dichlorophenyl)-. These compounds, like tretamine, reduced vigor and became more toxic as high levels of sterility were attained.

Hempa inhibited oviposition and egg hatch of the house fly at concentrations of 0.25–1 percent (Fye and others 5) when incorporated in fly food or sugar. It was tested on the boll weevil and found to sterilize effectively at higher concentrations, but toxicity was excessive at these levels.

Low concentrations of apholate and other promising alkylating agents were tested in conjunction with low concentrations of synergists, antimetabolites, hormones, and radioprotective agents with the idea that sterility could be augmented without increased mortality. In these combinations where sterility was increased, mortality also was increased. Also, combination tests were run against mixed sexes and in addition some compounds were tested against individual sexes. Generally males were

more effectively sterilized than females. For example, apholate plus piperonyl butoxide when tested against mixed sexes caused 100-percent sterility; against males sterility was 59 percent, and against females it was 15 percent. Apholate was the most effective in combination with insecticide synergists, and mortality was generally lower than with other alkylating agents.

Generally the synergists, such as piperonyl butoxide and propyl isome, were less effective when tested in combination with the alkylating agents than were the insecticide agents.

No protection was afforded by radioprotective agents. Generally mortality was the same as with apholate alone, and the insects were no more vigorous. Neither was there any augmentation of sterility.

When methyl 10,11-epoxy-7-ethyl-3,11-dimethyl-2,6-tridecadienoate (mixed isomers of synthetic juvenile hormone) was screened against the boll weevil by topical application at 0.001 percent, no sterility was noted against either sex, despite the fact that Bowers (2) noted some sterilizing effects against female house flies by feeding. However, the failure of this material to sterilize was probably due to the method of administration. Conceivably it would have shown more effectiveness if fed.

SUMMARY

Over 200 candidate chemosterilants or other known biologically active compounds have been evaluated alone and in various combinations against the boll weevil (*Anthonomus grandis* Boheman).

Twenty-seven of the compounds tested either alone or in combination with other compounds were found to sterilize 75 percent of the eggs collected from the test insects, but toxicity to the treated weevil was higher than 30 percent except in six specific tests.

A 12-percent concentration of 1-aziridinecarboxamide, *N,N'*-1,5-naphthylenebis-, a 1.5-percent concentration of tretamine, and a 10-percent concentration of urea, 1-[bis(1-aziridinyl)phosphinyl]-3-(3,4-dichlorophenyl)-when tested against mixed sexes by dipping were found to effectively sterilize 91, 93, and 100 percent of the eggs collected, respectively, and

mortality was 12, 11, and 14 to 60 percent, respectively, after 14 days.

In combination tests apholate at 1-percent concentrations with either 1-percent concentrations of piperonyl butoxide or Bucarpolate and 2-percent concentrations of carbazole sterilized 100, 86, and 94 percent of the eggs collected, respectively, but mortality was only 30, 15, and 10 percent, respectively.

A 2-percent concentration of busulfan, glycerol trimethanesulfonate, methanediol dimethanesulfonate, and *N,N*-bis(2-hydroxyethyl)-methanesulfonamide dimethanesulfonate when tested against males only by dipping effectively sterilized 60, 50, 68, and 58 percent of the eggs collected, respectively, and mortality was 85, 70, 65, and 55 percent, respectively, after 14 days.

Di-2-propynyl (6-propylpiperonyl)phosphon-

ate at 1, 5, and 10 mg., 4,5-(methylenedioxy)-2-propyl- α -(2-propynyloxy)toluene at 10 mg., and sesamex at 1 mg. per milliliter when tested

against males, females, or both reduced egg hatch to about 56, 38, and 6 percent, respectively, as compared to the control.

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