

GAS PROPELLED AEROSOLS AND MICRONIZED DUSTS  
FOR CONTROL OF INSECTS IN AIRCRAFT AND VANS<sup>1)2)</sup>

M.S. Schechter<sup>3)</sup>, W.N. Sullivan<sup>3)</sup>, B.M. Cawley<sup>3)</sup>,  
N.O. Morgan<sup>3)</sup>, R. Waters<sup>3)</sup>, C.M. Amyx<sup>4)</sup>, and J. Kennedy<sup>4)</sup>

A B S T R A C T

Sandoz SAN 52—135: 2—(diethylamino)-6-methyl-4-pyrimidinyl methyl methylphosphoramidate; Bay Hox 1619: 2-chloro-5,5-diethyl-1,3,2-dioxaphosphorinane 2-sulfide; phenothrin (S-2539): 3-(phenoxyphenyl)methyl *cis-trans* -(±)-2,2-dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylate; d-phenothrin (S-2539 Forte): 3-(phenoxyphenyl)methyl *cis-trans* — (+)-2,2-dimethyl-3-(2-methyl-1-propenyl) cyclopropanecarboxylate; Roussel-Uclaf RU-11679: (5-benzyl-3-furyl) methyl *trans* -(+)-3-(cyclopentylidene-methyl)-2,2-dimethylcyclopropanecarboxylate; d-cis-resmethrin: (5-benzyl-3-furyl)methyl *cis* -(+)-2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate; and resmethrin: (5-benzyl-3-furyl) methyl *cis-trans*-(±)-2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate, applied as micronized dusts and aerosols in tractor trailers produced kills in excess of 90% of adult boll weevil, *Anthonomus grandis* Boheman; tobacco budworms, *Heliothis virescens* (F.); brown dog tick, *Rhipicephalus sanguineus* (Latreille); alfalfa weevil, *Hypera postica* (Gyllenhal); American cockroaches, *Periplaneta americana* (L.); German cockroaches, *Blattella germanica* (L.); house flies, *Musca domestica* L.; stable flies *Stomoxys calcitrans* (L.); Mexican bean beetles, *Epilachna varivestis* Mulsant; and yellow fever mosquitoes, *Aedes aegypti* (L.).

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- 2) This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation for use by the U.S. Department of Agriculture, nor does it imply registration under FIFRA as amended. Also, mention of a proprietary or commercial product in this paper does not constitute an endorsement of this product by the U.S. Department of Agriculture.
- 3) Beltsville Agricultural Research Center, Agric..Res. Serv., U.S. Department of Agriculture, Beltsville, Md. 20705.
- 4) Animal and Plant Health Inspection Service, Hyattsville, Md. 20782.

## INTRODUCTION

The application of proper quarantine measures to prevent the spread of insects of agricultural or public health importance by aircraft, ship, and van travel is a matter of prime concern. For this reason, scientists from the U.S. Department of Agriculture, the U.S. Department of Health, Education, and Welfare, and the U.S. Department of Defense have joined in testing promising new insecticides as dusts and aerosols that might be used in quarantine application. Trials that took place at Miami, Fla. in 1969 and 1970 were reported in a series of 8 papers (Sullivan et al. 1972a, 1972b, Schechter and Sullivan 1972, Steiner et al. 1972, Gillenwater et al. 1972, Jakob et al. 1972, Burden 1972, and Smith and Boswell 1972). The present paper describes trials in 1971, 1972, and 1973 with a new group of pesticidal dusts and aerosols against a broad spectrum of insects.

## MATERIALS AND METHODS.

The new insecticides were chosen for the current series of tests with the criteria of Schechter and Sullivan (1972) in mind as follows:

- (1) It should be toxic to a reasonably wide spectrum of insects.
- (2) It should have some residual activity.
- (3) It should have low toxicity to mammals (Table 1).
- (4) It should be stable in aerosol or dust formulations, and the formulation should be readily dispersible.
- (5) It should have as little odor and produce as little irritation as possible and should leave no stains.
- (6) It should have no deleterious effects on the electronic components, metal parts, fabrics, or plastics (especially plastic windows) used in aircraft.
- (7) If it is to be used in an aerosol, it should be possible to formulate it in a high concentration.

The compounds tested were:

allethrin: *cis, trans*-(+)-2,2-dimethyl-3-(2-methylpropenyl)cyclopropanecarboxylic acid ester with (+)-2-allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one

*d-trans*-allethrin: *trans*-(+)-2,2-dimethyl-3-(2-methylpropenyl)cyclopropanecarboxylic acid ester with (±)-2-allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one

ASP-51 (Aspon <sup>R</sup>): 0,0,0',0'-tetrapropyl dithiopyrophosphate

BAS 235 I: 3,5-diethylphenyl methylcarbamate

Bay Hox 1619: 2-chloro-5,5-diethyl-1,3,2-dioxaphosphorinane 2-sulfide

carbaryl: 1-naphtyl methylcarbamate

chlorphoxim (Bay 78182): (*o*-chlorophenyl)glyoxylonitrile oxime 0,0-diethyl phosphorothioate

chlorpyrifos-methyl (DOWCO 214 <sup>R</sup>): 0,0-dimethyl 0-(3,5,6-trichloro-2-pyridyl) phosphorothioate

cyhexatin (Plictran): tricyclohexyl-hydroxystannane

DDT: 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane

iodofenphos(Ciba-Geigy C-9491): 0-(2,5-dichloro-4-iodophenyl) 0,0-dimethylphosphorothioate

lindane: 1,2,2,4,5,6-hexachlorocyclohexane, 99% or more gamma isomer

Mobil MC-6921: methyl 3-[cyano[[ (diethoxyphosphinothionyl)oxyl]imino]methyl]benzoate

methoxychlor: 1,1,1-trichloro-2,2-bis(*p*-methoxyphenyl) ethane

phenothrin (S-2539): 3-(phenoxyphenyl)methyl *cis-trans*-(±)-2,2-dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylate

*d*-phenothrin (S-2539 Forte): 3-(phenoxyphenyl)methyl *cis*,  
*trans*-(+)-2,2-dimethyl-3-(2-methyl-1-propenyl) cyclopropanecarboxylate

phosmet (Imidan <sup>R</sup>): 0,0-dimethyl phosphorodithioate *S*-ester  
with *N*-(mercaptomethyl)phthalimide

pirimiphos-methyl (PP-511): 0- [2-(diethylamino)-6-methyl-  
4-pyrimidinyl] 0,0-dimethyl phosphorothioate

propoxur: *o*-isopropoxyphenyl methylcarbamate

"Prothrin": [5-(2-propenyl)-2-furanyl] methyl 2,2-dimethyl-3-  
(2-methyl-1-propenyl)cyclopropanecarboxylate

resmethrin: (5-benzyl-3-furyl)methyl *cis-trans*-(±)-2,2-dimethyl-3-  
(2-methylpropenyl)cyclopropanecarboxylate

*d-cis*-resmethrin: (5-benzyl-3-furyl)methyl *cis*-(+)-2,2-dimethyl-3-  
(2-methylpropenyl) cyclopropanecarboxylate

*d-trans*-resmethrin: (5-benzyl-3-furyl)methyl *trans*-(+)-2,2-dime-  
thyl-3-(2-methylpropenyl) cyclopropanecarboxylate

Stauffer R-26375: [[(dimethoxyphosphinothioyl)oxy] imino] -  
2-thiopheneacetonitrile

Roussel-Uclaf RU-11679: (5-benzyl-3-furyl)methyl *trans*(+)-3-  
(cyclopentylidenemethyl)-2,2-dimethylcyclopropanecarboxylate

Roussel-Uclaf RU-16121: *trans*-(+)-2,2-dimethyl-3-(2-methylpro-  
penyl)cyclopropanecarboxylic acid ester with (+)-2-allyl-4-hydroxy-3-  
methyl-2-cyclopenten-1-one

Sandoz SAN 52-135: 2-(diethylamino)-6-methyl-4-pyrimidinyl  
methyl methylphosphoramidate

stirofos (Gardona <sup>R</sup>): 2-chloro-1-(2,4,5-trichlorophenyl) vinyl  
dimethyl phosphate

A few insecticides such as methoxychlor, carbaryl, and lindane  
were included for comparison. The 42.5% DDT + 42.5% carbaryl dust  
was used as a reference standard in tests of dusts. The 2% resmethrin  
aerosol was used as a reference standard for aerosol treatments.

All arthropods were tested in the adult stage (except that nymphs of the cockroaches and ticks were also tested) because the adult stages are most frequently encountered in aircraft, ships, and vans. Test species were sent air mail by the cooperation laboratories to arrive 1 day before the tests began and again at the midpoint in the tests. The test species and the personnel or laboratories of the Agricultural Research Service, USDA, that provided them were as follows: boll weevil, *Anthonomus grandis* Boheman were provided by T.B. Davich, Boll Weevil Research Laboratory, Mississippi State, Miss.; tobacco budworm, *Heliothis virescens* (F.) by J.R. Raulston, Cotton Insects Research Laboratory, Brownsville, Texas; brown dog tick, *Rhipicephalus sanguineus* (Latreille) by R.O. Drummond, Livestock Insects Investigations, Kerrville, Texas; American cockroach, *Periplaneta americana* (L.), German cockroach, *Blattella germanica* (L.), and yellow fever mosquito, *Aedes aegypti* (L.), by Otelia Bodenstein, Biological Evaluation of Chemicals, Beltsville, Md.; house fly, *Musca domestica* (L.), and stable fly, *Stomoxys calcitrans* (L.) by N.O. Morgan, Chemical and Biophysical Control Laboratory, Beltsville, Md.; alfalfa weevil, *Hypera postica* (Gyllenhal) by R. Ratcliffe, Applied Plant Genetics, Beltsville, Md.; and Mexican bean beetle, *Epilachna varivestis* Mulsant by T. Elden, Field Crops Laboratory, Beltsville, Md.

The insecticide dusts were generally formulated with HiSil<sup>R</sup> 233 as the carrier by dissolving the insecticide in methylene chloride, mixing the solution with the carrier, and allowing the solvent to evaporate while the mixture was rotated in a beaker or can tilted at an angle of about 45°. In those cases where the insecticide was not very soluble in methylene chloride, it was ground directly with HiSil<sup>R</sup> 233 in a ball mill. Dusts were micronized at Pulverizing Service, Inc., Moorestown, N.J.

Aerosols were prepared with propellants 11 and 12 (1:1), except those containing 10% insecticide, which were prepared with propellant 12 only.

Isopropanol was added as a cosolvent to the formulations of 2% Sandoz SAN 52-135 (9.5%) and 2% Bay Hox 1619 (13%).

The test protocol was the same as that used in the 1969-1970 trials (Sullivan et al. 1972a). However, only 2 species were tested uncaged (boll weevils and tobacco budworms); the others were confined in wire screen cages (house flies, stable flies, alfalfa weevils, Mexican bean beetles, yellow fever mosquitoes), in a series of vials (brown dog ticks), or in 7-in.-diam open crystalizing dishes (cockroaches). The insects were exposed to the aerosol and dust formulations for ½ hr (10 min closed and 20 min with 1 screened rear door opened) in tractor trailers.

Then they were collected, placed in fresh cages where they were fed and watered, and held in an air conditioned room (71°F). Mortality counts were made 24 hr later. Moribund insects were considered dead.

## RESULTS AND DISCUSSION

The effectiveness of the insecticidal dusts (% KD at 30 min and/or % kill at 24 hr) in 1971, 1972, and 1973 is given in Table 2; the effectiveness of the aerosols is given in Table 3. The results obtained with the control insects (held without treatment in the trailers) are reported in each table.

At a rate of 1 g dust/1000 ft<sup>3</sup>, Sandoz SAN 52-135 and Bay Hox 1619 were more effective than the standard (DDT-carbaryl) against 4 species, the boll weevil, the American cockroach, the alfalfa weevil, and the house fly; *d*-phenothrin was more effective than the standard against one species, the house fly; resmethrin was more effective against one species, the alfalfa weevil; and phenothrin was more effective against one species, the American cockroach. The standard was more effective than phenothrin and *d*-phenothrin against the boll weevil and more effective than resmethrin against the American cockroach. The effectiveness of all these materials decreased at a rate of 0.5 g/1000 ft<sup>3</sup>. A combination of primiphosmethyl (10%) + *d*-phenothrin (10%) + SAN 52-135 (28.33%) at a rate of 1 g/1000 ft<sup>3</sup> killed all test insects; a combination of SAN 52-135 (42.5% + *d*-phenothrin (15%) killed all test insects except the American cockroach.

At 6 g aerosol/1000 ft<sup>3</sup>, the most promising chemicals were 2% RU-16121 and 2% *d-cis*-resmethrin. In general, effectiveness improved as the dosage or concentration was increased. Thus, 2% *d-cis*-resmethrin at 10 g/1000 ft<sup>3</sup> gave a 99 + % kill of the test insects, and 10% resmethrin and 10% *d-trans*-resmethrin at 30 g/1000 ft<sup>3</sup> killed all test insects.

Table 1. -- Acute mammalian toxicity of Test compounds.<sup>a)</sup>

Insecticide	LD <sub>50</sub> Values (mg/kg) to rats by			
	Oral administration		Dermal administration	
	♂	♀	♂	♀
Allethrin		920		11,200
<i>d-trans</i> -Allethrin		680		1545 <sup>b)</sup>
ASP-51	> 891			3830
BAS 2351		6400		
Bay Hox 1619		> 1000		
Carbaryl	850			> 2000
Chlorphoxim		2500		
Chlorpyrifos-methyl	2140		1630	
Cyhexatin		540		> 2000 <sup>b)</sup>
DDT	113		118	2510
Iodofenphos		2000	1467	
Lindane	88		91	1000
MC-6921		Not available		900
Methoxychlor		6000		
Phenothrin		> 5000		
<i>d</i> -Phenothrin		> 5000		
Phosmet	230		299	> 3160 <sup>b)</sup>
Pirimiphos-methyl			2050	> 2000 <sup>b)</sup>
Proxur	90-128		104	800-1000
"Prothrin"		Not available		
Resmethrin		3500-4500		> 3040
<i>d-cis</i> Resmethrin		100-200		
<i>d-trans</i> Resmethrin		8600±1900		
R- 26375			1470	
RU-11679	100		120	
RU-16121		> 500		
SAN 52-135		1500	725	790
Stirofos		4000-5000	5000 <sup>b)</sup>	

a) Data from Pesticide Manual, Hubert Martin, Editor (British Crop Protection Council), third edition (1972), and manufacturers.

b) Rabbits.

Table 2.-- Effectiveness of selected micronized dusts against several important arthropods. Test species, caged or uncaged, were exposed in tractor trailer in Miami, Fla. to direct applications or to 6-hr-old residues for 1/2 hr.

Insecticide, insects (no.), and exposure <sup>a) b) c)</sup>	Dosage g/1000 ft <sup>3</sup>	% KD at 30 min	% Kill at 24 hr	Insecticide, insects (no.), and exposure <sup>a) b) c)</sup>	Dosage g/1000 ft <sup>3</sup>	% KD at 30 min	% Kill at 24 hr
<i>d-trans</i> -Allethrin (30.0%)	2.0			Iodofenphos (49.2%)	2.0		
Tobacco budworm (18): uncaged; direct		100	100	Tobacco budworm (18): uncaged; direct		10	89
(14): caged; residue		50	29	(15): caged; residue		40	100
Boll weevil (314): uncaged; direct		100	100	Boll weevil (427): uncaged; direct			100
(56): caged; residue		100	29	(182): caged; residue		5	96
Alfalfa weevil *8): caged; direct		100	100	Alfalfa weevil (10): caged; direct		50	30
(5): caged; residue		100	100	(6): caged; residue		0	83
Brown dog tick (13): caged; direct		70	100	Brown dog tick (12): caged; direct		0	100
(21): caged; residue		20	81	(9): caged; residue		12	89
<i>d-trans</i> -Allethrin (30.0%) on Microcel E	2.0			Lindane (85.0%)	1.0		
Tobacco budworm (8): uncaged; direct		100	100	Tobacco budworm (13): uncaged; direct			100
(10): caged; residue		70	100	Boll weevil (52): uncaged; direct			100
Boll weevil (44): uncaged; direct		100	100	American cockroach (30): caged; direct			60
(41): caged; residue		45	42	Brown dog tick (2): uncaged; direct			100
Brown dog tick (7): uncaged; direct		60	100	MC-6921 (50.0%)	0.5		
(5): caged; residue		80	100	Stable fly (38): caged; direct		0	97
ASP-51 (50%)	1.0			House fly (14): caged; direct		0	100
Stable fly (33): caged; direct		0	100	Tobacco budworm (12): uncaged; direct		0	8
House fly (96): caged; direct		0	16	American cockroach (18): caged; direct		0	0
Tobacco budworm (22): uncaged; direct		0	0	German cockroach (22): caged; direct		0	23
Boll weevil (115): uncaged; direct		0	82	MC-6921 (50.0%)	1.0		
American cockroach (53): caged; direct		0	34	Stable fly (83): caged; direct		90	100
Brown dog tick (10): caged; direct		0	100	House fly (58): caged; direct		50	72
Yellow fever mosquito (103): caged; direct		32	100	Tobacco budworm (16): uncaged; direct		50	25
BAS 235-1 (30%)	1.0			American cockroach (21): caged; direct		0	0
Stable fly (38): caged; direct		100	100	German cockroach (16): caged; direct		0	94
House fly (79): caged; direct		1	10	Brown dog tick (9): caged; direct		0	11
Tobacco budworm (26): uncaged; direct		0	0	Methoxychlor (42.5%)	1.0		
Boll weevil (135): uncaged; direct		47	92	Tobacco budworm (37): uncaged; direct			19
American cockroach (40): caged; direct		0	30	Boll weevil (80): uncaged; direct			64
Brown dog tick (11): caged; direct		0	100	American cockroach (30): caged; direct			0
Yellow fever mosquito (185): caged; direct		100	100	Brown dog tick (2): uncaged; direct			50
Bay Hox 1619 (85%)	0.5			Phenothrin (30.0%)	0.5		
Stable fly (77): caged; direct		14	77	Stable fly (50): caged; direct		100	100
House fly (121): caged; direct		23	21	House fly (75): caged; direct		95	72
Tobacco budworm (25): uncaged; direct		4	36	Tobacco budworm (57): uncaged; direct		93	96
Boll weevil (128): uncaged; direct		34	85	Boll weevil (223): uncaged; direct		65	70
American cockroach (66): uncaged; direct		3	21	American cockroach (41): caged; direct		22	37
German cockroach (14): caged; direct		0	0	Brown dog tick (16): caged; direct		6	62
Brown dog tick (17): caged; direct		0	29	Yellow fever mosquito (214): caged; direct		100	100
Yellow fever mosquito (651): caged; direct		93	93	Phenothrin (30.0%)	1.0		
Bay Hox 1619 (85%)	1.0			Stable fly (41): caged; residue		100	100
Stable fly (66): caged; direct		0	100	House fly (49): caged; residue		100	100
House fly (46): caged; direct		0	100	Tobacco budworm (24): uncaged; direct		100	100
Tobacco budworm (69): uncaged; direct		0	100	(8): caged; direct		100	100
Boll weevil (188): uncaged; direct		0	100	Boll weevil (35): uncaged; direct		100	31
American cockroach (71): caged; direct		0	99	American cockroach (10): caged; residue		40	100
German cockroach (13): caged; direct		8	100	German cockroach (16): caged; residue		75	100
Brown dog tick (10): uncaged; direct		0	90	Brown dog tick (7): caged; direct		71	100
Alfalfa weevil (2): caged; direct			100	(8): caged; residue		0	100
Carbaryl (42.5%)	1.0			<i>d</i> -Phenothrin (30.9%)	0.5		
Tobacco budworm (10): uncaged; direct			80	Stable fly (51): caged; direct		100	100
Boll weevil (26): uncaged; direct			96	House fly (77): caged; direct		100	100
American cockroach (44): caged; direct			100	Tobacco budworm (45): uncaged; direct		100	100
Brown dog tick (7): uncaged; direct			100	Boll weevil (227): uncaged; direct		67	81
Alfalfa weevil (1): caged; direct			100	American cockroach (63): caged; direct		52	22
Mexican bean beetle (11): caged; direct			100	Brown dog tick (17): caged; direct		35	76
Chlorpyrifos-methyl (40.0%)	2.0			Yellow fever mosquito (135): caged; direct		100	100
Tobacco budworm (21): uncaged; direct		25	95	<i>d</i> -Phenothrin (30.0%)	1.0		
(15): caged; residue		30	93	Stable fly (45): caged; residue		100	100
Boll weevil (315): uncaged; direct		95	100	House fly (44): caged; residue		100	100
(83): caged; residue		100	100	Tobacco budworm (8): uncaged; direct		100	100
Alfalfa weevil (10): caged; direct		0	100	(8): caged; residue		100	100
(12): caged; residue		80	100	Boll weevil (40): uncaged; direct		100	26
Brown dog tick (15): caged; direct		0	100	American cockroach (11): caged; direct		73	64
(30): caged; residue		0	97	(9): caged; residue		56	100
Chlorphoxim (85.0%)	1.0			German cockroach (13): caged; direct		92	100
Tobacco budworm (48): uncaged; direct			27	(23): caged; residue		100	100
Boll weevil (128): uncaged; direct			98	Brown dog tick (7): caged; direct		100	100
American cockroach (30): caged; direct			80	(8): caged; residue		0	100
Brown dog tick (2): caged; direct			100	Phosmet (50.0%)	0.5		
Alfalfa weevil (1): uncaged; direct			100	Tobacco budworm (16): uncaged; direct		0	6
				Boll weevil (25): uncaged; direct		0	100
				Brown dog tick (2): caged; direct		0	100
				Yellow fever mosquito (13): caged; direct		0	92

Phosmet (50.0%)	1.0		Sandoz SAN 52-135 (85.0%)	1.0	
Stable fly (92): caged; direct		1 100	Stable fly (20): caged; direct		100 100
(46): caged; residue		0 100	(63): caged; residue		51 100
House fly (71): caged; direct		0 31	House fly (58): caged; direct		0 79
(42): caged; residue		0 100	(40): caged; residue		0 100
Tobacco budworm (60): uncaged; direct		0 5	Tobacco budworm (45): uncaged; direct		0 60
(8): caged; residue		0 13	(10): caged; residue		0 100
Boll weevil (192): uncaged; direct		23 100	Boll weevil (214): uncaged; direct		100 100
American cockroach (53): caged; direct		0 45	American cockroach (65): caged; direct		0 98
(12): caged; residue		0 100	(17): caged; residue		0 100
German cockroach (16): caged; residue		13 100	German cockroach (7): caged; direct		0 100
Brown dog tick (17): caged; direct		0 65	(13): caged; residue		0 100
(8): caged; residue		0 100	Brown dog tick (7): caged; direct		0 100
Yellow fever mosquito (112): caged; direct		24 87	(1): uncaged; direct		0 100
			(11): caged; residue		0 100
			Yellow fever mosquito (47): caged; direct		0 100
Pirimiphos-methyl (30.0%)	0.5		Alfalfa weevil (2): caged; direct		100 100
Stable fly (41): caged; direct		24 100	Mexican bean beetle (9): caged; direct		100 100
House fly (35): caged; direct		0 0			
Tobacco budworm (29): uncaged; direct		0 21	Bay Hox 1619 (28.33%) + Resmethrin (10.00%) +		
Boll weevil (64): uncaged; direct		0 97	Sandoz SAN 52-135 (28.33%)	1.0	
Brown dog tick (14): caged; direct		0 43	Tobacco budworm (56): uncaged; direct		100 100
Yellow fever mosquito (166): caged; direct		98 100	Boll weevil (79): uncaged; direct		100 100
			American cockroach (30): caged; direct		97 100
			Brown dog tick (4): uncaged; direct		100 100
Pirimiphos-methyl (30.0%)	1.0				
Stable fly (59): caged; direct		22 100	Carbaryl (42.5%) + DDT (42.5%)	0.5	
(48): caged; residue		60 100	Stable fly (51): caged; direct		90 100
House fly (91): caged; direct		2 15	House fly (135): caged; direct		19 20
(35): caged; residue		0 83	Tobacco budworm (51): uncaged; direct		0 55
Tobacco budworm (43): caged; direct		0 60	Boll weevil (167): uncaged; direct		45 90
(7): caged; residue		0 100	American cockroach (14): caged; direct		0 50
Boll weevil (210): caged; direct		36 98	German cockroach (14): caged; direct		0 7
American cockroach (24): caged; direct		0 54	Brown dog tick (16): caged; direct		0 100
(14): caged; residue		0 64	Yellow fever mosquito (206): caged; direct		51 100
German cockroach (12): caged; residue		0 58			
Brown dog tick (15): caged; direct		0 47	Carbaryl (42.5%) + DDT (42.5%)	1.0	
(8): caged; residue		0 100	Stable fly (21): caged; direct		90 100
Yellow fever mosquito (124): caged; direct		81 100	(68): caged; residue		100 100
			House fly (39): caged; direct		0 0
Pyrethrins (5.0% on Microcel E)	2.0		(38): caged; residue		0 68
Tobacco budworm (10): uncaged; direct		30 10	Tobacco budworm (68): uncaged; direct		0 99
(10): caged; residue		0 20	(9): caged; residue		0 100
Boll weevil (12): uncaged; direct		100 98	Boll weevil (72): uncaged; direct		50 88
(72): caged; residue		60 46	American cockroach (44): caged; direct		0 70
Alfalfa weevil (5): caged; direct		40 0	(10): caged; residue		0 100
Brown dog tick (4): caged; direct		30 50	German cockroach (14): caged; direct		0 50
(6): caged; residue		0 0	(15): caged; residue		0 100
			Brown dog tick (7): caged; direct		0 100
R-26375 (40.0%)	1.0		(4): uncaged; direct		100 100
Stable fly (32): caged; direct		78 100	(8): caged; residue		0 100
House fly (91): caged; direct		7 25	Yellow fever mosquito (56): caged; direct		89 100
Tobacco budworm (23): uncaged; direct		0 13	Alfalfa weevil (1): caged; direct		0 0
Boll weevil (209): uncaged; direct		65 94			
American cockroach (57): caged; direct		0 19	Carbaryl (42.5%) + Methoxychlor (42.5%)	1.0	
Brown dog tick (9): caged; direct		0 0	Tobacco budworm (25): uncaged; direct		100 100
Yellow fever mosquito (134): caged; direct		99 100	Boll weevil (107): uncaged; direct		100 100
			American cockroach (29): caged; direct		100 100
			Alfalfa weevil (1): caged; direct		0 0
Resmethrin (30.0%)	0.5				
Stable fly (46): caged; direct		100 100	Chlorpyrifos-methyl (20.0%) + Resmethrin (15.0%)	2.0	
House fly (69): caged; direct		100 93	Tobacco budworm (10): uncaged; direct		100 100
Tobacco budworm (38): uncaged; direct		100 100	(10): caged; residue		100 100
Boll weevil (191): uncaged; direct		69 89	Boll weevil (117): uncaged; direct		100 100
American cockroach (40): caged; direct		20 30	(114): caged; residue		100 100
Brown dog tick (10): caged; direct		30 70	Brown dog tick (5): caged; direct		0 100
Yellow fever mosquito (183): caged; direct		100 100	(5): caged; residue		100 100
Resmethrin (30.0%)	1.0		Cyhexatin (41.0%) + <i>d</i> -Phenothrin (15.0%)	1.0	
Tobacco budworm (67): uncaged; direct		100 100	Stable fly (78): caged; direct		100 100
Boll weevil (178): uncaged; direct		97 100	House fly (90): caged; direct		100 100
American cockroach (71): caged; direct		8 8	Tobacco budworm (28): uncaged; direct		100 100
Brown dog tick (1): uncaged; direct		100 100	Boll weevil (36): uncaged; direct		94 92
Alfalfa weevil (6): caged; direct		100 100	American cockroach (19): caged; direct		58 26
			Brown dog tick (9): caged; direct		66 89
Resmethrin (30.0%)	2.0		Yellow fever mosquito (32): caged; direct		100 100
Tobacco budworm (20): uncaged; direct		100 100			
(16): caged; residue		100 100	Methoxychlor (42.5%) + Stirofos (40.0%)	1.0	
Boll weevil (158): uncaged; direct		100 100	Tobacco budworm (20): uncaged; direct		60 60
(97): caged; residue		0 37	Boll weevil (90): uncaged; direct		95 95
Alfalfa weevil (10): caged; direct		100 100	American cockroach (29): caged; direct		0 0
(5): caged; residue		100 100	Brown dog tick (4): uncaged; direct		100 100
Brown dog tick (9): caged; direct		90 100			
(20): caged; residue		50 85			
Sandoz SAN 52-135 (85.0%)	0.5				
Stable fly (62): caged; direct		81 100			
House fly (123): caged; direct		24 23			
Tobacco budworm (32): uncaged; direct		6 12			
Boll weevil (175): uncaged; direct		0 93			
American cockroach (26): caged; direct		0 100			
German cockroach (12): caged; direct		0 100			
Brown dog tick (28): caged; direct		0 46			
Yellow fever mosquito (256): caged; direct		24 100			

<i>d</i> -Phenothrin (15.0%) + Pirimiphos-methyl (15.0%) 1.0			
Stable fly (41): caged; direct		100	100
(72): caged; residue	100	100	
House fly (106): caged; direct		100	
(51): caged; residue	2	100	
Tobacco budworm (19): uncaged; direct		100	
(10): caged; residue	0	100	
American cockroach (14): caged; direct		7	29
(17): caged; residue	0	82	
German cockroach (37): caged; direct	59	91	
(16): caged; residue	32	100	
Brown dog tick (16): caged; direct		100	
(8): caged; residue	0	100	
<i>d</i> -Phenothrin (15.0) + Sandoz SAN 52-135 (42.5%) 1.0			
Stable fly (41): caged; direct	100	100	
(60): caged; residue	100	100	
House fly (61): caged; direct	100	100	
(35): caged; residue	37	100	
Tobacco budworm (27): uncaged; direct	100	100	
(9): caged; residue	56	100	
American cockroach (16): caged; direct	19	37	
(9): caged; residue	0	100	
German cockroach (38): caged; direct	79	100	
(20): caged; residue	55	100	
Brown dog tick (10): caged; direct	100	100	
(8): caged; residue	0	100	
<i>d</i> -Phenothrin (10.0%) + Phosmet (16.66%) + Sandoz SAN 52-135 (28.33%) 1.0			
Stable fly (97): caged; direct	100	100	
House fly (122): caged; direct	100	100	
Tobacco budworm (10): uncaged; direct	100	100	
American cockroach (20): caged; direct	5	0	
German cockroach (18): caged; direct	100	100	
Brown dog tick (5): caged; direct	100	100	
<i>d</i> -Phenothrin (10.0%) + Pirimiphos-methyl (10.0%) + Sandoz SAN 52-135 (28.33%) 1.0			
Stable fly (42): caged; direct	100	100	
House fly (65): caged; direct	100	100	
Tobacco budworm (6): uncaged; direct	100	100	
American cockroach (12): caged; direct	0	100	
German cockroach (39): caged; direct	90	100	
Brown dog tick (24): caged; direct	8	100	
Pirimiphos-methyl (15%) + Sandoz SAN 52-135 (42.5%) 1.0			
Stable fly (56): caged; direct	89	100	
House fly (74): caged; direct	95	100	
American cockroach (17): caged; direct	0	28	
German cockroach (68): caged; direct	0	99	
Brown dog tick (10): caged; direct	80	100	
Propoxur (32.0%) + Stirofos (40.0%) 1.0			
Tobacco budworm (26): uncaged; direct		69	
Boll weevil (226): uncaged; direct		100	
American cockroach (70): caged; direct		96	
Alfalfa weevil (6): caged; direct		100	
Brown dog tick (3): uncaged; direct		100	

Resmethrin (15.0%) + Sandoz SAN 52-135 (42.5%) 1.0			
Stable fly (18): caged; direct	100	100	
House fly (42): caged; direct	100	100	
Tobacco budworm (23): uncaged; direct	100	100	
American cockroach (12): caged; direct	8	25	
German cockroach (33): caged; direct	30	100	
Brown dog tick (17): caged; direct	0	100	
Controls - Hi Sil 233			
Tobacco budworm (10): caged; direct	0	0	
(10): caged; direct	0	0	
Boll weevil (129): caged; direct	0	4	
(111): caged; direct	0	3	
Alfalfa weevil (5): caged; direct	0	0	
Brown dog tick (1): caged; direct	0	0	
(5): caged; direct	0	0	
Controls - Exposed in untreated trailers for 30 min during test period			
Stable fly (56): caged; direct		4	
(63): caged; residue		3	
House fly (55): caged; direct		0	
(53): caged; residue		6	
Tobacco budworm (89): caged; direct		4	
(8): caged; residue		0	
Boll weevil (262): caged; direct		5	
American cockroach (26): caged; direct		4	
(15): caged; residue		0	
German cockroach (25): caged; direct		0	
(25): caged; residue		4	
Brown dog tick (40): caged; direct		0	
(9): caged; residue		0	
Yellow fever mosquito (43): caged; direct		12	
Alfalfa weevil (24): caged; direct		0	
Mexican bean beetle (11): caged; direct		9	

a) Caged insects (with exception of cockroaches and ticks) exposed in 14 x 16-mesh wire screen cages in a horizontal position.

b) The American and German cockroaches were exposed in 1 qt Mason jars covered with a cloth netting.

c) The ticks were exposed in small glass jars covered with a 20-mesh cloth cover.

Table 3. -- The effectiveness of several selected insecticidal aerosols against some agricultural insects. Pests exposed in 1669-2665 ft<sup>3</sup> tractor trailers

Allethrin (2.0%)	5			<i>d</i> -Phenothrin (2.0%)	10		
Tobacco budworm (4); uncaged		75	75	Stable fly (241)		100	99
Alfalfa weevil (5)		100	0	House fly (137)		100	100
Brown dog tick (7)		100	100	Tobacco budworm (5); uncaged		60	80
Tobacco budworm (10); uncaged	30	100	100	Boll weevil (177)		61	76
Boll weevil (67); uncaged		100	88	(227)		39	73
Alfalfa weevil (5)		0	0	American cockroach (88)		28	51
Brown dog tick (5)		0	20	Brown dog tick (21)		33	71
<i>d-trans</i> -Allethrin (2.0%)	5			"Prothrin" (1.2%)	5		
Tobacco budworm (5)		80	60	Tobacco budworm (31); uncaged		50	74
Alfalfa weevil (5)		0	0	Boll weevil (235); uncaged		5	57
Brown dog tick (5)		0	20	American cockroach (40)		15	53
<i>d-trans</i> -Allethrin (10.0%)	10			Brown dog tick (14)		0	0
Tobacco budworm (15); uncaged		100	100	Alfalfa weevil (9)		0	33
Boll weevil (98)		50	81	"Prothrin" (2.0%)	5		
Alfalfa weevil (5)		0	60	Tobacco budworm (14); uncaged		0	86
Brown dog tick (10)		100	100	Boll weevil (47); uncaged		50	34
Tobacco budworm (15)	30	100	100	American cockroach (40)			30
Boll weevil (138)		100	100	Brown dog tick (1)			100
Alfalfa weevil (5)		20	40	Resmethrin (1.2%)	5		
Brown dog tick (9)		50	100	Tobacco budworm (13); uncaged		100	92
Bay Hox 1619 (0.5%)	10			Boll weevil (154); uncaged		60	42
Stable fly (211)		14	100	American cockroach (40)		60	78
House fly (87)		38	40	Brown dog tick (11)		0	0
Tobacco budworm (85); uncaged		71	66	Alfalfa weevil (7)		0	0
Boll weevil (99); uncaged		40	71	Mexican bean beetle (10)		0	30
American cockroach (35)		0	3	Resmethrin (1.2%)	10		
Brown dog tick (9)		0	33	Stable fly (152)		100	70
Bay Hox 1619 (2.0%)	10			House fly (97)		99	97
Stable fly (119)		16	82	Tobacco budworm (16); uncaged		37	69
House fly (112)		26	29	Boll weevil (185); uncaged		18	61
Tobacco budworm (16); uncaged		0	25	American cockroach (26)		4	15
Boll weevil (116); uncaged		25	46	Brown dog tick (10)		0	60
American cockroach (57)		0	9	Resmethrin (2.0%)	5		
German cockroach (29)		0	17	Tobacco budworm (19); uncaged			95
Brown dog tick (26)		0	27	Boll weevil (54); uncaged			52
Phenothrin (0.5%)	10			American cockroach (40)			98
Stable fly (128)		98	100	Brown dog tick (10)			10
House fly (134)		69	53	Alfalfa weevil (5)			0
Tobacco budworm (19); uncaged		11	26	Resmethrin (2.0%)	10		
Boll weevil (267); uncaged		32	77	Stable fly (140)		100	100
American cockroach (49)		4	18	House fly (87)		100	99
German cockroach (17)		0	18	Tobacco budworm (11); uncaged		64	82
Brown dog tick (23)		4	17	Boll weevil (152); uncaged		40	58
Phenothrin (2.0%)	10			American cockroach (25)		44	44
Stable fly (111)		100	98	Brown dog tick (10)		50	100
House fly (99)		96	62	Resmethrin (10.9%)	10		
Tobacco budworm (7)		57	57	Tobacco budworm (15); uncaged		100	100
Boll weevil (290); uncaged		17	77	Boll weevil (148); uncaged		100	100
American cockroach (24)		12	21	Alfalfa weevil (1)			100
Brown dog tick (10)		0	30	Brown dog tick (10)		100	100
<i>d</i> -Phenothrin (1.2%)	5			Tobacco budworm (15); uncaged	30	100	100
Tobacco budworm (15); uncaged		40	73	Boll weevil (55); uncaged		100	100
Boll weevil (101); uncaged		10	74	Alfalfa weevil (5)		100	100
American cockroach		95	95	Brown dog tick (10)		60	100
Brown dog tick (12)		80	8	<i>d-cis</i> -Resmethrin (1.2%)	5		
Alfalfa weevil (4)		0	0	Tobacco budworm (25); uncaged		100	100
<i>d</i> -Phenothrin (0.5%)	10			Boll weevil (205); uncaged		20	53
Stable fly (109)		100	94	American cockroach (40)		75	70
House fly (119)		83	29	Brown dog tick (13)		100	77
Tobacco budworm (5); uncaged		0	100	Alfalfa weevil (8)		0	13
Boll weevil (282); uncaged		47	70	Mexican bean beetle (10)		90	100
American cockroach (45)		20	9	<i>d-cis</i> -Resmethrin (2.0%)	5		
Brown dog tick (11)		18	27	Tobacco budworm (40); uncaged			100
<i>d</i> -Phenothrin (2.0%)	5			Boll weevil (306); uncaged			78
Tobacco budworm (50); uncaged			94	American cockroach (80)			99
Boll weevil (345); uncaged			88	Brown dog tick (9)			100
American cockroach (120)			92	Alfalfa weevil (9)			33
Brown dog tick (41)			28	<i>d-cis</i> Resmethrin (2.0%)	10		
Alfalfa weevil (10)		0	0	Tobacco budworm (14); uncaged			100
				Boll weevil (69); uncaged			99
				American cockroach (40)			100
				Brown dog tick (9)			100

<i>d-trans</i> -Resmethrin (1.2%)	5			<i>d-trans</i> -Allethrin (1.0%) + Methoxychlor (3.0%)	5		
Tobacco budworm (14); uncaged		100	100	Tobacco budworm (13); uncaged		95	100
Boll weevil (127); uncaged		100	94	Boll weevil (140); uncaged		50	99
American cockroach (40)		75	83	American cockroach (40)		90	98
Brown dog tick (6)		100	17	Alfalfa weevil (10)		0	40
Alfalfa weevil (3)		10	0	Mexican bean beetle (10)		0	90
Mexican bean beetle		0	56				
<i>d-trans</i> -Resmethrin (1.2%)	10			<i>d-trans</i> -Allethrin (1.0%) + Methoxychlor (3.0%)	10		
Stable fly (54)		100	100	Tobacco budworm (13); uncaged		95	85
House fly (49)		100	100	Boll weevil (222); uncaged		50	49
Tobacco budworm (9); uncaged		100	100	American cockroach (40)		90	98
Boll weevil (252); uncaged		30	96	Brown dog tick (8)		20	13
American cockroach (17)		12	41	Alfalfa weevil (2)		0	100
Brown dog tick (10)		20	50	Mexican bean beetle (7)		50	100
<i>d-trans</i> -Resmethrin (2.0%)	5			<i>d-trans</i> -Allethrin (1.0%) + Methoxychlor (3.0%)	30		
Tobacco budworm (66); uncaged		100	100	Tobacco budworm (12); uncaged		80	92
Boll weevil (233); uncaged		100	58	Boll weevil (79); uncaged		80	84
American cockroach (80)		100	71	American cockroach (40)		33	100
Brown dog tick (17)		35	53	Brown dog tick (3)			100
Alfalfa weevil (5)			0	Alfalfa weevil (22)			5
<i>d-trans</i> -Resmethrin (2.0%)	10			<i>d-trans</i> -Allethrin (5.0%) + Resmethrin (5.0%)	10		
Stable fly (126)		100	91	Tobacco budworm (5); uncaged		100	100
House fly (113)		100	100	Alfalfa Weevil (5)		0	60
Tobacco budworm (4); uncaged		100	100	Brown dog tick (5)		0	60
Boll weevil (137); uncaged		59	71	Tobacco budworm (5); uncaged		30	100
American cockroach (30)		20	37	Alfalfa weevil (5)		100	100
Brown dog tick (11)		36	18	Brown dog tick (4)		80	100
<i>d-trans</i> -Resmethrin (10.0%)	10			Bay Hox 1619 (2.0%) + S-2539 Forte (2.0)	10		
Tobacco budworm (17); uncaged		100	100	Stable fly (61)		100	100
Boll weevil (108)		100	97	House fly (97)		100	100
Alfalfa weevil (4)		40	100	Tobacco budworm (8) uncaged		100	75
Brown dog tick (9)		50	89	American cockroach (10)		20	30
Tobacco budworm (14); uncaged		100	100	German cockroach (12)		17	58
Boll weevil (83); uncaged		100	100	Brown dog tick (11)		0	100
Alfalfa weevil (5)		80	100				
Brown dog tick (11)		80	100				
RU-11679 (1.2%)	5			<i>d-Phenothrin</i> (2.0%) + Sandoz SAN 52-135 (2.0%)	10		
Tobacco budworm (30); uncaged		67	73	Stable fly (45)		100	100
Boll weevil (576); uncaged		53	69	House fly (82)		100	100
American cockroach (80)		86	88	Tobacco budworm (3); uncaged		100	100
Brown dog tick (16)		69	0	American cockroach (20)		5	15
Alfalfa weevil (11)		0	9	German cockroach (17)		6	82
Mexican bean beetle (20)		50	55	Brown dog tick (6)		0	100
RU-11679 (2.0%)	5			Control - Insects in untreated van during test period			
Tobacco budworm (89); uncaged			97	Stable fly (34)			9
Boll weevil (282); uncaged			73	House fly (64)			0
American cockroach (160)			100	Tobacco budworm (59)			5
Brown dog tick (36)			50	(13); uncaged			0
Alfalfa weevil (8)			0	Boll weevil (367)			4
				(38); uncaged			26
RU-11679 (2.0%)	10			American cockroach (161)			10
Tobacco budworm (15); uncaged			93	German cockroach (9)			0
Boll weevil (41); uncaged			81	Brown dog tick (60)			0
American cockroach (40)			100	Alfalfa weevil (30)			7
Brown dog tick (8)			88	Mexican bean beetle (7)			43
Sandoz SAN 52-135 (0.5%)	10						
Stable fly (144)		94	100	a) Caged unless noted. Caged insects (with exception of cockroaches and ticks) exposed in 14 x 16-mesh wire screen cages in a horizon- tal position.			
House fly (78)		0	29	b) The American and German cockroaches were exposed in 1 qt Mason jars covered with a cloth netting.			
Tobacco budworm (19); uncaged		0	0	c) The ticks were exposed in small glass jars covered with a 20-mesh cloth cover.			
Boll weevil (116); uncaged		65	84				
American cockroach (33)		3	12				
Brown dog tick (11)		0	55				
Sandoz SAN 52-135 (2.0%)	10						
Stable fly (253)		92	98				
House fly (182)		12	41				
Tobacco budworm (25); uncaged		8	24				
Boll weevil (214); uncaged		33	59				
American cockroach (40)		2	22				
German cockroach (14)		21	21				
Brown dog tick (21)		5	76				

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