



**Suggested
Insecticides
for
Managing
Cotton
Insects**

**in the Lower Rio Grande Valley
2007**

This publication is to be used with E-7, "Managing Cotton Insects in the Lower Rio Grande Valley, 2007."

Suggested Insecticides for Managing Cotton Insects in the Lower Rio Grande Valley

Boris A. Castro, Manda Cattaneo and C. G. Sansone*

A committee of state and federal research scientists and Extension specialists meets annually to review cotton pest management research and management guidelines. Guidelines are revised at this meeting to reflect the latest proven techniques for maximizing profits for the Texas cotton producer by optimizing inputs and production.

Management of Cotton Pests

The proper management of cotton pests is dependent upon the use of pest management principles. Pest management does not rely solely on insecticides. Therefore, the USER of this insert is strongly encouraged to refer to E-7 for discussion of pest biology, scouting techniques, economic thresholds, insecticide resistance management, conservation of existing natural control agents, overall crop management practices which do not promote pest problems, ovicide use, microbial insecticide use, and guidelines for protecting bees from insecticides.

Insecticide Resistance Management

Experience has shown that relying on a single class of insecticides that act in the same way may cause pests to develop resistance to the entire group of insecticides. To delay resistance, it is strongly recommended that growers use IPM principles and integrate other control methods into insect or mite control programs. One way to help prevent pest resistance is to rotate the use of insecticide groups in order to take advantage of different modes of action. In addition, do not tank-mix products from the same insecticide class. These management practices should delay the development of resistance and provide better overall insect control.

Insecticides with similar chemical structures act on insects in similar ways. For example, pyrethroids (including esfenvalerate, bifenthrin, cyfluthrin, cyhalothrin and tralomethrin) all act on an insect's nervous system in the same way. Other types of insecticides such as organophosphates (methyl parathion, dicrotophos) or carbamates (thiodicarb) also affect the insect's nervous system, but in a different way than do the pyrethroids.

The Insecticide Resistance Action Committee (IRAC) has developed a mode of action classification system that is based on a numbering system (see <http://www.irc-online.org/>). This system makes it simpler for producers and consultants to determine different modes of action among the insecticides. Insecticides with the same number (e.g., 1) are considered to have the same mode of action. Producers should rotate among different numbers where appropriate to delay resistance. The IRAC numbering system is used in this publication to assist producers with their choices.

Policy Statement for Making Insecticide Use Recommendations

This is not a complete listing of all products or their uses registered for cotton. The insecticides and their suggested use patterns included in this publication reflect a consensus of opinion of Extension entomologists based on field tests. The data from

these field tests met the minimum requirements as outlined in the Guidelines for the Annual Entomology Research Review and Extension Guide Revision Conference. Products listed must conform to our performance standards and avoid undue environmental consequences.

Suggested insecticide use rates have exhibited sufficient efficacy in tests to be effective in providing adequate control in field situations. However, it is impossible to eliminate all risks. Conditions or circumstances that are unforeseen or unexpected may result in less than satisfactory results. Texas Cooperative Extension will not assume responsibility for such risks. Such responsibility shall be assumed by the user of this publication.

Suggested pesticides must be registered and labeled for use by the Environmental Protection Agency and the Texas Department of Agriculture. The status of pesticide label clearances is subject to change and may have changed since this publication was printed. The USER is always responsible for the effects of pesticide residues on his livestock and crops as well as problems that could arise from drift or movement of the pesticide.

Always read and follow carefully the instructions on the container label. Pay particular attention to those practices which ensure worker safety. For additional information, contact your county Extension staff or write the Extension Entomologist, Department of Entomology, Texas A&M University, College Station, TX 77843; or call (979) 845-7026.

Endangered Species Regulations

The Endangered Species Act is designed to protect and to assist in the recovery of animals and plants that are in danger of becoming extinct. In response to the Endangered Species Act, many pesticide labels now carry restrictions limiting the use of products or application methods in designated biologically sensitive areas. These restrictions are subject to change. Refer to the Environmental Hazards or Endangered Species discussion sections of product labels and/or call your county Extension agent or Fish and Wildlife Service personnel to determine what restrictions apply to your area. Regardless of the law, pesticide users can be good neighbors by being aware of how their actions may affect people and the environment.

Worker Protection Standard

The Worker Protection Standard (WPS) is a set of federal regulations that applies to all pesticides used in agricultural plant production. If you employ any person to produce a plant or plant product for sale and apply any type of pesticide to that crop, WPS applies to you. The WPS requires you to protect your employees from pesticide exposure. It requires you to provide three basic types of protection: You must inform employees about exposure, protect employees from exposure, and mitigate pesticide exposures that employees might receive. The WPS requirement will appear in the "DIRECTIONS FOR USE" part of the label. For more detailed information consult EPA publication 735-B-93-001 (GPO #055-000-0442-1) *The Worker Protection Standard for Agricultural Pesticides — How to Comply: What Employers Need to Know*, or call Texas Department of Agriculture, Pesticide Worker Protection Program, (512) 463-7717.

*Extension Entomologist, Extension agent-IPM and Extension Entomologist, respectively, The Texas A&M University System.

Table 1. Insecticide suggestion table.

Pest	Insecticides (listed alphabetically)	Insecticide MOA ¹	Pounds active ingredient per acre ²	Formulated amount per acre	Precaution status ³	Re-entry interval (hrs) ⁴	Honey bee hazard ⁵	
Cutworms	Bifenthrin	3	0.04-0.10	2.6-6.4 oz	W	12	H	
	Chlorpyrifos 4E	1B	0.75-1.0	24.0-32.0 oz	W	24	H	
	Beta-cyfluthrin (Baythroid® XL)	3	0.00625-0.0125	0.8-1.6 oz	D	12	H	
	Cyhalothrin 1.0 EC	3	0.02-0.03	2.56-3.84 oz	D	24	H	
	Cyhalothrin 2.08 CS		0.02-0.03	1.28-1.92 oz	W	24	H	
	Cypermethrin 2.5 E	3	0.025-0.1	1.3-5 oz	C	12	H	
	Deltamethrin (Decis® 1.5 E)	3	0.013-0.019	1.11-1.62 oz	D	12	H	
	Esfenvalerate (Asana XL® 0.66 E)	3	0.03-0.05	5.8-9.6 oz	W	12	H	
	Gamma-cyhalothrin (Proaxis® 0.5 E) (Prolex® 1.25 E)	3	0.0075-0.01 0.0075-0.01	1.92-2.56 oz 0.07-1.02 oz	C	24	H	
	Methyl Parathion (4 E)	1B	1	32 oz	D	4 days**	H	
	Zeta-cypermethrin (Mustang® Max 0.8E) (Mustang® 1.5 E)	3	0.008-0.012 0.016-0.024	1.28-1.92 oz 1.4-2.0 oz	W	12	H	
	Silverleaf Whitefly (Adults) (Adults and Immatures)‡	Endosulfan 3 E	2A	0.5-1.5	21-64 oz	D	24	M
		Bifenthrin 2 E + Acephate 75 S	3 + 1B	0.08 + 0.5	5.2 oz + 10.66 oz	W C	24	H
		Acephate 90 S			9 oz	C	24	H
Acephate 97				8 oz	C	24	H	
Fenpropathrin (Danitol® 2.4 E) + Acephate 75 S		3 + 1B	0.15 + 0.5	8 oz + 10.66 oz	W C	24	H	
Acephate 90 S				9 oz	C	24	H	
Acephate 97				8 oz	C	24	H	
Cotton Fleahopper		Acephate 75 S	1B	0.188-0.25	3.34-5.33 oz	C	24	H
		Acephate 90 S		0.225	4 oz	C	24	H
		Acephate 97		0.2425	4 oz	C	24	H
	Acetamiprid (Intruder® 70 WP)	4A	0.025-0.05	0.6-1.1 oz	C	12	H	
	Chlorpyrifos 4 E	1B	0.19-0.5	6-16 oz	W	24	H	
	Dicrotophos (Bidrin® 8 E)	1B	0.05-0.1	0.8-1.6 oz	D	48**	H	
	Dimethoate 2.67 E	1B	0.11-0.22	5.3-10.7 oz	W	12	H	
	Dimethoate 4 E		0.125-0.25	4-8 oz	W	12	H	
	Dimethoate 5 E		0.125-0.25	3.2-6.4 oz	D	48	H	
	Imidacloprid (Provado® 1.6 F) (Trimax® Pro 4.4 SC)	4A	0.047 0.062	3.75 oz 1.8 oz	C C	12 12	H H	
	Indoxacarb (Steward® 1.25 SC)	22	0.09-0.11	9.2-11.3 oz	C	12	H	
	Methomyl (Lannate® 2.4 LV)	1A	0.113-0.225	6-12 oz	D	72	H	
	Methyl Parathion 4 E	1B	0.1	3.2 oz	D	4 days**	H	
	Oxamyl (Vydate® 2 L) (Vydate® 3.77 C-LV)	1A	0.25 0.25	16 oz 8.5 oz	D D	48 48	H H	
	Thiamethoxam (Centric® 40 WG)	4A	0.031-0.0625	1.25-2.5 oz	C	12	H	
	Cotton Aphids	Acetamiprid (Intruder® 70 WP)	4A	0.025-0.05	0.6-1.1 oz	C	12	H
		Chlorpyrifos 4 E	1B	0.25-1.0	8-32 oz	W	24	H
		Dicrotophos (Bidrin® 8E)	1B	0.25-0.5	4-8 oz +	D	48**	H
Dicrotophos (Bidrin® 8E) + Profenofos (Curacron® 8 E)		1B + 1B	0.25-0.5 +	4-8 oz +	D+W	48**	H	
Dimethoate 2.67 E		1B	0.11-0.22	5.3-10.7 oz	W	12	H	
Dimethoate 4 E			0.125-0.25	4-8 oz	W	12	H	
Dimethoate 5 E			0.125-0.25	3.2-6.4 oz	D	48	H	
Imidacloprid (Provado® 1.6 F) (Trimax® Pro 4.4 SC)		4A	0.047 0.062	3.75 oz 1.8 oz	C C	12 12	H H	

continued

Table 1. Insecticide suggestion table. (continued)

Pest	Insecticides (listed alphabetically)	Insecticide MOA ¹	Pounds active ingredient per acre ²	Formulated amount per acre	Precaution status ³	Re-entry interval (hrs) ⁴	Honey bee hazard ⁵	
Spider Mites	Methomyl (Lannate® 2.4 LV)	1A	0.225	12 oz	D	72	H	
	Methyl Parathion 4 E	1B	0.25-0.375	8-12 oz	D	4 days**	H	
	Profenofos (Curacron® 8 E)	1B	0.5	8 oz	W	48**	H	
	Thiamethoxam (Centric® 40 WG)	4A	0.031-0.05	1.25-2 oz	C	12	H	
	Avermectin B ₁ 0.15 E	6	0.01-0.02	8-16 oz.	W	48	H	
	Dicofol (Kelthane® 4MF)	20	0.75-1.5	24-48 oz	C	12	R	
	Profenofos (Curacron® 8 E)	1B	0.5-0.75	8-12 oz	W	48**	H	
Boll Weevil (Overwintered)	Propargite (Comite® 6.55 E)	14	0.8-1.6	16-32 oz	D	24	R	
	Endosulfan 3 E	2A	0.5-1.5	21-64 oz	D	48	M	
	Malathion (Fyfanon® ULV 9.9)	1B	0.61-1.22	8-16 oz	C	12	H	
	Methyl Parathion 4 E	1B	0.25-0.5	8-16 oz	D	4 days**	H	
	Methyl Parathion encapsulated (Penncap M® 2 F)	1B	0.25-0.5	16-48 oz	W	4 days**	H	
	Oxamyl (Vydate® 2 L)	1A	0.25	16 oz	D	48	H	
	(Vydate® 3.77 C-LV)		0.25	8.5 oz	D	48	H	
	(In-season)	Dicrotophos (Bidrin® 8 E)	1B	0.5	8 oz	D	48**	H
		Endosulfan 3 E	2A	0.5-1.5	21-64 oz	D	48	M
		Malathion (Fyfanon® ULV 9.9)	1B	0.92-1.22	12-16 oz	C	12	H
Methyl Parathion 4 E		1B	0.375-0.5	12-16 oz	D	4 days**	H	
Methyl Parathion encapsulated (Penncap M® 2 F)		1B	0.25	16 oz	W	4 days**	H	
Oxamyl (Vydate® 2 L)		1A	0.25	16 oz	D	48	H	
(Vydate® 3.77 C-LV)			0.25	8.5 oz	D	48	H	
Bollworm and Tobacco Budworm (Eggs)		(Use only with a larvicide, see ovicide section in E-7.)						
		Methomyl (Lannate® 2.4 LV)	1A	0.113-0.225	6-12 oz	D	72	H
		Profenofos (Curacron® 8 E)	1B	0.125-0.25	2-4 oz	W	48**	H
	Thiodicarb (Larvin® 3.2 F)	1A	0.125-0.25	5-10 oz	W	12	M	
	(Bollworm Larvae)	Acephate 75 S	1B	1	21.33 oz	C	24	H
		Acephate 90 S			17.7 oz	C	24	H
		Acephate 97			16.5 oz	C	24	H
		<i>Bacillus thuringiensis</i> (See listing in Table 2. See "Microbial Insecticides" section in E-7.)						
		Bifenthrin 2 E***	3	0.04-0.10	2.6-6.4 oz	W	12	H
		Beta-cyfluthrin*** (Baythroid® XL)	3	0.0125-0.02	1.6-2.6 oz	D	12	H
	Cyfluthrin*** + Imidacloprid (Leverage® 2.7 SE)	3 + 4A	0.032 +	3.75 oz	W	12	H	
	Cyhalothrin 1.0 EC***	3	0.025-0.04	3.2-5.12 oz	D	24	H	
	Cyhalothrin 2.08 CS		0.025-0.04	1.6-2.56 oz	W	24	H	
	Cypermethrin 2.5 E***	3	0.04-0.1	2-5 oz	C	12	H	
	Deltamethrin*** (Decis® 1.5 E)	3	0.019-0.03	1.62-2.56 oz	D	12	H	
	Esfenvalerate*** (Asana XL® 0.66 E)	3	0.03-0.05	5.8-9.6 oz	W	12	H	
	Gamma-cyhalothrin (Proaxis® 0.5 E) (Prolex® 1.25 E)	3	0.0125-0.02 0.0125-0.02	3.20-5.12 oz 1.28-2.05 oz	C	24	H	
	Indoxacarb (Steward® 1.25 SC)	22	0.09-0.11	9.2-11.3 oz	C	12	H	

continued

Table 1. Insecticide suggestion table. (continued)

Pest	Insecticides (listed alphabetically)	Insecticide MOA ¹	Pounds active ingredient per acre ²	Formulated amount per acre	Precaution status ³	Re-entry interval (hrs) ⁴	Honey bee hazard ⁵	
(Tobacco Budworm Larvae)	Methomyl (Lannate® 2.4 LV)	1A	0.45	24 oz	D	72	H	
	Methoxyfenozide (Intrepid® 2 F)	18	0.25-0.38	16-24 oz	C	4	R	
	Methyl Parathion 4 E	1B	1.25-2	40-64 oz	D	4 days**	H	
	Profenofos (Curacron® 8 E)	1B	0.5-1.0	8-16 oz	W	48**	H	
	Spinosad (Tracer® 4 SC)	5	0.067-0.089	2.14-2.9 oz	C	4	H	
	Thiodicarb (Larvin® 3.2 F)	1A	0.6-0.9	24-36 oz	W	12	H	
	Zeta-cypermethrin*** (Mustang® Max 0.8E) (Mustang® 1.5E)	3	0.0165-0.0225 0.033-0.045	2.64-3.6 oz 2.8-3.8 oz	W	12	H	
	Acephate 75 S	1B	1	21.33 oz	C	24	H	
	Acephate 90 S			17.7 oz	C	24	H	
	Acephate 97			16.5 oz	C	24	H	
	<i>Bacillus thuringiensis</i> (See listing in Table 2. See "Microbial Insecticides" section in E-7.)							
		Emamectin benzoate (Denim® 0.16 EC)	6	0.01-0.015	8-12 oz	D	48	H
		Indoxacarb (Steward® 1.25 SC)	22	0.09-0.11	9.2-11.3 oz	C	12	H
		Methomyl (Lannate® 2.4 LV)	1A	0.45	24 oz	D	72	H
		Methoxyfenozide (Intrepid® 2 F)	18	0.25-0.38	16-24 oz	C	4	R
		Methyl Parathion (4 E)	1B	1.25-2.0	40-64 oz	D	72	H
		Profenofos (Curacron® 8 E)	1B	0.5-1.0	8-16 oz	W	48**	H
	Spinosad (Tracer® 4 SC)	5	0.067-0.089	2.14-2.9 oz	C	4	H	
	Thiodicarb (Larvin® 3.2 F)	1A	0.6-0.9	24-36 oz	W	12	M	
Plant Bug (<i>Creontiades signatus</i>)	Acephate 75 S	1B	0.5	10.66 oz	C	24	H	
	Acephate 90 S			9 oz	C	24	H	
	Acephate 97			8 oz	C	24	H	
	Bifenthrin 2 E***	3	0.04-0.1	2.6-6.4 oz	W	12	H	
	Beta-cyfluthrin*** (Baythroid® XL)	3	0.0125-0.02	1.6-2.6 oz	D	12	H	
	Cyfluthrin*** + Imidacloprid (Leverage® 2.7 SE)	3 + 4	0.032 + 0.047	3.75 oz	W	12	H	
	Cyhalothrin 1.0 EC***	3	0.02-0.03	2.56-3.84 oz	D	24	H	
	Cyhalothrin 2.08 CS		0.02-0.03	1.28-1.92 oz	W	24	H	
	Cypermethrin 2.5 E***	3	0.04-0.1	2-5 oz	C	12	H	
	Deltamethrin*** (Decis® 1.5 E)	3	0.013-0.019	1.11-1.62 oz	D	12	H	
	Dicrotophos (Bidrin® 8 E)	1B	0.5	8 oz	D	48	H	
	Dimethoate 2.67 E	1B	0.22	10.7 oz	W	12	H	
	Dimethoate 4 E		0.25	8 oz	W	12	H	
	Dimethoate 5 E		0.25	6.4 oz	D	48	H	
	Esfenvalerate*** (Asana XL® 0.66 E)	3	0.03-0.05	5.8-9.6 oz	W	12	H	
	Gamma-cyhalothrin*** (Proaxis® 0.5 E) (Prolex® 1.25 E)	3	0.01-0.015 0.01-0.015	2.56-3.84 oz 1.02-1.54 oz	C	24	H	
	Methomyl (Lannate® 2.4 LV)	1A	0.225	12 oz	D	72	H	
Methyl Parathion 4 E	1B	0.5-1.0	16-32 pt	D	4 days**	H		
Methyl Parathion encapsulated (PennCap M® 2 F)	1B	0.25	16 oz	W	4 days**	H		
Oxamyl (Vydate® 2 L) (Vydate® 3.77 C-LV)	1A	0.25 0.25	16 oz 8.5 oz	D D	48 48	H H		
Zeta-cypermethrin***	3							

continued

Table 1. Insecticide suggestion table. (continued)

Pest	Insecticides (listed alphabetically)	Insecticide MOA ¹	Pounds active ingredient per acre ²	Formulated amount per acre	Precaution status ³	Re-entry interval (hrs) ⁴	Honey bee hazard ⁵
Beet Armyworm	(Mustang [®] Max 0.8E)		0.0175-0.02	2.8-4.0 oz	W	12	H
	(Mustang [®] 1.5 E)		0.033-0.045	2.8-3.8 oz			
	Chlorpyrifos 4 E	1B	1	32 oz	W	24	H
	Diffubenzuron (Dimilin [®] 2 F)	15	0.0625-0.125	4-8 oz	C	12	R
	Indoxacarb (Steward [®] 1.25 SC)	22	0.09-0.11	9.2-11.3 oz	C	12	H
	Methomyl (Lannate [®] 2.4 LV)	1A	0.45	24 oz	D	72	H
	Methoxyfenozide (Intrepid [®] 2 F)	18	0.06-0.16	4-10 oz	C	4	R
	Profenofos (Curacron [®] 8 E)	1B	0.75-1.0	12-16 oz	W	48**	H
	Spinosad (Tracer [®] 4 SC)	5	0.067-0.089	2.14-2.9 oz	C	4	H
	Tebufenozide (Confirm [®] 2 F)	18	0.06-0.25	4-16 oz	C	4	R
	Thiodicarb (Larvin [®] 3.2F)	1A	0.6-0.9	24-36 oz	W	12	M

¹ Refer to Table 5 for Insecticide Resistance Action Committee (IRAC) Mode of Action classification.

² Refer to Table 2 for converting pounds active ingredient per gallon to acres per gallon and to Table 3 for converting percent active ingredient of dry insecticides to formulated insecticides per acre.

³ C=Caution; W=Warning; D-Danger

⁴ Time after application before re-entering fields without protective clothing. The wearing of protective clothing as described on the label may shorten the re-entry interval. In general, no insecticide label will have the statement "allow spray to dry" or "allow dust to settle" as a re-entry interval. However, there may be limited instances where EPA could grant a shorter re-entry interval than the minimum of 12 hours following application. Re-entry intervals are determined by the product's federal label or by Texas Department of Agriculture regulations and are subject to change.

⁵ H=highly toxic; M=moderately toxic; R=relatively non-toxic

* Refer to federal label for specific field re-entry instructions

** Re-entry interval increases from 48 to 72 hours or from 4 days to 5 days where the average annual rainfall is less than 25 inches.

*** The synthetic pyrethroid insecticides (examples include bifenthrin, deltamethrin, esfenvalerate, cyfluthrin, beta-cyfluthrin, cyhalothrin, tralomethrin, cypermethrin and zeta-cypermethrin) recommended for control of bollworms also will provide boll weevil control. However, application intervals similar to those recommended for the traditional phosphate insecticides (3 to 5 days under heavy pressure) are necessary to provide adequate control. When treatments are to be made for a bollworm-boll weevil complex, a suggested treatment regime is to use a pyrethroid followed 3 to 5 days later by a phosphate boll weevil insecticide. Since pyrethroids are not more effective than phosphates for boll weevil control, but are more effective for bollworm control, they should be saved for bollworm management.

We do not recommend using pyrethroids for boll weevil control alone or for early season pests because increased use may make it more likely that insects will develop resistance to pyrethroids.

Bifenthrin suppresses spider mites when used for control of bollworms.

The use of synthetic pyrethroid insecticides may increase cotton aphid numbers.

†A wide variety of product combinations suppress whiteflies. These combinations generally include a pyrethroid combined with an organophosphate or endosulfan. The products listed have provided superior control of SLWF in efficacy studies conducted in the Lower Rio Grande Valley.

‡Efficacy studies have shown that the combination with Orthene[®] is necessary for Danitol[®], whereas performance of Capture[®] is sometimes satisfactory on its own.

Table 2. Registered *Bacillus thuringiensis* products and labeled rates for controlling bollworm and tobacco budworm.

Product	Rate per acre (formulated material)
Dipel [®] DF	0.5-2.0 lb
Dipel [®] ES	1.0-6.0 pt
Javelin [®] WG	0.5-1.5 lb

Table 3. Converting pounds active ingredient per gallon to acres per gallon.

Pounds active ingredient needed per acre	Pounds active ingredient per gallon																	
	0.15	0.30	0.66	0.90	1.00	1.80	2.00	2.40	2.50	2.67	3.00	3.20	4.00	6.00	6.55	7.50	8.00	9.33
	Acres per gallon*																	
0.01	15.0	30.0	66.0	90.0	100.0	180.0	200.0	240.0	250.0	267.0	300.0	320.0	400.0	600.0	655.0	750.0	800.0	933.0
0.015	10.0	20.0	44.0	60.0	66.7	120.0	133.3	160.0	166.7	178.0	200.0	213.3	266.7	400.0	436.7	500.0	533.3	622.0
0.019	7.9	15.8	34.7	47.4	52.6	94.7	105.3	126.3	131.6	140.5	157.9	168.4	210.5	315.8	344.7	394.7	421.1	491.1
0.02	7.5	15.0	33.0	45.0	50.0	90.0	100.0	120.0	125.0	133.5	150.0	160.0	200.0	300.0	327.5	375.0	400.0	466.5
0.025	6.0	12.0	26.4	36.0	40.0	72.0	80.0	96.0	100.0	106.8	120.0	128.0	160.0	240.0	262.0	300.0	320.0	373.2
0.03	5.0	10.0	22.0	30.0	33.3	60.0	66.7	80.0	83.3	89.0	100.0	106.7	133.3	200.0	218.3	250.0	266.7	311.0
0.04	3.8	7.5	16.5	22.2	25.0	45.0	50.0	60.0	62.5	66.8	75.0	80.0	100.0	150.0	163.8	187.5	200.0	233.3
0.05	3.0	6.0	13.2	18.0	20.0	36.0	40.0	48.0	50.0	53.4	60.0	64.0	80.0	120.0	131.0	150.0	160.0	186.6
0.0625	2.4	4.8	10.6	14.4	16.0	28.8	32.0	38.4	40.0	42.7	48.0	51.2	64.0	96.0	104.8	120.0	128.0	149.3
0.08	1.9	3.8	8.3	11.3	12.5	22.5	25.0	30.0	31.3	33.4	37.5	40.0	50.0	75.0	81.9	93.8	100.0	116.6
0.1	1.5	3.0	6.6	9.0	10.0	18.0	20.0	24.0	25.0	26.7	30.0	32.0	40.0	60.0	65.5	75.0	80.0	93.3
0.11	1.4	2.7	6.0	8.2	9.1	16.4	18.2	21.8	22.7	24.3	27.3	29.1	36.4	54.5	59.5	68.2	72.7	84.8
0.113	1.3	2.7	5.8	7.9	8.8	15.9	17.7	21.2	22.1	23.6	26.5	28.3	35.4	53.1	58.0	66.4	70.8	82.6
0.125	1.2	2.4	5.3	7.2	8.0	14.4	16.0	19.2	20.0	21.4	24.0	25.5	32.0	48.0	52.4	60.0	64.0	74.6
0.17	0.9	1.8	3.9	5.3	5.9	10.6	11.8	14.1	14.7	15.7	17.6	18.8	23.5	35.3	38.5	44.1	47.1	54.9
0.19	0.8	1.6	3.5	4.7	5.3	9.5	10.5	12.5	13.2	14.1	15.8	16.8	21.1	31.6	34.5	39.5	42.1	49.1
0.2	0.7	1.5	3.3	4.5	5.0	9.0	10.0	12.0	12.5	13.4	15.0	16.0	20.0	30.0	32.8	37.5	40.0	48.7
0.22	0.7	1.4	3.0	4.1	4.5	8.2	9.1	10.9	11.4	12.1	13.6	14.5	18.2	27.3	29.8	34.1	36.4	42.4
0.225	0.6	1.3	2.9	4.0	4.4	8.0	8.9	10.7	11.1	11.9	13.3	14.2	17.8	26.7	29.1	33.3	35.6	41.5
0.25	0.6	1.2	2.6	3.6	4.0	7.2	8.0	9.6	10.0	10.7	12.0	12.8	16.0	24.0	26.2	30.0	32.0	37.3
0.33	0.4	0.9	2.0	2.7	3.0	5.5	6.1	7.3	7.6	8.1	9.1	9.7	12.1	18.2	19.8	22.7	24.2	28.3
0.37	0.4	0.8	1.8	2.5	2.7	4.9	5.4	6.5	6.7	7.2	8.1	8.6	10.8	16.2	17.7	20.3	21.6	25.2
0.375	0.4	0.8	1.8	2.4	2.7	4.8	5.3	6.4	6.7	7.1	8.0	8.5	10.7	16.0	17.5	20.0	21.3	24.9
0.45	0.3	0.7	1.5	2.0	2.2	4.0	4.4	5.3	5.6	5.9	6.7	7.1	8.9	13.3	14.6	16.7	17.8	20.7
0.5	0.3	0.6	1.3	1.8	2.0	3.6	4.0	4.8	5.0	5.3	6.0	6.4	8.0	12.0	13.1	15.0	16.0	18.7
0.55	0.3	0.5	1.2	1.6	1.8	3.3	3.6	4.4	4.5	4.9	5.5	5.8	7.3	10.9	11.9	13.6	14.5	17.0
0.58	0.3	0.5	1.1	1.5	1.7	3.1	3.4	4.1	4.3	4.6	5.2	5.5	6.9	10.3	11.3	12.9	13.8	16.1
0.6	0.2	0.5	1.1	1.5	1.7	3.0	3.3	4.0	4.2	4.5	5.0	5.3	6.7	10.0	10.9	12.5	13.3	15.6
0.675	0.2	0.4	1.0	1.4	1.5	2.7	3.0	3.6	3.7	4.0	4.4	4.7	5.9	8.9	9.7	11.1	11.9	13.8
0.75	0.2	0.4	0.9	1.2	1.3	2.4	2.7	3.2	3.3	3.6	4.0	4.3	5.3	8.0	8.7	10.0	10.7	12.4
0.8	0.2	0.4	0.8	1.2	1.3	2.3	2.5	3.0	3.1	3.3	3.8	4.0	5.0	7.5	8.2	9.4	10.0	11.7
0.88	0.2	0.3	0.8	1.0	1.1	2.0	2.3	2.7	2.8	3.0	3.4	3.6	4.5	6.8	7.4	8.5	9.1	10.6
0.9	0.2	0.3	0.7	1.0	1.1	2.0	2.2	2.7	2.8	3.0	3.3	3.6	4.4	6.7	7.3	8.3	8.9	10.4
1	0.1	0.3	0.7	0.9	1.0	1.8	2.0	2.4	2.5	2.7	3.0	3.2	4.0	6.0	6.6	7.6	8.0	9.3
1.17	0.1	0.3	0.6	0.8	0.9	1.5	1.7	2.1	2.1	2.3	2.6	2.7	3.4	5.1	5.8	6.4	6.8	8.0
1.25	0.1	0.2	0.6	0.7	0.8	1.4	1.6	1.9	2.0	2.1	2.4	2.6	3.2	4.8	5.2	6.0	6.4	7.5
1.5	0.1	0.2	0.4	0.6	0.7	1.2	1.3	1.6	1.7	1.8	2.0	2.1	2.7	4.0	4.4	5.0	5.3	6.2
1.8	0.1	0.2	0.4	0.5	0.6	1.1	1.3	1.5	1.6	1.7	1.9	2.0	2.5	3.8	4.1	4.7	5.0	5.8
2	0.1	0.2	0.3	0.5	0.5	0.9	1.0	1.2	1.3	1.3	1.5	1.6	2.0	3.0	3.3	3.8	4.0	4.7

*See Table 1 for specific rates of insecticides for each insect or mite pest.

Table 4. Converting percent active ingredient of dry insecticides to formulated insecticide per acre.

Pounds active ingredient needed per acre	Percent active ingredient					
	5	15	20	50	80	90
	Pounds of formulated product per acre*					
0.09	1.80	0.60	0.45	0.18	0.11	0.10
0.188	3.76	1.25	0.94	0.38	0.24	0.21
0.25	5.00	1.67	1.25	0.50	0.31	0.28
0.3	6.00	2.00	1.50	0.60	0.38	0.33
0.45	9.00	3.00	2.25	0.90	0.56	0.50
0.5	10.00	3.33	2.50	1.00	0.63	0.56
0.6	12.00	4.00	3.00	1.20	0.75	0.67
0.75	15.00	5.00	3.75	1.50	0.94	0.83
1.0	20.00	6.67	5.00	2.00	1.25	1.11
1.25	25.00	8.33	6.25	2.50	1.56	1.39
1.33	26.60	8.87	6.65	2.66	1.66	1.48
1.5	30.00	10.00	7.50	3.00	1.88	1.67
1.6	32.00	10.67	8.00	3.20	2.00	1.78
2.0	40.00	13.33	10.00	4.00	2.50	2.22
2.4	48.00	16.00	12.00	4.80	3.00	2.67

*See Table 1 for specific rates of insecticides for each insect or mite pest.

Table 5. IRAC Mode of Action Classification, September 2005.

Main group primary site of action	Chemical sub-group or exemplifying active ingredient	Active ingredients
1 Acetylcholine esterase inhibitors	1A Carbamates	Aldicarb (Temik®), Carbofuran (Furadan®), Methomyl (Lannate®), Oxamyl (Vydate®), Thiodicarb (Larvin®)
	1B Organophosphates	Acephate (Orthene®, Address®), Chlorpyrifos (Lorsban®, Lock On®), Dicrotophos (Bidrin®), Dimethoate, Disulfoton (Di-Syston®), Malathion (Fyfanon®), Parathion-methyl, Phorate (Thimet®), Profenofos (Curacron®)
2 GABA-gated chloride channel antagonists	2A Cyclodiene organochlorines	Endosulfan (Thionex®), gamma-HCH (Lindane®)
	2B Phenylpyrazoles (Fiproles)	Ethiprole, Fipronil
3 Sodium channel modulators	DDT	
	Methoxychlor	
	Pyrethroids	Bifenthrin (Capture® Brigade®, Discipline®, Fanfare®), beta-Cyfluthrin (Baythroid® XL), Cyhalothrin, lambda-Cyhalothrin (Karate®, Silence®), gamma-Cyhalothrin (Proaxis®, Prolex®), Cypermethrin (Ammo®, Battery®, Up-Cyde®), alpha-Cypermethrin, beta-Cypermethrin, zeta-Cypermethrin (Mustang®), Deltamethrin (Decis®, Delta Gold®), Esfenvalerate (Asana®), Fenpropathrin (Danitol®)
	Pyrethrins	Pyrethrins (pyrethrum)
4 Nicotinic acetylcholine receptor agonists / antagonists	4A Neonicotinoids	Acetamiprid (Intruder®), Clothianidin, Dinotefuran (Venom®), Imidacloprid (Admire®, Couraze®, Gaucho®, Provado®, Trimax®), Nitenpyram, Thiocloprid, Thiamethoxam (Centric®, Cruiser®)
	4B Nicotine	
	4C Bensultap	
	Cartap hydrochloride	
	Nereistoxin analogs	Thiocyclam, Thiosultap-sodium
5 Nicotinic acetylcholine receptor agonists (allosteric) (not group 4)	Spinosyns	Spinosad (Tracer®, Entrust®)
6 Chloride channel activators	Avermectins, Milbemycins	Abamectin (Abba®, Zephyr®), Emamectin benzoate (Denim®), Milbemectin
7 Juvenile hormone mimics	7A Juvenile hormone analogs	Hydroprene, Kinoprene, Methoprene (Extinguish®)
	7B Fenoxycarb	
	7C Pyriproxyfen	Pyriproxyfen (Knack®)
8 Compounds of unknown or non-specific mode of action (fumigants)	8A Alkyl halides	Methyl bromide
	8B Chloropicrin	Chloropicrin (Telone®)
	8C Sulfuryl fluoride	
9 Compounds of unknown or non-specific mode of action (selective feeding blockers)	9A Cryolite	
	9B Pymetrozine	Pymetrozine (Fulfil®)
	9C Fonicamid	Fonicamid (Carbine®)
10 Compounds of unknown or non-specific mode of action (mite growth inhibitors)	10A Clofentezine	
	Hexythiazox	Hexythiazox (Onager®)
	10B Etoazole	Etoazole (Zeal®)

continued

Table 5. IRAC Mode of Action Classification, September 2005. (continued)

Main group primary site of action	Chemical sub-group or exemplifying active ingredient	Active ingredients
11 Microbial disruptors of insect midgut membranes (includes transgenic crops expressing <i>Bacillus thuringiensis</i> (B.t. toxins)	11A <i>B.t. subsp. israelensis</i> 11A2 <i>B. sphaericus</i> 11B1 <i>B.t. subsp. aizawai</i> 11B2 <i>B.t. subsp. kurstaki</i> 11C <i>B.t. subsp. tenebrionis</i>	<i>B.t. subsp. aizawai</i> (Xentari®, Agree®) <i>B.t. subsp. kurstaki</i> (Deliver®, Dipel®, Bollgard®, Bollgard® II, WideStrike®)
12 Inhibitors of oxidative phosphorylation, disruptors of ATP formation (inhibitors of ATP synthase)	12A Diafenthiuron 12B Organotin miticides 12C Propargite Tetradifon	Azocyclotin, Cyhexatin, Fenbutatin oxide Propargite (Comite®)
13 Uncouplers of oxidative phosphorylation via disruption of proton gradient	Chlorfenapyr DNOC	
14 vacant		
15 Inhibitors of chitin biosynthesis, type 0, Lepidopteran	Benzoylureas	Diflubenzuron (Dimilin®), Novaluron (Diamond®)
16 Inhibitors of chitin biosynthesis, type 1, Homopteran	Buprofezin	Buprofezin (Courier®)
17 Molting disruptor, Dipteran	Cyromazine	
18 Ecdysone agonists / molting disruptors	18A Diacylhydrazines 18B Azadirachtin	Methoxyfenozide (Intrepid®), Tebufenozide (Confirm®)
19 Octopaminergic agonists	Amitraz	
20 Mitochondrial complex III electron transport inhibitors (Coupling site II)	20A Hydramethylnon 20B Acequinocyl 20C Fluacrypyrim	
21 Mitochondrial complex I electron transport inhibitors	METI acaricides Rotenone	Fenazaquin, Fenpyroximate, Pyrimidifen, Pyridaben, Tebufenpyrad, Tolfenpyrad
22 Voltage-dependent sodium channel blockers	Indoxacarb	Indoxacarb (Steward®)
23 Inhibitors of lipid synthesis	Tetronic acid derivatives	Spirodiclofen, Spiromesifen (Oberon®)
24 Mitochondrial complex IV electron transport inhibitors	24A Aluminum phosphide 24B Cyanide 24C Phosphine	
25 Neuronal inhibitors (unknown mode of action)	Bifenazate	
26 Aconitase inhibitors	Fluoroacetate	

continued

Table 5. IRAC Mode of Action Classification, September 2005. (continued)

Main group primary site of action	Chemical sub-group or exemplifying active ingredient	Active ingredients
27 Synergists	27A P450-dependent mono-oxygenase inhibitors	Piperonyl butoxide
	27B Esterase inhibitors	Tribufos
28 Ryanodine receptor modulators	Flubendiamide	
un Compounds with unknown modes of action	unC Dicofol	Dicofol (Kelthane®)
ns Miscellaneous non-specific (multi-site) inhibitors	Borax Tartar emetic	

The information given herein is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by Texas Cooperative Extension is implied.

Cover photo by Winfield Sterling.

Produced by Agricultural Communications,
The Texas A&M University System

Extension publications can be found on the web at: <http://tcebookstore.org>

Visit Texas Cooperative Extension at: <http://texasextension.tamu.edu>

Educational programs conducted by Texas Cooperative Extension serve people of all ages regardless of socioeconomic level, race, color, sex, religion, handicap or national origin.

Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914 in cooperation with the United States Department of Agriculture, Edward G. Smith, Director, Texas Cooperative Extension, The Texas A&M University System.

Revised