Again, looking at the emergence from treatments 3 and 4 one can see the effect of burying the moths and protecting them from the extreme weather conditions. The implication from this is that an interaction exists between climatic conditions and cultural practices. It is not within the scope of this experiment to more precisely define the interaction.

Conclusions

Climatic conditions play an important role in survival of overwintering pink bollworm larvae. Dessication and cold temperatures have an adverse effect on the survival of the larvae.

There was no reduction in survival of the pink bollworm larvae when stalks were shredded with a flail-type shredder.

As larvae enter diapause many do leave the boll and enter the soil to overwinter.

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ECOLOGICAL FACTORS AFFECTING THE ABUNDANCE AND CULTURAL CONTROL OF THE PINK BOLLWORM

T. F. Watson, Associate Entomologist
D. G. Fullerton, Research Associate
J. E. Slosser, Graduate Assistant
W. E. Larsen, Extension Agricultural Engineer

Objectives:

A. To study environmental factors influencing behavior and abundance of the pink bollworm.
B. To investigate physical, mechanical, cultural, chemical, and biological agents as possible control measures under Arizona conditions.

Summary of Progress:

Eight methods of burying plant debris were compared in a replicated field experiment. Results are shown in Table 1. Total moth emergence was greatest in the treatment which was only shredded and disked. However, more moths emerged after squares were available in the deep-plowing (12") treatment. Fewer moths emerged from the treatment which was rototilled than from any other; no emergence occurred in this treatment after squares were available.

Table 2 presents the results obtained from an experiment designed to evaluate various irrigation practices on pink bollworm control. Water applied only as a preplant practice resulted in significantly greater moth emergence than with any of the other treatments. There was no difference in numbers of moths emerging from the nonirrigated check, two winter irrigations--both border or furrow irrigated--or the treatment which simulated the practice of irrigating-up.

None of the treatments in the shredding experiment resulted in a reduction of pink bollworm larvae, based on a comparison of moth emergence from these treatments and that which was hand-harvested. Moth emergence was delayed in these treatments, resulting in greater nonsuicidal emergence. These data are presented in Table 3.

Several granular insecticides were compared, in both wet and dry soil in the laboratory, for control of pink bollworm larvae in the soil. None of these insecticides showed any effect on pink bollworm larvae in dry soil; however, three of the materials--parathion, diazinon and aldrex--appeared very promising in the wet-soil treatment.

Based on these promising laboratory results, several granule-formulated insecticides were applied in small field plots to determine effectiveness, if any, on overwintering pink bollworm larvae. No apparent control was obtained from the insecticides in either of the field experiments. However, method of incorporating the chemicals apparently influenced survival since moth emergence was reduced by 55.2% in the experiment utilizing the moldboard plow as compared to the one which utilized the Howard rotavator. These data are presented in Table 4.

Three insecticide-timing schedules were compared on long-staple cotton at Phoenix, Arizona for pink bollworm suppression. At each schedule, Guthion at the rate of 1.0 lb/A. and Sevin, at 2 lbs/A. were compared and, additionally, Guthion at the rate of 0.5 lb/A. was tested on the early-squaring schedule. All schedules and all insecticidal treatments resulted in satisfactory and comparable degrees of control, Table 5. No significant differences were detected in yields among the three timing schedules; however, all resulted in significant yield-increases when compared to the untreated check, Table 6.

A similar experiment, utilizing tox-DDT as the insecticide, and involving two insecticide-timing schedules was conducted at Solomon, Arizona. Both timing schedules effectively reduced the pink bollworm infestation when compared to the untreated check, Table 7. However, the highest infestation level reached in the check was 28.0% of the bolls infested and no detectable yield differences were found in either the first or second harvests or total yields, Table 8.

Several insecticides and insecticidal combinations were evaluated in a replicated field experiment for pink bollworm control at Phoenix, Arizona. The influence of the various treatments on percent bolls infested and number of larvae per 100 bolls is presented in Tables 9 and 10, respectively. Table 11 presents the statistical analysis of the infestation present in the last boll sample collected on September 21. The lowest infestation, 3% infested bolls, was obtained in the Guthion treatment; the highest infestation, 98% infested bolls, resulted from the untreated check plots. Yield analyses are presented in Tables 12 and 13. In general, effectiveness of treatments as shown by the infestation counts is reflected in yields.

Preliminary laboratory experiments were conducted to determine the influence of the larval habitat on adults, particularly the female. Larvae obtained from bolls resulted in moths which lived for a shorter period of time than did those obtained from diapausing or square-reared larvae. Square-reared females produced more eggs than did those from either of the other sources.

The influence of temperature and soil moisture on pink bollworm larvae was studied under laboratory conditions. Wet soil adversely affected larval survival at all temperature--38°, 59°, 77°, and 95°F. The most optimum conditions for the pink bollworm, both from the standpoint of adult emergence and low immature mortality were dry soil and a temperature of 77°F. There was little, if any difference between the wet- and dry-soil treatments at the three highest temperatures with regard to time required for adult emergence. Temperature did, however, influence the rate of moth emergence and the rate of survival.

Wet soil conditions appeared to be the more detrimental of the two factors--temperature and soil moisture--studied since significantly higher mortalities were obtained with larvae in wet as compared with those in dry soil at the same temperature. Poor survival resulted from the wet-soil treatment at all temperatures after 12 and 14 week exposure periods, whereas considerably lower mortalities were noted at all temperatures of dry-soil treatments, except at 38°F.

The influence of temperature alone on survival was more evident in the dry-soil treatment. Immature mortality ranged from 100 percent at the 38°F temperature to a low of 37.8 percent in the 77°F cabinet. After 14 weeks, only larvae in the 59°F box were surviving; however, fewer adults had emerged than at either of the higher temperatures.

Table 1. Influence of several cultural practices on pink bollworm moth emergence. Phoenix, 1966-67.

	Mean Number Moths Emerging Per Acre			
Cultural Treatment[3/]	Total Moth Emergence	Stat.[2/] Sig. (5%)	Effective Moth Emergence	Stat. Sig. (5%)
Shredded and Disked	7,583	a	1,833	a b
Deep Burial - 12" plow w/C.A.[1/]	5,917	a b	2,750	a
Deep Burial - 12" plow w/o C.A.	4,417	a b	1,917	a b
Medium Burial - Chisel List	4,167	a b	1,750	a b
Medium Burial - 6" plow w/C.A.	3,167	a b c	583	b c
Deep Burial + Seal (12" plow + cultipack)	3,083	b c	1,000	a b
Medium Burial + Seal (6" plow + cultipack)	2,583	b c	667	a b
Rototilled - 6" depth	917	c	000	c

1/ C.A. - covering attachments.

2/ Duncan's multiple range test.

3/ No water was applied to any of the treatments.

Table 2. Influence of various irrigation and cultural practices on pink bollworm moth emergence. Phoenix, 1966-67.

Irrigation Practice[1/]	Mean Number Moths Emerging Per Acre			
	Total Moth Emergence	Stat.[2/] Sig. (5%)	Effective Moth Emergence	Stat. Sig. (5%)
Furrow-Irrigated - Feb. 28	7,167	a	1,833	a
Nonirrigated - Check	3,417	b	1,083	a b
Furrow Irrigated - 12/30 & 1/17	2,417	b	417	b
Furrow Irrigated - 4/5	2,417	b	417	b
Border Irrigated - 12/30 & 1/17	1,833	b	583	b

1/ All treatments were subjected to the same cultural practice, i.e., shredded, disked, and plowed to a depth of 12 inches.

2/ Duncan's multiple range test.

Table 3. Results of shredding practices on pink bollworm moth emergence. Phoenix, 1966-67.

Shredding Treatments	Mean Number Moths Emerging Per Acre		
	Total	Effective[1/]	Percent Effective Emergence
Hand Harvested	3406	2358	69.2
Servis Shredder - Maximum	5240	3537	67.5
Servis Shredder - Minimum	7205	5240	72.7
Mott Vertical Flail	3799	2358	62.1
Low-Energy Experimental	4061	3013	74.2

1/ Moths emerging after May 30.

Table 4. Effects of soil applications of granular insecticides on pink bollworm larvae. Phoenix, 1966-67.

Treatment[1/]	Mean Number Moths Emerging Per Acre	
	Method of Incoporation	
	Rototilled	Plowed - 6"
Check	11,000	7,333
Aldrex	12,333	5,333
Diazinon	20,667	8.000
Nia 10242	9,000	7,333
Niran	19,667	4,333

1/ All insecticides were applied at the rate of 10 lbs. active per acre; following application and incorporation all plots were irrigated.

Table 5. Influence of insecticides and timing-schedules on pink bollworms infesting long-staple cotton. Phoenix, 1967.

Treatment[1]	Insecticides and Rates (lbs/A)	Percent Infested Bolls Collected on Following Dates: 7/20	7/27	7/31	8/7	8/16	8/23	8/30	9/7	9/12	9/21	9/30	10/7
Check	---	7.0	11.5	14.0	18.5	10.5	24.5	45.0	42.0	50.5	61.0	84.5	84.5
Early-Squaring[2]	Guthion (0.5)	1.5	0.5	1.5	2.0	0.5	1.5	1.5	4.5	4.5	5.5	5.5	4.0
and continue	Guthion (1.0)	0.5	0.5	0.5	0.5	1.0	0.0	1.0	0.5	1.5	1.5	1.5	3.0
(19 appl.)	Sevin (2.0)	1.0	3.5	0.5	1.0	0.0	0.5	0.5	0.5	2.0	0.5	2.0	3.0
Early Bolls[2] and	Guthion (1.0)	1.0	2.5	0.0	1.5	0.5	1.0	1.0	0.5	2.0	1.0	2.0	2.5
2nd Generation (15 appl.)	Sevin (2.0)	2.5	2.0	0.5	1.5	0.5	1.0	1.5	0.5	1.0	2.0	2.0	1.5
Heavy Boll[2] Populations and	Guthion (1.0)	---	---	---	---	15.5	9.5	2.0	1.0	0.5	1.0	2.0	2.5
3rd Generation (10 appl.)	Sevin (2.0)	---	---	---	---	16.0	9.0	1.5	1.5	1.0	2.0	2.5	2.5

1/ One application of methyl parathion (1.0 lb/A) was made to all plots on August 9 for control of *Heliothis zea*.

2/ Applications began on June 21, July 12, and August 8, respectively, for the three schedules.

Table 6. Comparison of cotton yields obtained from three insecticide-timing schedules and an untreated check. Phoenix, 1967.

	Mean Plot Yields (lbs. Seed Cotton) and Stat. Sig.[1/]							
Treatment	1st Harvest[2/]	.05	2nd Harvest[3/]	.05	.01	Total Yield	.05	.01
Check	292	a	50	a	a	342	a	a
Early-Square Protection	365	b	80	b	b	445	b	b
Early-Boll Protection	381	b	79	b	b	460	b	b
Late-Boll Protection	352	b	90	b	b	442	b	b

1/ Duncan's Multiple Range Test; yields having a common letter are not significantly different.

2/ 1st harvest on November 9.

3/ 2nd harvest on December 8.

Table 7. Effects of toxaphene-DDT on pink bollworm control when applied to long-staple cotton on two timing-schedules. Solomon, 1967.

Treatments	Percent Bolls Infested on Following Collection Dates:3/								
	8/9	8/16	8/23	8/29	9/6	9/12	9/19	9/26	10/4
Check	4.0	8.0	10.7	8.0	5.3	28.0	25.3	21.7	13.0
Tox-DDT @ 4-2 1/	6.7	6.7	2.7	1.3	1.3	8.3	2.3	2.3	3.0
Tox-DDT @ 4-2 2/	---	---	---	10.7	5.3	10.7	1.7	2.3	0.3

1/ Applications began on July 31; ten applications were made.

2/ Applications began on August 28; six applications were made.

3/ Samples taken through September 6 were made by pulling 25 bolls per plot; thereafter, each sample consisted of 100 bolls per plot.

Table 8. Comparison of timing schedules on pink bollworm control. Solomon, Arizona, 1967.

Treatment	Rate lbs/A	No. Appl.	Mean Yields Seed Cotton Per Plot: 1st Harvest 1/	2nd Harvest 2/	Total
Check	-	0	498	266	764
Tox-DDT 3/	4-2	10	580	227	807
Tox-DDT 4/	4-2	6	573	299	872
			n.s.	n.s.	n.s.

1/ 1st harvest on November 3.

2/ 2nd harvest on December 1.

3/ Insecticide applications begun on July 31 and applied at weekly intervals for 10 applications.

4/ Insecticide applications begun on August 28 and continued at weekly intervals until a total of 6 applications were made.

Table 9. Influence of insecticidal treatments on percent bolls infested with pink bollworm larvae. Phoenix, 1967.

Treatment[1/]	Rate lbs/A	Percent Infested Bolls Collected On: 8/17	8/25	8/30	9/13	9/21
Check	---	51.5	56.5	86.0	95.0	98.0
Guthion	1.0	16.0	12.0	5.5	1.5	3.0
Thuricide	2 qt.	45.0	53.0	67.5	73.5	64.5
Mobam	1.0	19.5	20.5	29.0	23.5	21.5
CP 47114	1.0	14.0	26.5	37.0	28.0	31.5
Niran M-4	0.5	13.5	33.0	59.0	54.5	47.5
Azodrin	.625	13.5	19.5	33.5	27.0	22.0
GC 6506	1.0	18.0	29.5	39.5	27.0	18.5
Tox-DDT	4-2	14.0	15.0	19.5	12.0	10.5
Tox-Azodrin	3.0-.625	10.0	18.0	21.5	18.5	12.5
Tox-M.P.	3.0-.625	19.5	14.5	42.5	34.0	32.5
Tox-Guthion	3.0-1.0	6.5	10.0	7.[illegible]	5.5	4.5
Tox-Dylox	3.0-1.5	22.0	29.0	41.0	41.0	36.5

1/ Insecticidal applications were made on the following dates: 7/2[illegible], 8/2, 8/8-9, 8/15, 8/22, 8/28, 9/2, 9/6-7, and 9/12.

Table 10. Effects of several insecticides and/or insecticide combinations in reducing pink bollworm infestations. Phoenix, 1967.

			Mean No. Larvae/100 Bolls Collected On:						
	Rate	Pre-	August					Sept.	
Treatment	lbs/A	treat	1	8	17	25	30	13	21
Check	-	95.5	95.0	77.0	102.5	103.5	212.5	249.0	307.0
Thuricide	2 qts.	68.0	68.5	61.5	62.5	92.0	132.5	147.5	130.5
Niran M-4	0.5	60.0	62.5	45.0	17.5	44.0	100.0	92.5	84.5
Tox-Dylox	3-1.5	56.0	55.0	30.5	34.5	54.5	62.5	77.0	74.0
Tox-M. P.	3-.625	48.0	47.5	40.0	26.5	22.5	70.5	44.0	50.0
CP 47114	1.0	84.0	84.5	41.0	17.0	31.5	55.5	39.5	48.0
Azodrin	.625	54.5	60.0	34.5	16.5	22.0	47.5	41.0	32.0
Mobam	1.0	61.5	68.0	28.5	26.0	24.0	43.5	29.0	30.0
GC 6506	1.0	58.0	58.0	35.0	27.0	37.5	60.0	35.5	29.0
Tox-Azodrin	3-.625	43.5	41.0	29.0	12.0	18.0	29.0	20.0	19.5
Tox-DDT	4-2	45.5	48.5	29.5	17.0	20.0	28.5	15.5	18.5
Tox-Guthion	3-1	63.5	69.0	45.5	14.0	11.0	8.0	5.5	5.5
Guthion	1.0	77.5	63.0	29.0	18.0	14.0	6.5	2.0	3.0

Table 11. Comparison of various insecticidal treatments on reducing boll infestation by the pink bollworm. Phoenix, 1967.

Treatment	Rate lbs/A	% Bolls infested on 9/21	Stat. Sig.1/ 5%	1%
Check	-	98.0	a	a
Thuricide	2 qts.	64.5	b	b
Niran M-4	0.5	47.5	c	bc
Tox-Dylox	3.0-1.5	36.5	cd	cd
Tox-M. P.	3.0-.625	32.5	cd	cde
CP 47114	1.0	31.5	cd	cde
Azodrin	.625	22.0	de	def
Mobam	1.0	21.5	de	def
GC 6506	1.0	18.5	def	def
Tox-Azodrin	3.0-.625	12.5	ef	def
Tox-DDT	4.0-2.0	10.5	ef	ef
Tox-Guthion	3.0-1.0	4.5	ef	f
Guthion	1.0	3.0	f	f

1/ Analysis of pink bollworm infestations in last boll sample collected on September 21 using Duncan's Multiple Range Test.

Table 12. Comparison of insecticidal treatments for pink bollworm control. Phoenix, 1967.

Treatment 2/	Rate lbs/A	Mean Plot Yields	Stat. Sig.1/ 5%	1%
Check	-	201.0	a	a
Thuricide	2 qts.	256.5	b	a
Azodrin	.625	400.8	c	b
Tox-Guthion	3.0-1.0	439.5	cd	b
Guthion	1.0	456.0	d	b

1/ Duncan's Multiple Range Test; treatment means followed by the same letter are not significantly different. Analysis is based on yields from 4 replications.

2/ Spray applications were made on: 7/28, 8/2, 8/8-9, 8/15, 8/22, 8/28, 9/2, 9/6-7, and 9/12.

Table 13. Comparison of insecticidal treatments for pink bollworm control. Phoenix, 1967.

Treatment[2/]	Rate lb/A	Mean Plot Yields	Stat. Sig.[1/] 5%	1%
Check	-	201.0	a	a
Thuricide	2 qts.	285.0	b	b
Tox-Dylox	3-1.5	355.0	c	c
Mobam	1.0	358.5	c	c
Niran M-4	0.5	378.5	cd	cd
CP 47114	1.0	395.0	cd	cd
Tox-M.P.	3-.625	396.5	cd	cd
GC 6506	1.0	413.5	de	cde
Tox-Azodrin	3-.625	418.0	de	cde
Azodrin	.625	430.5	de	cde
Tox-DDT	4-2	431.5	de	cde
Tox-Guthion	3-1	453.0	ef	de
Guthion	1.0	485.5	f	e

1/ Duncan's Multiple Range Test; treatment means followed by the same letter are not significantly different. Analysis is based on 2 harvested replicates.

2/ Spray applications were made on: 7/28, 8/2, 8/8-9, 8/15, 8/22, 8/28, 9/2, 9/6-7 and 9/12.

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BIOLOGY AND CONTROL OF INSECTS AFFECTING COTTON IN ARIZONA

T. F. Watson, Associate Entomologist
T. A. Fadare, Graduate Student
J. S. Phillip, Graduate Assistant
J. E. Slosser, Graduate Assistant

Objectives:

A. To study the field ecology of important cotton pests.
B. To conduct field experiments with insecticides for the purpose of developing practical and effective cotton insect control programs.

Summary of Progress:

Bollworm Investigations.

A. Methods and Materials.
   1. Field Control:

Four insecticidal treatments were compared with an untreated check on a heavily-infested, late-planted field of short-staple cotton. The design was a randomized complete block with 4 replications. All plots were 700 feet