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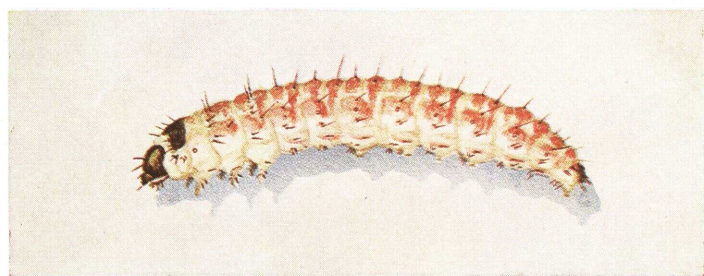
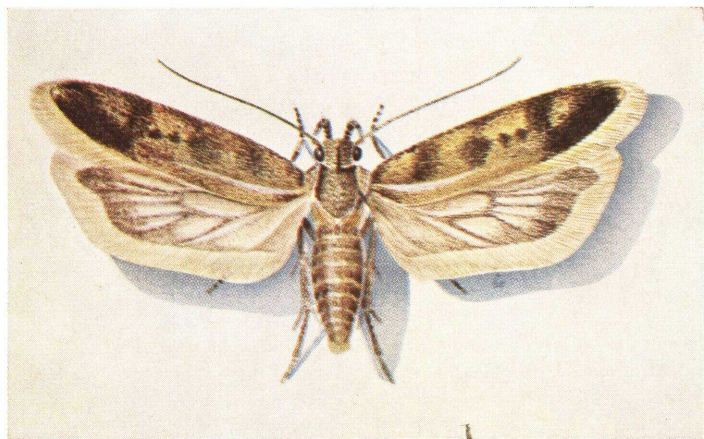
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CONTROLLING THE PINK BOLLWORM ON COTTON

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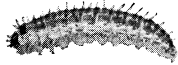
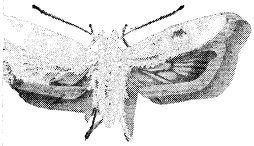
Illustrations on the cover and on page 4 are printed in natural color to enable you to identify the pink bollworm. Illustrations on the cover: Moth and larva of the pink bollworm.

This bulletin supersedes Leaflet 339, "The Pink Bollworm: How We Fight It."

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CONTROLLING THE PINK BOLLWORM ON COTTON

The pink bollworm is an insect that can cause severe damage to cotton; it also damages okra.

This pest probably originated in India and was spread in planting seed to Egypt and from there to Mexico. Today it occurs in most countries where cotton is grown. For years it has been a seriously destructive pest in India, China, Egypt, and Brazil.

The pink bollworm can cause a heavy loss of cotton wherever its population builds up to "outbreak" numbers. In a single year, 1952, it was responsible for cotton losses of more than \$28 million in 38 counties in southern Texas. Such losses can be prevented by proper efforts to prevent the buildup and spread of this insect.

OCCURRENCE IN THE UNITED STATES

The pink bollworm was first found in the United States at Hearne, Tex., in 1917. Although this infestation was eradicated, the insect later crossed the Rio Grande from Mexico into Texas, and its occurrence has been general through-

out the State. Since 1952 this pest has caused considerable damage to cotton periodically in southern, central, and parts of western Texas. In 1958 and 1959 it caused very heavy damage on some acreages in the El Paso Valley of Texas.

The pink bollworm soon spread to other States. General infestations have occurred throughout Oklahoma and New Mexico. Infestations in some parts of Louisiana and Arkansas have been light.

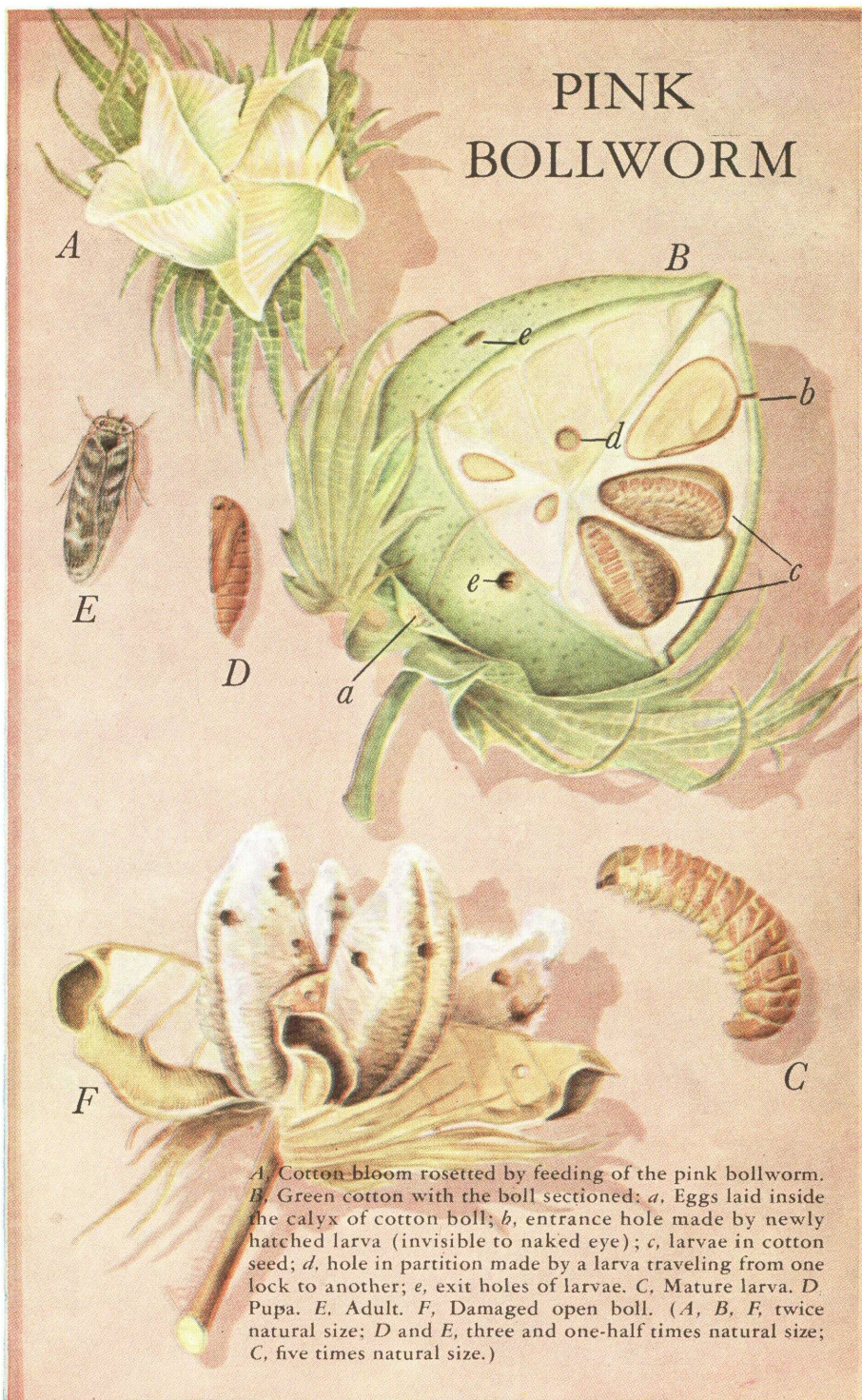
Since 1940 the pink bollworm has caused heavy cotton losses in some areas of Arizona; in 1958 and 1959, severe outbreaks of the pest occurred in the Gila Valley and in the Salt River Valley of that State, and extended into Pima County. In the same years—1958 and 1959—this insect caused serious cotton losses in some parts of the Mesilla Valley of New Mexico.

DEVELOPMENT AND HABITS

The pink bollworm has four stages of development: Egg, larva (or worm), pupa, and adult (or moth).

Adults are small, grayish-brown

PINK BOLLWORM



A, Cotton bloom rosetted by feeding of the pink bollworm. B, Green cotton with the boll sectioned; *a*, Eggs laid inside the calyx of cotton boll; *b*, entrance hole made by newly hatched larva (invisible to naked eye); *c*, larvae in cotton seed; *d*, hole in partition made by a larva traveling from one lock to another; *e*, exit holes of larvae. C, Mature larva. D, Pupa. E, Adult. F, Damaged open boll. (A, B, F, twice natural size; D and E, three and one-half times natural size; C, five times natural size.)

moths that have a wingspread of about one-half inch. They look much like clothes moths. The average life of the adult is about 2 weeks.

Early in the cotton season, female moths lay eggs on cotton stems, squares, and terminal buds. When green bolls are present, the moths usually lay most of their eggs in masses beneath the glovelike calyx at the base of the bolls. A moth lays 100 to 200 eggs, which are white and oval.

In 4 to 5 days, the eggs hatch into larvae. Newly hatched larvae are glossy white and have light-brown heads. They eat their way into squares or bolls, where they feed 10 to 14 days. At the end of this period they are full-grown larvae. They are about one-half inch long, light cream colored, and have fairly well defined transverse bands of mottled pink on the dorsal side.

Larvae feeding in squares usually complete development by the time the bloom opens and rarely damage the developing boll. These larvae produce the typical rosette bloom that is readily recognized. Many of these larvae drop to the ground and pupate in cracks in the soil or in surface trash. A few remain in the bloom until it sheds. Occasionally a square or young boll may shed as a result of feeding injury.

Larvae in bolls feed on the seeds. When a larva has finished feeding in a green boll, it either cuts a small hole through the carpel wall and drops to the ground to pupate, or remains in the seed in which it completed feeding.

A larva that remains in the seed

may hibernate in a single seed or it may pull two hollowed-out seeds together and unite them by spinning a continuous cocoon within the two cavities. Seeds thus united are called double seeds; their presence, which becomes apparent after ginning, is usually an indication that the pink bollworm is there.

The larvae change to pupae, and the pupae transform to moths. In 3 or 4 days the female moths begin laying eggs. The moths are active only at night. In the daytime they stay under trash or clods of dirt, or in cracks in the soil.

In midsummer the pink bollworm completes its life cycle in 25 to 30 days. As many as six generations may occur in a year.

NATURE OF DAMAGE

Pink bollworm damage to cotton is caused by feeding of the larvae. Only minor damage results when larvae feed in squares, since blossoming is not hindered and the resulting young bolls usually are not damaged.

Severe damage occurs when larvae feed within the bolls, moving from one seed to another and eating out the kernel of each. This causes a loss of seed viability, and a reduction in the volume and quality of oil. Some bolls—often a high percentage of late-produced bolls—are damaged so severely that they are unpickable and therefore are a total loss.

When larvae feed within the bolls, they cut and stain the fibers; a low-grade lint results. Fibers so damaged, when mixed with undamaged

lint in the harvesting and ginning processes, reduce the average grade of the crop.

Some larvae may leave the bolls to pupate or hibernate by cutting exit holes in the carpels. This increases damage because a single hole permits entrance of moisture and disease organisms that cause boll rot. In fields heavily infested by the pink bollworm, boll damage may be so severe that the cotton may not be worth harvesting.

CONTROL MEASURES

Cultural Practices

The pink bollworm is the only major cotton insect that passes the winter in cotton or okra residues left in the field after harvest, or in seed and seed cotton taken from the field.

Many larvae left in the field in crop residue can be destroyed by using the cultural practices recommended here. To be more effective, cultural practices should be employed as a community, county, State, or regional program and followed by every grower in the control area.

Early maturity

Control of the pink bollworm can be made more effective if you control other insects and if you follow other sound production practices that promote rapid, early setting and maturity of fruiting forms. Early bolls escape severe damage because they mature before the pink bollworm infestation builds up to its seasonal maximum intensity.

Try to obtain a thick, vigorous stand. This will hasten maturity and increase the efficiency of mechanical harvesting. Treat seed with fungicide, plant the variety of cotton recommended for your area, and use a suitable fertilizer.

In a generally infested area, follow the insecticide-control practices recommended for that area in your State guide. At the proper time, use chemical defoliant or desiccants to speed up harvest.

Cotton should not be irrigated late in the season. Absence of this irrigation will help to prevent late-season generations of pink bollworms (and boll weevils, if they are present) from going into winter hibernation.

The possibility of a high winter carryover of the pest, plus the cost of additional insecticide applications, usually makes the production of a late top crop unprofitable to the cottongrower. The production of a top crop of bolls with resultant fall breeding of the pest seriously jeopardizes the efforts to suppress or eliminate the pink bollworm, and may greatly increase damage the following year.

Stalk shredding and plow-under

Cotton should be produced in the shortest time possible and harvested promptly and completely. Most larvae in cotton taken to gins are destroyed in the ginning process, but approved sanitation practices should be followed to prevent carryover in waste cotton on the gin premises; clean harvesting reduces the number of larvae left in the field.



Clean harvesting removes most of the pink bollworms from the field.

BN-21030X



Shredding stalks. This practice kills many pink bollworms; it should be undertaken immediately after harvest.

BN-21029X

Stalks should be cut promptly after harvest with a power-operated shredder. The flail-type shredder is preferred; it is quite effective in killing pink bollworms, and it spreads the residue evenly on the ground, thus aiding plow-under efficiency.

Crop residue, including infested material knocked to the ground at harvest, should be plowed under promptly to a depth of at least 6 inches—the deeper, the better.

Prefrost stalk destruction increases winter mortality of the pink bollworm; it reduces the pest's reproduction in the fall, sometimes by two or three generations.

Fields left fallow or unplowed in fall or winter should be plowed early in the spring. Survival of the pest is highest in bolls lying on the ground. In areas that have sustained low temperatures, high mor-

tality occurs in bolls on standing stalks.

Soil moisture helps to kill pink bollworms. So in cold, arid climates, fall or early winter plowing of the dry soil may not be as effective against pink bollworms as it is in other climates. Under arid conditions, irrigation after winter plowing increases mortality of the pest.

Planting dates

Many pink bollworm moths from overwintered larvae emerge early in the spring and die before cotton squares become available for their reproduction. Thus, the degree of infestation can be influenced by the date of planting.

Extremely early, scattered plantings attract moths emerging from hibernating larvae in surrounding fields; therefore, heavy infestations



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Plowing under the waste cotton and shredded stalks. Very few pink bollworms survive the winter when buried in wet soil by this practice.

occur in these early plantings. When early plantings mature, the moths emerging in them migrate to later fruiting, more attractive cotton.

Usually late plantings are severely damaged because moths migrate into them in large numbers. The potential overwintering population is increased because an abundance of green bolls are available for pink bollworm development after the early and intermediate plantings have matured.

An increase in the number of pink bollworm generations results when cotton is planted over a long planting period. Then the increased population of the pest causes increased crop damage. Because of this, cotton should be planted within a short, uniform planting season for a given area.

Planting should not be started until near the time when soil temperature becomes favorable for rapid seed germination and seedling growth. This is considered the best planting time whether or not there is an insect problem.

Use of Insecticide

For many years after it first appeared as a cotton pest, nothing was known of how to effectively control or eliminate the pink bollworm. Through research, we have learned more about this insect. Today cultural methods of control can be effectively supplemented in either control or eradication programs by properly timed and adequate applications of insecticide.

Determining need for insecticide

The need for insecticide applications to prevent damage by the pink bollworm may be determined by making bloom and boll inspections early in the season, as follows:

Bloom inspection.—Five days after the first bloom appears, but not later than 15 days, make an inspection to determine the number of larvae present, in this way: At each of 5 representative locations in the field, step off 300 feet of row (100 steps) and count the rosetted blooms. Multiply the number of rosetted blooms by 10 to learn the number of larvae present per acre.

Boll inspection.—Walk diagonally across the field and collect at random 100 firm bolls. Crack the bolls, or cut each section of carpel (hull) lengthwise, so the locks can be removed. Examine the insides of the carpels for mines made by the young larvae when they were entering the bolls. Record the number of infested bolls on a percentage basis.

When to apply insecticide

When bloom inspection shows that there are 350 or more larvae per acre, begin insecticide applications immediately and continue them at 5-day intervals until most of the bolls have opened.

When bloom inspection shows that there are fewer than 350 larvae per acre, inspect the bolls weekly and begin insecticide applications when 10 to 15 percent of the bolls are found to be infested; continue applications at 5-day intervals until most of the bolls have opened.

Kind and quantity to apply

To control the pink bollworm alone, apply 1½ to 2 pounds per acre of either DDT or carbaryl. The maximum rate should be used during midseason and late season. Applications may be made in either a dust or a spray. Continue the applications at 5-day intervals.

If you need to control the pink bollworm plus the boll weevil and bollworm, add one-fourth pound of Guthion or one-half pound of methyl parathion to DDT, or use carbaryl, and make applications as recommended for the pink bollworm alone. If the bollworm is resistant to DDT in your area, use carbaryl, or a mixture of toxaphene or strobane and DDT at the rate of 2 to 3 pounds of toxaphene or strobane and 1 to 1½ pounds of DDT per acre.

Consult your county agricultural agent for the latest information pertaining to your particular locality.

Precautions

Insecticides are poisonous to man and animals. Follow directions and heed all precautions on container labels. Read the label each time you use an insecticide; do not depend on your memory.

Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture.

If you get insecticide on your clothing, remove clothing as soon as possible; if you get it on your skin, bathe with soap and water.

Do not open insecticide containers in closed rooms. Do not leave metal containers of emulsifiable concentrates in the sun.

Empty containers are particularly hazardous. Empty bags should be burned in the open or buried. Containers of liquids should be crushed and buried.

Do not apply insecticides where they can drift onto pastures being grazed by livestock. Dusts are particularly dangerous in this respect.

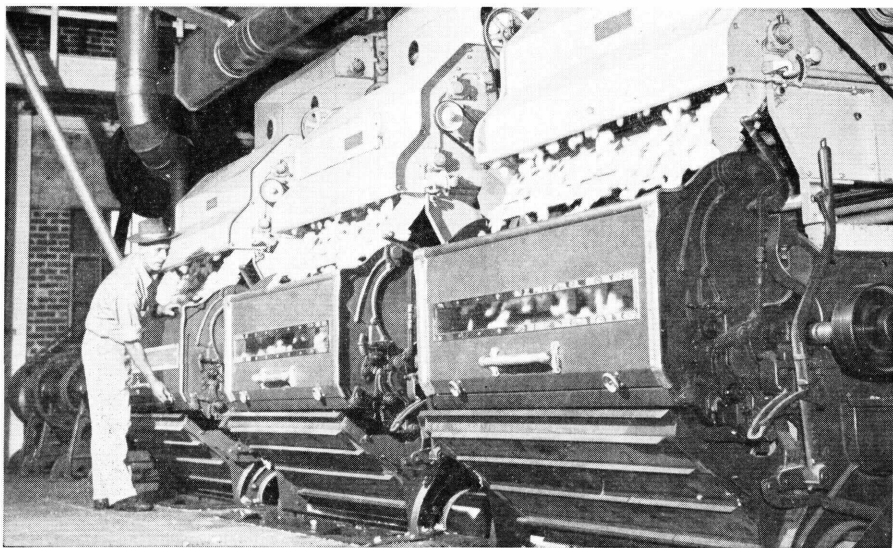
Protect food and feed crops from the drift of insecticide being applied for control of cotton insects.

Avoid killing honey bees and other pollinating insects; make insecticide applications, if possible, when bees are not visiting the plants. Notify beekeepers at least 48 hours before dusting or spraying, so that measures can be taken to protect the bees.

To protect fish and wildlife, be careful not to contaminate streams, lakes, or ponds with insecticide. Do not clean spraying equipment and do not empty excess spraying material, near such water.

ERADICATION

Progress in research indicates that eradication of the pink bollworm from all areas may be feasible in the future. Even now, the pest can be eradicated from some localities if all cotton growers in an infested area cooperate in the pro-



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Machinery in a modern cotton gin kills pink bollworms by impact during the ginning operation.

gram. Practices to bring about eradication may vary in different localities. However, in an eradication program a *combination of the following practices must be used:*

1. Plant the crop during a short, uniform period.

2. Prevent seedling diseases and practice early-season control of other cotton insects; this will insure the early setting of bolls for a profitable crop.

3. Produce the crop in the shortest possible time by using effective fertilizing, cultivating, and irrigating practices.

4. Apply a defoliant or desiccant when most of the bolls are mature. This will hasten the opening of latest-formed bolls, and help stop the propagation of pink bollworms.

5. Undertake a planned program

of insecticide applications at intervals best suited to local conditions.

6. Harvest the crop promptly and thoroughly.

7. Use appropriate methods to reduce the number of pink bollworms going into hibernation. Some or all of these methods may be required:

- Collect and burn crop residues in heavily infested fields.

- Shred stalks immediately after harvest.

- Plow the crop residues under deeply and promptly following stalk destruction. An alternative, if authorized in an eradication area, is to follow stalk shredding with cross disking and the planting of a sown or broadcast winter crop.

8. Maintain a host-free period between crops. In subtropical areas,

this may require destruction of seedling or volunteer plants.

9. Prohibit the production of "stub" cotton.

10. Observe regulatory measures designed to prevent movement of the pest, in cottonseed and other materials, from infested to non-infested areas.

QUARANTINES

A Federal quarantine regulates the interstate movement, from pink-bollworm-infested areas, of cotton and unmanufactured cotton products, cotton gin and mill wastes, cotton picking and ginning equipment, okra, and other articles that may spread the pest. Such articles may require treatment or certification at the point of origin under supervision of an inspector. Parallel State quarantines control the interstate movement of these articles and commodities.

HOW YOU CAN HELP

If your farm is in a noninfested area, you can help to locate new infestations by watching for the pink bollworm. Illustrations on the cover and on page 4 of this bulletin will help you identify the pest. If you find it, promptly notify your county agent and other cotton-growers in your area. Cooperative control or eradication measures can then be started.

If you find larvae or moths that resemble those of the pink bollworm, put a few specimens in a small bottle of diluted alcohol and send them to the Plant Pest Control Division, Agricultural Research Service, USDA, Federal Center Building, Hyattsville, Md., 20781. Enclose information as to date and place of collection, and your name and address. Do not send live specimens.
