THE STATUS OF HEAT TREATMENT OF PLANT COTTON SEED FOR THE CONTROL OF PINK BOLLWORM, *Pectinophora scutigera* Hold., IN QUEENSLAND.

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SUMMARY.

1. Present control measures for pink bollworm are based on the elimination of sources of infestation by destroying over-wintering host plants, farm hygiene, and the prevention of dispersal through seed. Complete control of over-wintering stages in the field cannot be achieved.

2. An investigation at Glenmore Ginnery in 1941 showed that pink bollworm infestation of plant seed before heat treatment is negligible. This is probably due to (a) the ginning of only high grade seed cottons for plant seed; (b) the efficient cleaning machinery in the ginnery; (c) a difference in habits between the cosmopolitan P. gossypiella and the local species P. scutigera, which does not form double seeds or have a resting larval stage within the seed.

3. Heat treatment of plant cotton seed is not an essential phase of control measures for pink bollworm in Queensland.

INTRODUCTION.

In Queensland, pink bollworm injury is often severe in the late maturing top-crop, and larval populations may be very high in snap cotton†, particularly in scrub areas. Usually attacks on squares and green bolls formed in early- and mid-season are not serious unless a plant crop is grown near heavily infested ratoon, standover, or undestroyed old plants.

The measures at present recommended in Queensland for the control of pink bollworm are designed to control the pest in areas already known to be infested, and to prevent dispersal into other districts. These recommendations are based on the elimination of larval and pupal populations which may otherwise survive the winter, the careful selection of seed cotton grades for ginning for plant seed, and the heat treatment of used hessian seed-cotton packs and plant seed before they are forwarded to growers (Wells and Veitch, 1942).

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† Snap cotton is cotton harvested in the boll at the end of the season after frosts have occurred. It is usually of inferior quality.

SOURCE OF PLANT SEED.

The seed cotton from which plant seed is ginned must grade strict middling light spot* or better. Occasionally a middling grade may be used if there is insufficient seed from better grades to meet requirements. Low grade and snap cotton, which are sometimes heavily infested with pink bollworm, are never used as sources of plant seed.

HEAT TREATMENT OF SEED-COTTON PACKS AND PLANT COTTON SEED.

After being emptied, the hessian seed-cotton packs are rolled into bundles and held in a heating chamber for two hours at a temperature of 320-325°F. to kill any attached larvae and pupae.

All plant seed is treated in the Simon heater before being issued to growers. This heater consists of a horizontal cylinder in which revolves a skeleton comprising several longitudinal steam pipes and an equal number of flanged bars which mix the seed and so distribute the heat through it. The heater is maintained at a temperature such that all seed passing through it is raised to between 136°F. and 142°F. Normally a bag of seed takes three minutes to pass through the apparatus and, although the outer layer of seed cools down somewhat after discharge and bagging, the temperature inside the stacked bags may remain high for at least another hour.

PINK BOLLWORM INFESTATION OF PLANT COTTON SEED.

When heat treatment of cotton seed was initiated in Queensland, it was believed that the pink bollworm species was *Pectinophora gossypiella* Saund. However, Holdaway (1926 and 1929), after detailed morphological studies of larvae, pupae and adult moths, considered the insect an indigenous species, for which he proposed the name *Pectinophora scutigera*. Although this insect was bred from several native Malvaceæ which occur in cotton-growing areas and elsewhere, Holdaway (1926) considered that distribution in seed was the chief method of dispersal. Since the extent of seed infestation and the status of heat treatment of plant cotton seed in the control schedule for pink bollworm in Queensland had been in doubt for some time, an investigation was made at Glenmore ginnery in 1941.

Plant seed was sampled before heat treatment and examined in the laboratory for insect infestation. Seed was collected twice weekly at the ginnery while treatment was in progress. If freshly ginned seed was being fed into the Simon heater, a 1-ounce sample was collected from the seed stream

* Cotton grades are based on World Universal Standards for American Upland Cotton and are as follows:—M.F.—Middling fair; S.G.M.—Strict good middling; G.M.—Good middling; S.M.—Strict middling; M.—Middling; S.L.M.—Strict low middling; L.M.—Low middling; S.G.O.—Strict good ordinary; G.O.—Good ordinary. Every grade may be modified by light spot (l.s.) or yellow spot (y.s.) with the exception that no spot is allowed in M.F., no yellow spot in S.G.M., and no spot modifications are used with S.G.O. or G.O.

TABLE 1.

PINK BOLLWORM INFESTATION IN PLANT COTTON SEED BEFORE HEAT TREATMENT.

Date.		Grade of Seed Cotton.	Infestation of Seed Cotton.	Storage of Seed before Treatment.	No. of Seeds Examined.	Percentage Defective.	No. of Larvae.
				Days.			
May	21	S.M.l.s.	Slight	0	2,754	30·0	Nil
	23	S.M.l.s.	Slight	0	3,914	23·0	Nil
	27	S.M.l.s.	Slight	0	4,000	30·4	Nil
	30	S.M.l.s.	Slight	0	4,000	33·1	Nil
	30	S.M.	Slight	0	..	..	..
	30	M.l.s.	Slight	0	..	..	..
June	3	Unknown	Unknown	1	4,000	29·9	Nil
	10	Unknown	Unknown	4	4,000	33·2	1 dead
	19	S.M.l.s.	Slight	0	4,000	37·4	Nil
	24	Unknown	Slight	1	4,000	40·2	Nil
July	1	Unknown	Slight	4	4,000	34·8	1 dead
	1	M.l.s.	Moderate	0	4,000	38·6	Nil
	8	Unknown	Unknown	61	4,000	18·3	Nil
	10	M.l.s.	Slight	0	4,000	33·2	Nil
	10	S.M.l.s.	Slight	0	..	..	..
	17	Unknown	Unknown	92	4,000	32·7	Nil
	22	Unknown	Unknown	92	4,000	33·1	Nil
	24	Unknown	Unknown	92	4,000	24·2	Nil
	29	Unknown	Unknown	63	4,000	21·5	Nil
	31	Unknown	Unknown	92	4,000	23·3	Nil
Aug.	12	Unknown	Unknown	61	4,000	25·6	Nil
	29	Unknown	Unknown	35	4,000	20·4	Nil
Sept.	2	Unknown	Unknown	122	4,000	22·7	Nil
	5	Unknown	Unknown	122	4,000	30·2	Nil
	9	Unknown	Unknown	153	8,942	22·0	Nil
	12	Unknown	Unknown	92	6,803	24·1	Nil
				Totals ..	98,413	28·3	2 dead

at approximately 5-minute intervals. When seed which had been stacked for varying periods was being treated, the sample was taken from every third or fourth bag at a depth of about 10 inches below the top. In either case sampling was continued until about 4,000 seeds had been obtained on each occasion. Except in the case of recently ginned seed, it was not possible to ascertain the grade of the original seed cotton, nor the degree of pink bollworm infestation in it.

The seeds were examined individually in the laboratory for the presence of double seeds and insects within the seed. In order to separate good from suspected seed, each was subjected to firm pressure between a glass jar and the bench surface. If the seed coat cracked an injured kernel was suspected, and the seed was then cut for detailed examination. Seed was usually examined shortly after collection, though examinations were sometimes delayed for a week, during which period the seed was always held in insect-proof jars.

The results are summarized in Table 1. Of 98,413 seeds examined, 28·3 per cent. were classed as defective. The insects found in the damaged seeds comprised *Pectinophora scutigera* Hold.—2 dead larvae; *Pyroderces* sp.—1 dead larvae; *Ephestia cautella* Walk.—28 larvae; *Tribolium castaneum* Herbst.—3 adults, 10 pupae and 25 larvae. No double seeds were found, nor any evidence to suggest that such seeds had been present in the original seed cotton. Defective seed comprised immature seeds, seeds with sound kernels but weak coats, seeds broken during ginning, diseased seeds and seeds in which the kernels had been destroyed by insects either in the field or during storage. Hard pieces of diseased seed cotton containing as many as four seeds were occasionally found in the seed samples. Other extraneous material included pieces of dry leaf petioles, fragments of leaf laminae, small dry bolls, grass and weed burrs.

The work extended over several months and included the sampling of plant seed ginned from seed cotton known to be infested. Pink bollworm infestation of plant seed, however, was negligible, and the few larvae recovered were dead. Storage pests were also unimportant even in seed held for as long as five months in the main seed shed. One sample of 3-months' old seed was infested with *Ephestia* and *Tribolium,* but it came from reserve stocks held near oil mill seed, in which these pests are usually active.

DISCUSSION.

The freedom of plant seed from pink bollworm larvae is largely due to the caution exercised in selecting the seed cotton from which it is ginned. Only a low level of infestation is permissible in high grade seed cottons, and plant seed taken from them is unlikely to contain many larvae. Any which are present appear to be removed almost entirely in the seed cotton cleaning processes which precede ginning. The three main units* of the cleaning processes are known as the "Airline Cleaner," the "Incline Cleaner," and the "Big Four Cleaner." These cleaners are equipped with revolving spiked rollers of various types and are designed to operate so as to thoroughly agitate the seed cotton, the operation in the "Airline Cleaner" being assisted by a current of air. Insects, dust and debris are separated and fall through grids to be conveyed to exits, while the cleaned seed cotton passes along the lines. Finally, just before the lint is torn from the seed by the gin saws, hulls, large pieces of plant fragments and diseased cotton which have escaped earlier cleaning are removed and diverted to another collecting bin. Much of the plant debris and most of the insects present are removed from the seed cotton in the first or "Airline Cleaner." Fewer insects are thrown out in the second or "Incline Cleaner," but some pink bollworm larvae are found in the collecting bins when infested seed cotton is being ginned. Very few insects reach the third or "Big Four Cleaner," and only occasionally are larvae seen in the associated bins. Larvae are rarely present in the waste material at the gin saws when high grade seed cotton is being ginned.

* These three cleaners were made by Hardwicke-Etter, Sherman, Texas, U.S.A.

The freedom of plant seed from larvae may also indicate an essential difference between the local species *P. scutigera* and *P. gossypiella.* Although *P. scutigera* injures green bolls in a manner similar to the other species, it does not appear to form a resting larval stage within the seed, and the double seed characteristic of the hibernating larvae of the latter insect has not been seen in Queensland. *P. scutigera,* however, has a prolonged larval stage in the winter, for larvae collected in late autumn and early winter and held with dry undelinted seed and trash did not pupate for periods as long as 16 weeks.

The absence of live larvae in plant cotton seed held at the ginnery emphasizes the importance of field sources in the infestation of the cotton crop. Chief of these are ratoon and standover cotton, crop residues and native host plants, while baling sites, storage sheds and railway trucks are of less importance. Ratoon and standover cotton are not now widely grown in Queensland, but the few crops found in most districts usually harbour the pest early in the season. They may therefore be sources of infestation for any adjacent plant cotton which sets its crop later. Crop residues, after picking is completed, are not always destroyed efficiently. Paddocks which carry weeds and grass at the end of the cropping period may be held as an insurance against pasture shortage in the dry winter and spring months. For this and other reasons, the farmer sometimes may not destroy old plants and plough the land during the winter. In scrub areas also, where the timber is felled and burnt before the cotton seed is planted amongst the stumps, Rhodes grass seed is usually broadcast during or immediately after the summer rains to establish a pasture when picking is completed. At the end of the season the old plants are seldom destroyed, although some may be grazed by cattle. In most areas, therefore, undestroyed plants are a potential source of pink bollworm infestation to cotton planted in the following spring and early summer.

Native Malvaceous plants, in which the pest breeds, occur most commonly in the scrub areas, but are also present in some forest lands. The complete destruction of these host plants is quite impracticable. Since undestroyed old plants on scrub burns are also commoner than elsewhere, greater losses from pink bollworm are experienced in cotton grown on scrub lands.

Appreciable numbers of larvae may be found in and around baling sites and storage sheds, particularly late in the season when crops are being snap picked. The larvae find harbourage in crevices of buildings and in the debris which occurs around them. Unless a thorough clean-up is made when harvesting in finished, the pest may be carried over from season to season in such places.

Seed and snap cottons are baled and then railed to the ginnery, where they may be held on platforms and in sheds for some time before ginning. *Pectinophora* larvae are often present on the outside of the packs, particularly those containing snap cotton from scrub lands, when they are unloaded from the trucks. Some larvae remain in the trucks while others find their way into crevices on the ginnery platform; as many as 100 larvae and pupae have been

counted in one linear foot of space between adjoining floorboards. Thus the insect may be carried from the ginnery to country areas in railway trucks when plant seed is forwarded to cotton-growers in late winter or spring.

CONCLUSIONS.

Treatment in the Simon heater serves little or no useful purpose for the control of *P. scutigera* in Queensland, because infestation is negligible in plant seed ginned from high grade cottons. The important sources of infestation are in the field, and include ratoon cotton, standover cotton, undestroyed crop residues, and Malvaceous host plants in scrub areas. Baling sites, storage sheds, and railway trucks may constitute minor sources of infestation. Even if seed infestation did occur it would be of little significance compared to the sources of infestation in the field which are not, or cannot, be eliminated.

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