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THE FOUR-SPOTTED COWPEA WEEVIL

(Bruchus quadrimaculatus, Fabricius*)*

BY OTIS WADE
DEPARTMENT OF ENTOMOLOGY

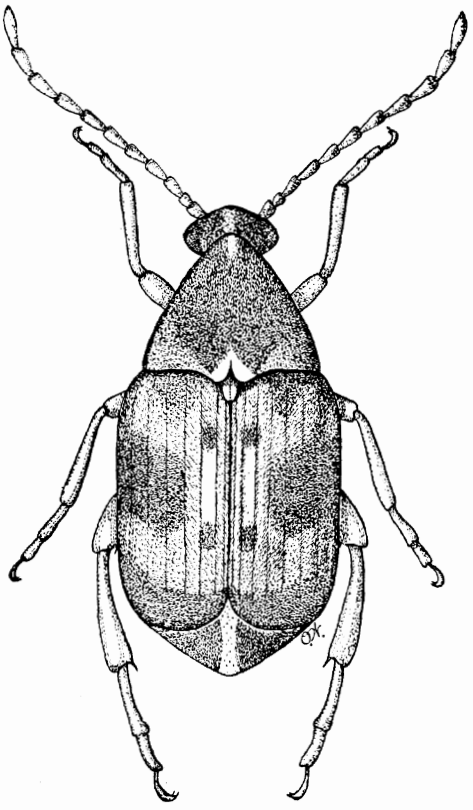

Figure 1—*Bruchus quadrimaculatus,* Fab.
Enlarged about 20 times

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THE FOUR-SPOTTED COWPEA WEEVIL

(*Bruchus quadrimaculatus,* Fabricius)

BY OTIS WADE
Assistant Entomologist

SUMMARY

Insect injury to cowpeas in Oklahoma has increased at an alarming rate in recent years. Observations indicate the four-spotted cowpea weevil to be the chief cause of the injury, especially to the stored seed. This species begins its depredations in the field, the female laying the eggs on the pods or on the seed through vents in the pods. The cowpeas, when brought from the field to the storeroom at harvest time, are almost certain to be infested, all stages—eggs, larvae, pupae and adults—being present.

They will continue to breed rapidly in the stored seed throughout the autumn and early winter, and during the winter, if it be especially mild or warm.

The cowpeas may thus be reduced to mere hulls and powder before spring.

During the past year (1918-19) seven generations and a partial eighth were reared in the life history experiments, conducted under conditions simulating those of the ordinary storage house.

Tests made during this time demonstrated that this weevil can be effectively controlled and stored cowpeas protected from damage by either of two methods, which are both practicable for common use.

1. Store cowpeas in ordinary bins or common sacks after having mixed the seed with air-slaked lime, using 1 part of lime to 8 parts peas, by weight.

2. Fumigate cowpeas with carbon bisulfide, using not less than 5 pounds carbon bisulfide per 1,000 cubic feet of space; dosing three times at intervals of one week (this method will insure weevil-free peas), then sacking in bags of close weave and tight seams, and tying the top securely.

The above methods will insure protection even though the weevil be in the vicinity or in the store rooms. It is impractical for the average grower to keep his store houses and premises entirely free from weevil.

Contrary to certain published statements, fumigation of cowpeas with carbin bisulfide for twenty-four, thirty-six or forty-eight hours will not insure weevil-free peas if infestation be present at the time of fumigating. Carbon bisulfide treatment does not injure the germinating qualities of the seed.

The storage of cowpeas in the pod without further treatment will not prevent their destruction by this pest.

No method has been devised to control or eliminate the weevil in the fields on growing cowpeas.

INTRODUCTION

Data collected at this Station in recent years indicate the Four-Spotted Cowpea Weevil (*Bruchus quadrimaculatus, Fabricius*) to be the most numerous of the weevils infesting beans and peas, and probably the most serious pest of the cowpea in Oklahoma. Observations fail to show the presence of *B. chinesis* in as great numbers, or as much damage by it. Cowpeas obtained for seed by Dr. Rolfs, horticulturist of this Station, from Texas, Tennessee, Louisiana and California also showed severe weevil infestation, the species invariably being *B. quadrimaculatus*.

Cowpea culture has developed rapidly in Oklahoma, and to date the cowpea is one of our most important legumes, both from a feed crop standpoint, and as a valuable rotation crop and soil-builder. However, the ravages of this weevil have of late so discouraged the growers that it was deemed advisable to perfect some practical methods and means for weevil control for their use. Also a study of its life history and habits was undertaken to get more complete information than was already known for intelligent procedure in control experiments.

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HISTORICAL

This species has been in the United States for many years. The earliest record of its presence seems to be by Oliver in 1795, who reports it from Carolina. Fabricius first described the species in 1792, and records it from Santa Cruz, West Indies.

Chittenden states that it is probably of foreign origin, native to the Orient, it having been brought over with its favorite food plant. Very little attention was given it by entomologists prior to the early nineties.

In 1885 it was reported as being numerous in Texas peas at the Atlanta Cotton Exposition, and again in 1893 at the World's Fair in various peas and beans.

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DISTRIBUTION

Bruchus quadrimaculatus is now to be found throughout the southern states and as far north as Iowa and New York. As Chittenden observes, it probably has followed its preferred host plant, the cowpea, and is present wherever this legume is grown.

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BIOLOGY

Distinguishing Characteristics of Bruchus quadrimaculatus

It is unlikely that cowpeas will ordinarily be infested with weevils of this group, other than the one being discussed, and the other cowpea weevil, *B. chinensis*. They can be separated readily by the following characters:

B. quadrimaculatus is the more slender, not so robust, and the

basal lobes of the thorax, due to white pubesence, are quite light in color, in contrast to the remaining darker portions of the dorsum. The antennae of the male are serrate.

B. chineses bears "two large, elevated, ivory-like lobes at the base of the thorax", and the antennae of the male are "strongly pectinate". Typical specimens of the quadrimaculatus have "four large black spots" on the back. However, the coloration varies so greatly that it cannnot be considered a true guide for either species.

Life History and Habits

Last year (1918) weevils were observed in the field, and eggs on the cowpea pods in late September. The first brood was issuing the latter part of October, as indicated by the exit holes cut through the shells.

The growth of cowpeas was materially retarded by the excessive drouth last year, which undoubtedly delayed the field breeding of the weevil. With early-planted cowpeas and a normal growing season the appearance of the weevil should be earlier by several weeks than herein recorded.

The female beetle lays her eggs quite readily on the green cowpea pods, indicating that the more mature peas are not necessary to weevil development. The egg is attached to the pod, or seed, through vents or cracks in the pod, by a glutinous substance, whitish in color. The larva on hatching bores directly down through the pod into the seed, and not through the upper unattached portion of the egg. The egg-shell is thus left intact from outward appearance. The empty shell, however, has a dull whitish color in contrast to the translucent appearance of the unhatched egg.

Temperature governs the development of all stages to a very marked degree. Moisture does not seem to be important or necessary.

Weevils were bred in successive generations in glass vials, tin boxes, paper and wooden boxes devoid of moisture, the adults taking neither food nor drink throughout their existence without apparent injury to them or effect upon their activities. Under these conditions adult females were kept alive for as many as forty days. The adult males are shorter lived, living but two or three weeks.

That the adults will drink was demonstrated on several occasions when water was given them, of which they partook greedily. So far as could be learned, access to water did not stimulate their activities or prolong their life. That they feed cannot be stated definitely; none were ever observed to do so, although it is quite possible that they may feed some on the green pods and foliage of the host plant.

Two varieties of cowpeas were used in the life history studies, the Blackeye and Whippoorwill. No preference by the weevil for either variety was indicated, they breeding readily in both.

The number of eggs deposited by females varies from eleven to more than 100, seventy-five being about the average with favorable

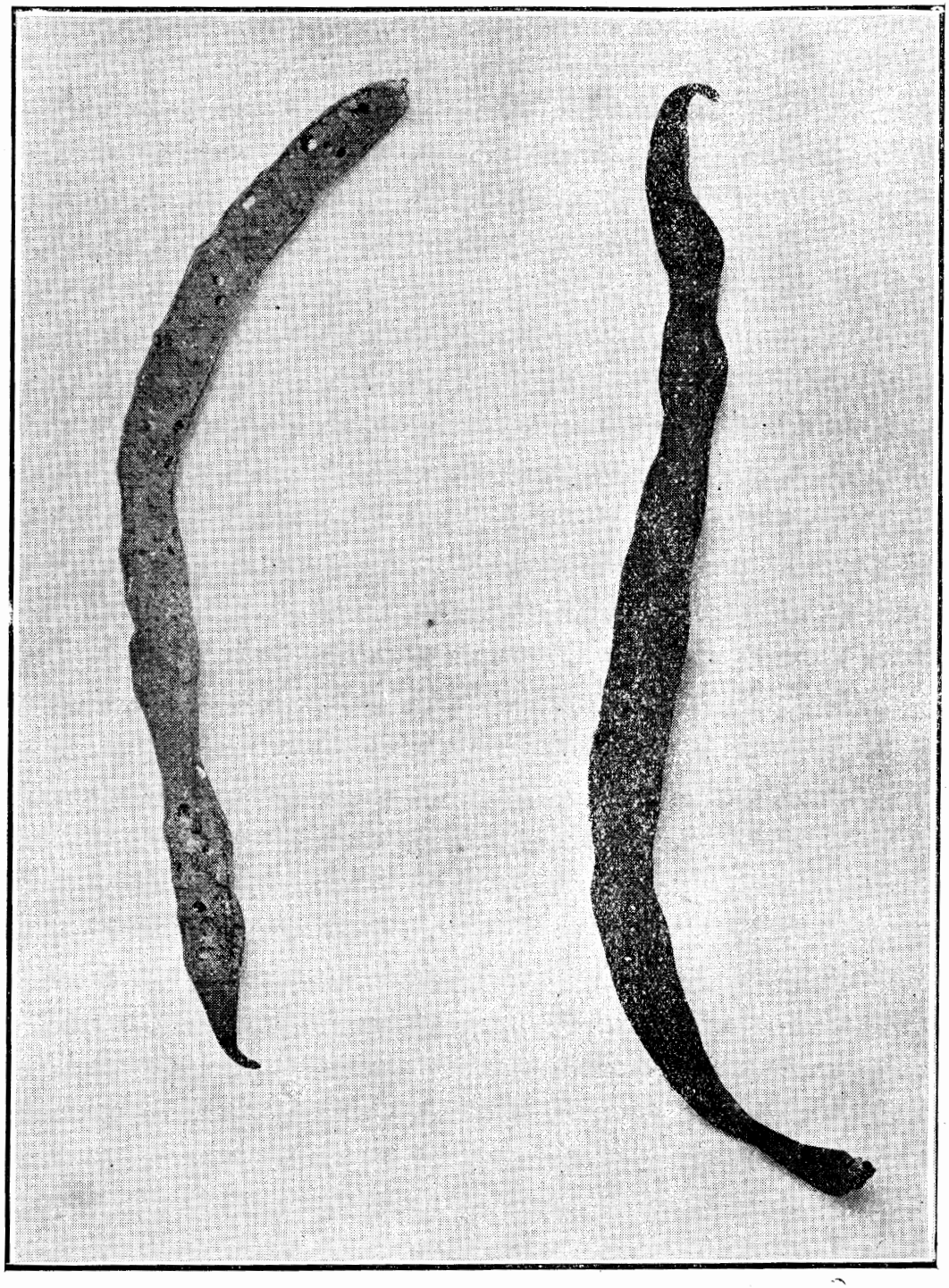

Figure 2—Cowpea Pods, Showing Eggs and Exit Holes of *B. quadrimaculatus*
(Photo by C. W. Rapp)

conditions obtaining. The larvae at maturity eat out a pupal cell to the surface of the seed, but leave the covering or skin intact. In this cell the larva transforms to the adult. The adult gnaws its wa yout, cutting a circular flap through the seed skin, leaving the characteristic round hole to be found in all infested cowpeas. If the peas are unshelled, then an exit is also gnawed through the pod, not so round or regular in outline as in the seed, and frequently too small for the adult to get through, it often becoming wedged in the hole, not being able to retreat or go forward, and is thus trapped.

When numerous, the female weevils oviposit great numbers of eggs on the cowpeas, and even on the sides of the containers. Very many larvae, therefore, are cut off in the first stage of their existence, and many times are so crowded even after entering the seed that, through the food shortage, many never reach maturity. Under such conditions there are many undersized adults, some less than half the size of the larger ones, and dwarf-like in appearance. Twenty or more larvae have been noted in a single seed.

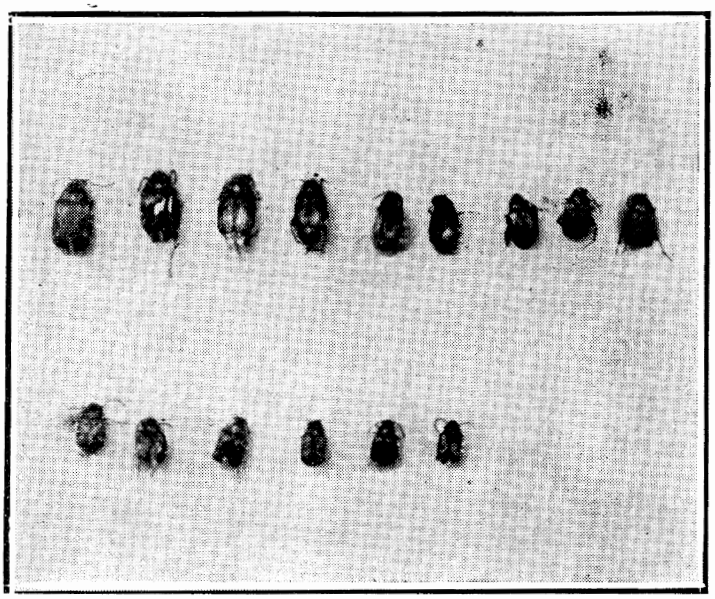

Figure 3—Adult Weevils, showing variation in size. While the males are smaller than the females, there is frequently a striking difference in the size of individuals of either sex; this being due largely to the amount of food the larvae are able to obtain. (Photo by C. W. Rapp)

Normally there are about seven generations annually in Oklahoma. In our life history studies the past year, seven generations and a partial eighth were successfully reared.

Following are the dates of these broods as indicated by the emergence of adults of each generation:

May 3, 1918, adults were placed with cowpeas and allowed to oviposit.
June 7, adults of first generation emerging.
July 11, adults of second generation emerging.

August 15, adults of third generation emerging.
September 19, adults of fourth generation emerging.
October 24, adults of fifth generation emerging.
January 15, 1919, adults of sixth generation emerging.
March 16, adults of seventh generation emerging.
May 25, adults of eighth generation emerging.

Females will mate and begin oviposition within twenty-four hours after issuing from the seed. All breeding experiments were conducted under conditions approximating those of the usual granary.

There is an evident resting or inactive stage through November and December. During warmer periods in January, February and March, they evidently resume activity, although slowly.

Duration of Life Stages

Egg.—The duration of the egg stage varies with temperature, being five to twenty days. With optimum conditions, six to eight days is the usual incubation period.

Larva.—This stage also varies considerably, the grubs reaching maturity from seventeen to forty days after hatching; nineteen to twenty days being common.

Pupa.—Pupation (or transformation from larva to adult) requires seven to nineteen days; the greater number transforming in eight to ten days through summer weather.

Thus we have a life cycle, with summer temperature prevailing, of thirty to thirty-five days; eighty-two days was the longest period noted.

Description of Life Stages

THE EGG is oblong, oval in outline, one end broadly rounded, the other apically pointed. The upper surface is convex; lower or attached surface, flat, slightly concave; color translucent, becoming whiter, especially after hatching.

THE LARVA, OR GRUB, at hatching has two-jointed thoracic legs. After entering the seed it molts and loses these legs. Thoracic plate, armed with six pointed teeth on lower portion, upper part also bears pointed teeth; color white to yellowish-white; head brownish.

THE PUPA is about the size of an adult with all appendages folded in front of body; the antennæ along sides, just outside wing pads and legs, wing pads prominent.

ADULTS.—Length 2 to 4 mm., width 1 to 2 mm. Size varies, due partly to quantity of food. Male smaller. Antennae prominent, serrate in both sexes. Eyes globose, large. Elytra striate.

COLOR OF BODY VIEWED FROM ABOVE.—There is an exceedingly wide range of color in this species, varying from a dark or almost black, to brown or reddish-brown. The middle of the elytra (wing covers) along the lateral edges may each bear a large black spot, and each tip may be blackened. there may also be, due to the coloration of the pubescence, a short, light line on and parallel to the inner margin of each elytron, and terminating in a small black spot at each end.

This is frequently wanting. Many individuals have almost solid color with very little marking.

Tip of abdomen dark, separated by light line down the middle. Small scutellum, usually light colored. Thorax dark except basal lobes, which are faintly raised and light to whitish in color. Head black. Base of antennae reddish.

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NATURAL ENEMIES

A hymenopterous fly (*Bruchobius laticeps,* Ashmead*) is a common parasite of this weevil in Oklahoma. It makes its appearance late in June and early July and again in late September and October.

Last year it was present in considerable numbers; and in several quantities of stored cowpeas being used for breeding purposes, it was effective enough to finally completely rid the peas of the weevil. However, it was confined to the cages, and no doubt was more efficient as a check on weevil development for that reason. Normally, while it probably destroys many immature weevils, the damage is done to the cowpeas before this parasite can materially reduce the numbers of the weevil.

A common dermistid (*Dermestes sp.*) is to be found in cowpeas badly infested with *Bruchus quadrimaculatus.* It, however, is of no value as a parasite since it lives on the dead bodies of the weevil and other material, as the powder, trash and decaying cowpeas, while it does add considerably to the unfitness of the peas for use.

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CONTROL MEASURES

Tests for weevil control were begun in June, 1918, and continued one year, to June, 1919. They were conducted along two lines:

1. By treating the cowpeas with material, such as air-slaked lime, sulphur and Hofstra, depending on such treatment to prevent the weevil breeding in same.
2. By first fumigating the seed to obtain weevil-free peas, then storing in sacks of various thicknesses or coating sacks with whitewash to ascertain if any of these methods would prevent the entrance of the weevil.

Two varieties of cowpeas, the Whippoorwiill and Blackeye, were used. The weevil infestation was about 4%. All experiments were duplicated. The sacks used were of stout, close-weave material with tight seams.

Air-Slaked Lime

The use of air-slaked lime mixed with peas had been tested by Professor Z. P. Metcalf, North Carolina Experiment Station, and reported on favorably by him. Our tests duplicated his in general, except that a

*Mr. A. B. Gahan, United States Bureau of Entomology, very kindly identified this parasite through the courtesy of Dr. L. O. Howard, chief of the bureau.

greater series in amount of lime used was tried, and the cowpeas so treated were put in both sacks and box bins. Lime was used with peas in the following quantities by weight:

Lime 1 part, peas 1 part
Lime 1 part, peas 2 parts
Lime 1 part, peas 4 parts
Lime 1 part, peas 8 parts
Lime 1 part, peas 10 parts
Lime 1 part, peas 12 parts

When the experiment terminated in 1919 the cowpeas so treated were found to be in the following condition:

Lime 1 part, peas 1 part—no further weevil damage
Lime 1 part, peas 2 parts—no further weevil damage
Lime 1 part, peas 4 parts—no further weevil damage.
Lime 1 part, peas 8 parts—no further weevil damage
Lime 1 part, peas 10 parts—weevil continued to breed in these peas, doing serious damage. The peas treated with lime at the rate of 1 to 12 were also unfit for use.

CONCLUSION.—Cowpeas can be safely kept when mixed with air-slaked lime at the rate of 1 part lime to 8 parts peas, by weight. Nor is the objection to peas for table use, when so treated, valid, since they

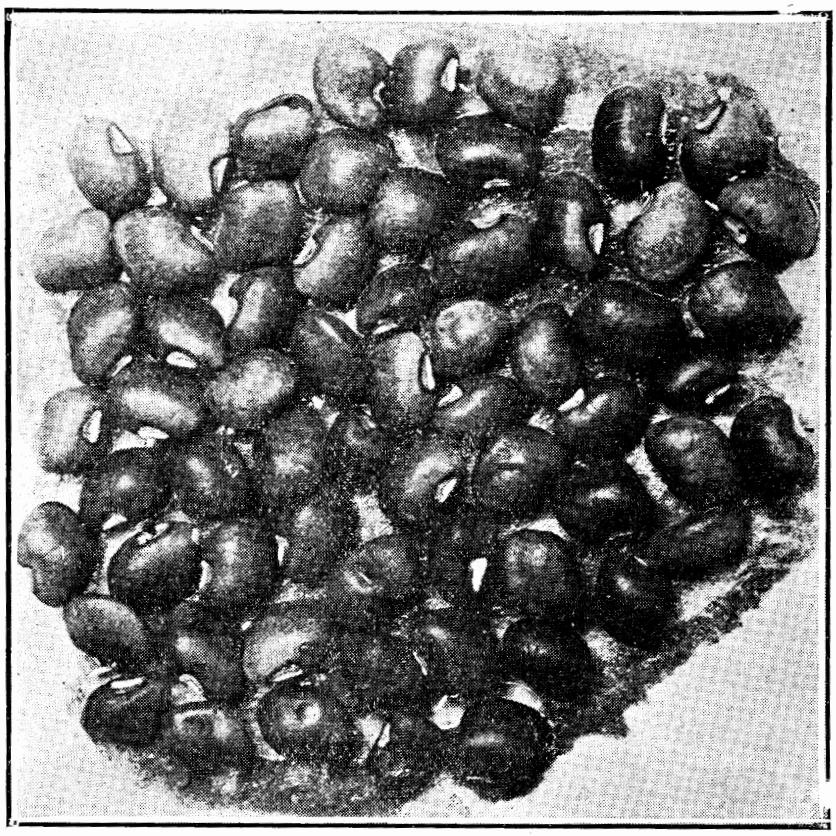

Figure 4—Cowpeas from lots which had been treated with lime (1 to 8) and kept for one year. (Photo by C. W. Rapp)

are thoroughly washed (or should be) before cooking, and any seed having cavities which might contain lime, removed. Certainly the lime is no more a "nuisance" than the immature weevils present in the peas which we eat.

Since these tests were begun, Metcalf, using larger amounts of cowpeas, reports that same results were obtained with lime by simply spreading a layer of it over the seed in the bin. Unless the bin is tight and no weevils present in it at the time the peas are stored it seems there would be danger of the weevil working at the sides and bottom of the bin. This might be overcome by first dusting the bottom and sides of the bin with lime.

Sulphur and Hofstra

In addition to lime, sulphur and Hofstra (an insecticide in powder form, manufactured by the Hofstra Manufacturing Company at Tulsa, Oklahoma,) were used at the rate of 8-10-12-14 parts peas to 1 part sulphur or Hofstra. Satisfactory results were obtained in each test, but since the cost greatly exceeds that of lime, they are not recommended for general use.

Fumigation With Carbon Bisulfide

One of the first difficulties encountered in our tests was to kill all stages of the weevil in cowpeas by fuminating with carbon bisulfide for the usual length of time.* It was determined before proceeding far that all of the immature stages were not overcome by the fumigant, especially where several bushels were treated. At first it was thought that the eggs, due to the glutinous secretion covering them, and the fact that the eggshell on the exterior surface is not broken at hatching, were not affected. Careful experiments, however, showed that the eggs can be killed with a dosage of 5 pounds carbon bisulfide per 1,000 cubic feet of space for forty-eight hours in a tight fumigatorium, or 8 pounds carbon bisulfide for twenty-four hours.

Tests made with seed containing larvae and pupae showed that the larvae were not all killed when fumigated for forty-eight hours if quantities of a bushel or more were treated. This is probably because the entrance to the larval channels either become closed by the growth of the cowpea, or are filled tightly with the powdered cuttings and excrement of the grub, thus preventing the entrance of the vapor of the fumigant. Briefly, the larvae are practiclly sealed within the seed, and if there be any quantity of seed it is just so much more difficult for the fumigant to penetrate to the center of the mass. With only a few adults emerging, reinfestation will then continue at a rapid rate after the peas are stored. It is therefore absolutely necessary that all weevils in all stages be destroyed before sacking. It was found that this

*Osborn and Mally were unable to get weevil-free peas with a single treatment lasting twenty-four hours, and advised fumigation for about four weeks. Krall, in Circular No. 31, this Station, also questioned the possibility of killing all immature forms with one application.

could be accomplished by charging the fumigatorium three times at intervals of one week, using at least 5 pounds carbon bisulfide per 1,000 cubic feet of space.

After getting sufficient quantities free from infestation they were sacked in lightweight, close-weave muslin sacks, with tight seams, and tied securely at the top to prevent entrance of weevil. These bags were then stored in a small frame building having a brick floor.

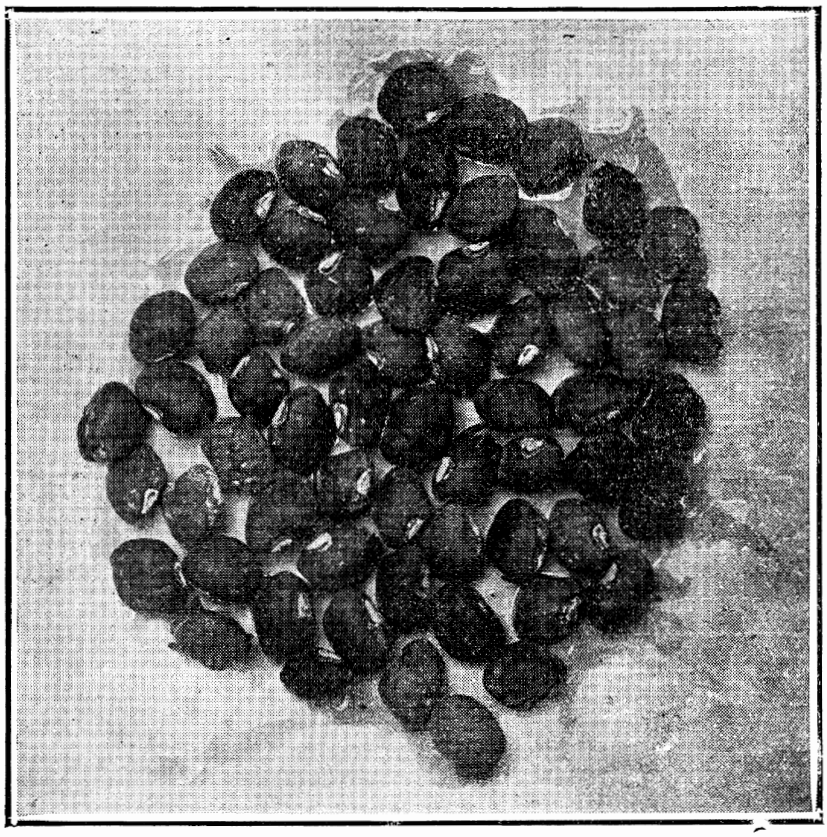

Figure 5—Cowpeas which had been fumigated, sacked in single bags and kept for one year. (Photo by C. W. Rapp)

Infested peas were scattered over the floor and the sacked ones placed on the floor together with the checks (see illustration). The checks were not fumigated, but were sacked as were the treated ones. One, two, three and four thicknesses of sacks were used. The experiment began June 10, 1918. They were examined November 4, 1918, and found to be in excellent shape. June 30, 1919, they were again opened when the experiment was terminated, and found to be weevil-free.

The peas in sacks of one thickness were as free from weevil as were those in the sacks of two, three and four thicknesses.

Some tests with whitewashed sacks also preserved peas from further weevil attacks.

Figure 6—Cowpeas from "checks", untreated, showing weevil damage during one year. (Photo by C. W. Rapp

The checks were reduced to mere shells and powder, and partially decomposed.

CONCLUSION.—Cowpeas made weevil-free by fumigation with carbon bisulfide and then sacked in bags of strong, closely woven material with tight seams will prevent entrance of more weevils and protect peas from their ravages.

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FUMIGATORIUMS

There are a number of receptacles or containers which can be used for fumigating purposes that are usually available and cheap, where not too great quantities of cowpeas are to be treated, such as stone jars, waste paper cans, washtubs, washboilers, etc. Canvas makes a good covering for the vessels, also several thicknesses of newspapers, if cheesecloth or other cloth is placed over the paper to prevent tearing when tied.

Barrels make very good containers in which to fumigate if they are tight and dry. Both these conditions, however, are difficult to have at the same time. If the barrels are not tight, and have to be first soaked in water, then a great deal of the effectiveness is lost through the consequent moisture retarding the full generation of the fumes.

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