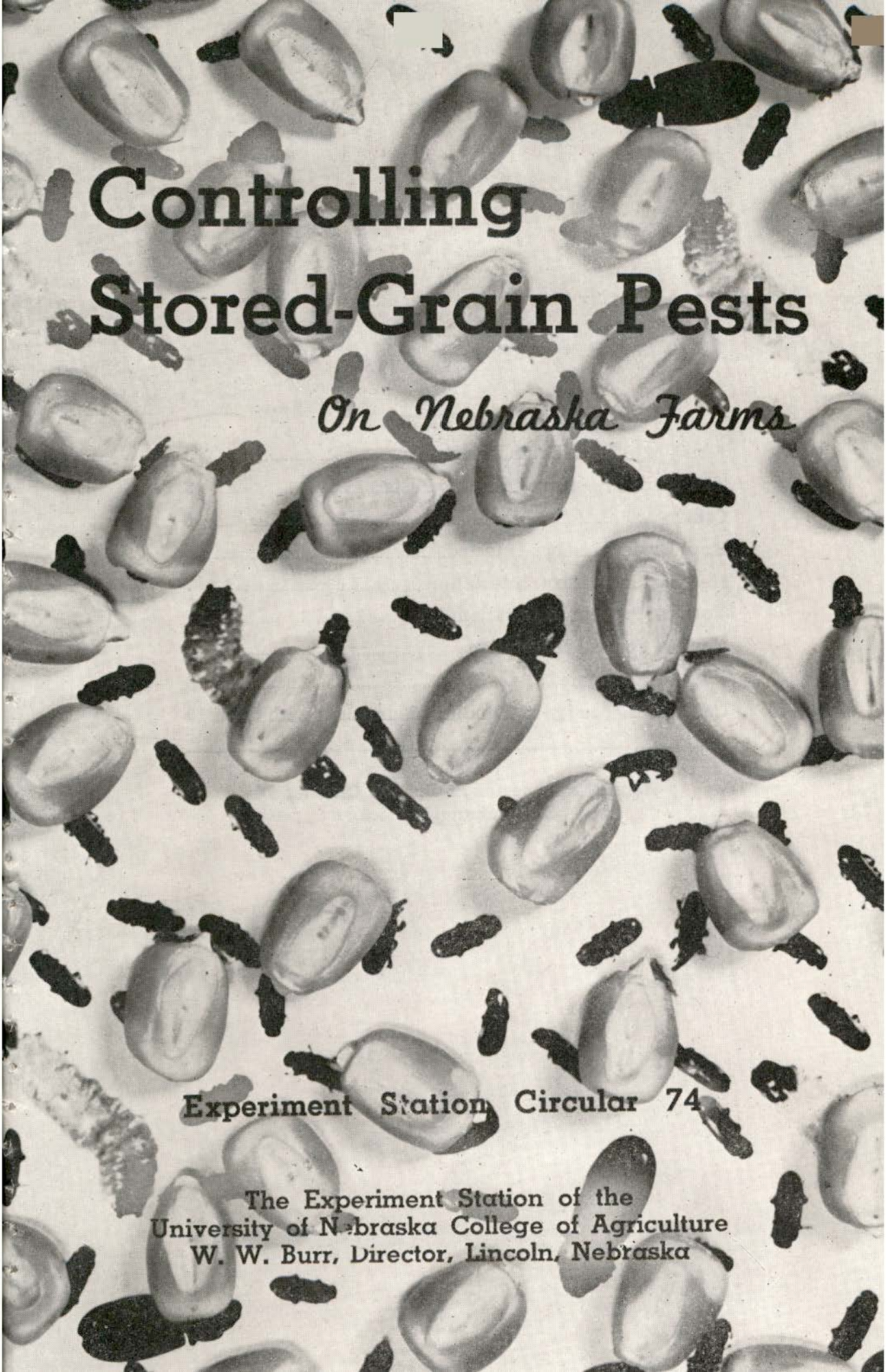
11-1943

Controlling Stored-Grain Pests on Nebraska Farms

H. D. Tate

D. B. Whelan



Controlling Stored-Grain Pests

On Nebraska Farms

Experiment Station Circular 74

The Experiment Station of the
University of Nebraska College of Agriculture
W. W. Burr, Director, Lincoln, Nebraska

CONTENTS

Nebraska Experiment Station Circular 74
November, 1943, 5m

Controlling Stored-Grain Pests on Nebraska Farms

H. Douglas Tate and Don B. Whelan

WARFARE against destructive insects is not ended when grain has been placed in the bin. Here it is subject to attack by stored-grain pests which reduce its weight, feeding quality, and value for seed. These losses become especially serious when large stocks of grain are held for extended periods on farms and in warehouses. This circular describes methods available for handling and storage that will prevent or suppress infestations before they reach serious proportions.

Kinds of Stored-Grain Insects

Many kinds of insects may be found in stored grain. Not all of them are destructive; only a few are able to cause serious damage to clean, dry grain. Several are primary pests in that they are able to bore into sound kernels, and their attack opens the way for many other kinds which feed upon damaged products. A number of the primary pests are called "weevils," while several other kinds of beetles, which live largely in milled or damaged grain are referred to by the grain trade as 'bran bugs."

The More Important Primary Pests

Weevils. The granary weevil and the rice weevil are among the most destructive insect pests of stored grain. The granary weevil (Fig. 1) is a shiny, dark brown to blackish snout-beetle, about 1/8 of an inch long. The rice weevil closely resembles it in size and general appearance. However, the rice weevil can fly and frequently infests grain in the field, whereas the granary weevil, being incapable of flight, infests only stored grain. Both of these weevils attack sound kernels and develop inside the grain. They also damage other seeds.

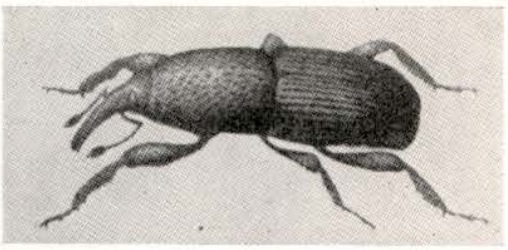


Fig. 1. Adult of the granary weevil. (U.S.D.A.)

Angoumois grain moth. The adult is a light-tan-colored moth, about 1/2 inch in length, with narrow, pointed, and fringed wings. The larvae, the stage which causes the damage, feed largely within wheat or corn kernels, frequently infesting ear corn, boring into the grains and filling them with holes (Fig. 2). In the southern states, where it is most destructive, field infestation often occurs.

The cadelle. This is an elongated flattened black beetle about 1/3 of an inch long (Fig. 3). The larvae, which are whitish in general color with the

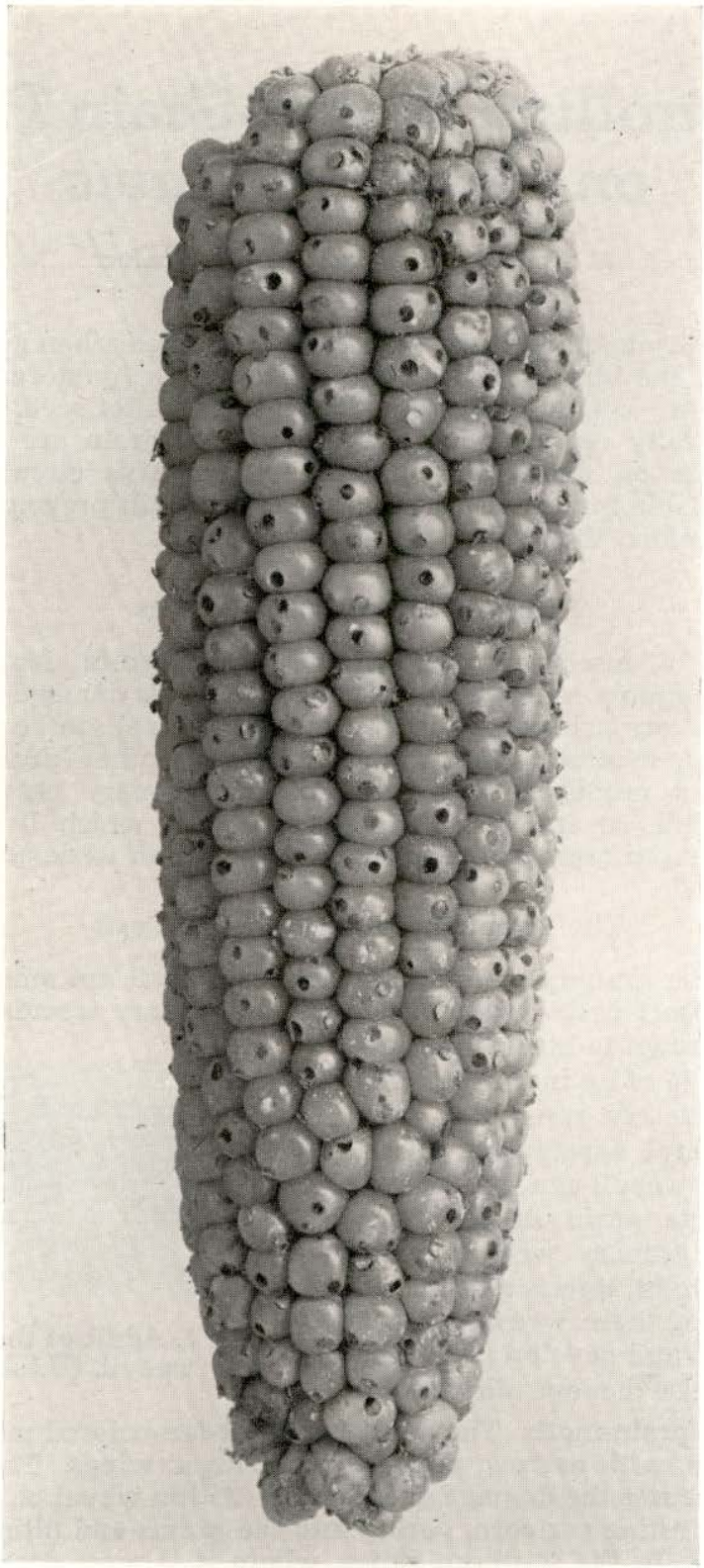
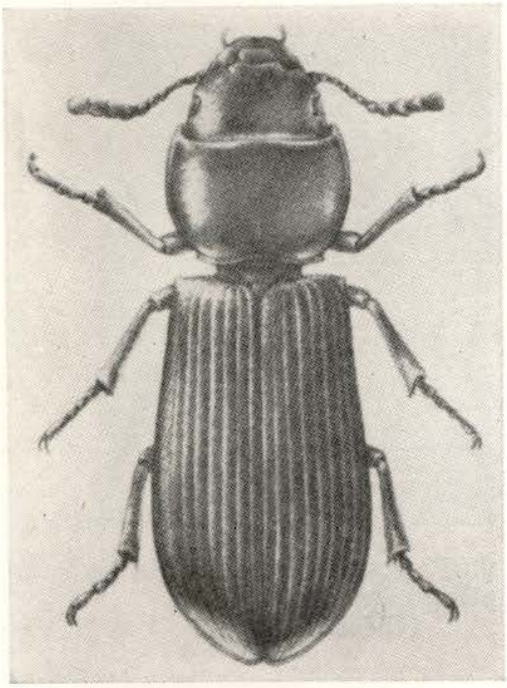


Fig. 2. Ear of corn showing emergence holes of the Angoumois grain moth. (U.S.D.A.)

rear segments black and ending in two sharp, horny points, are probably the most commonly noticed of the stored-grain beetles. Unlike other grain pests, they can burrow into the woodwork of the bins and remain there for long periods ready to attack new grain.

Indian meal moth. The adult moth is reddish-brown, about ½ inch in length, and has a grayish band across the fore part of each wing. Larvae of this species are among those most often found in grain or shelled corn. As the nearly mature larvae move over the grain, they spin a dirty silken web.

Mealworms. Adult mealworms are dark brown to black beetles about ⅝ of an inch long. The larvae are either waxy yellow or brownish in color, about an inch long when full grown, with hard wire-like bodies, resembling wireworms (Fig. 4). They are common pests of bran, meal, and similar products and are usually found in damp, decaying material. They will also attack grain in which there are numerous broken kernels.



← Fig. 3. The cadelle, one of the most common pests in farm-stored grain. (U.S.D.A.)

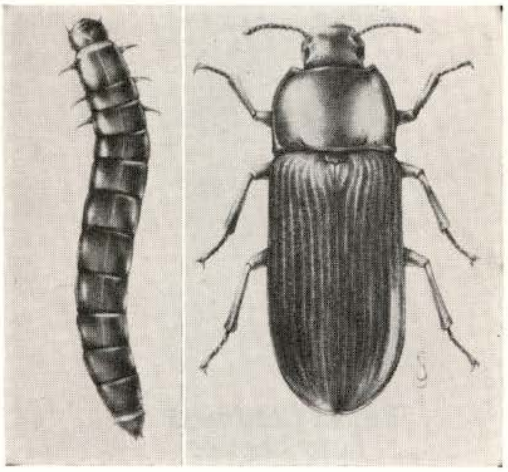


Fig. 4. The dark mealworm: a. larvae; b. adult. (U.S.D.A.)

"Bran Bugs"

There are a number of different kinds of "bran bugs" and fungus beetles, ranging in length from about 1/16 of an inch to 1/7 of an inch, and they are usually either brown or black. They are not regarded as primary pests since they feed in broken grain, moldy grain, grain dust, or grain damaged by other insects. They may, however, become even more troublesome at times than primary insects, which often do not survive winter in the Nebraska area.

Typical examples of these are the confused flour beetle (Fig. 5) and the red flour beetle which are the worst pests of flour. Their presence in

grain is chiefly responsible for infesting flour mills. The saw-toothed grain beetle (Fig. 6) commonly occurs in bins of oats, barley, shelled corn, and wheat. When present in large numbers, they may cause the grain to heat. This group also includes the so-called flat grain beetle (Fig. 7), and the foreign grain beetle.

Others

A number of other insects of varying importance occur in stored grain and grain products. Book lice, which are small, pale, soft-bodied, louse-like insects occasionally are present in large numbers, but cause no direct injury to the grain, since their food consists of foreign material. In addition, several kinds of very small, whitish-colored mites sometimes develop in grain that is damp or moldy or that contains a large proportion of cracked kernels or foreign material. Dry, clean grain is seldom infested by these mites.

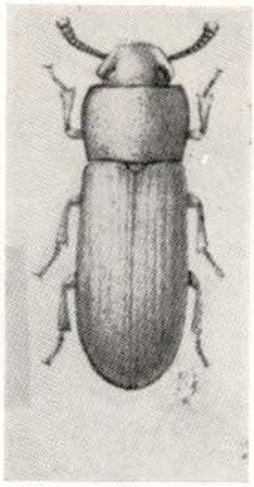


Fig. 5. Confused flour beetle. (U.S.D.A.)

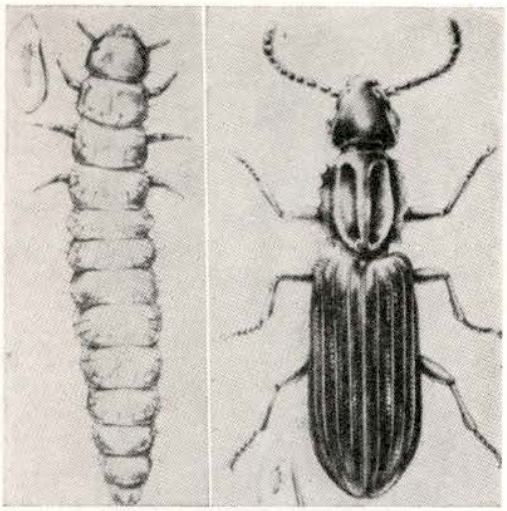


Fig. 6. The saw-toothed grain beetle: a. larvae; b. adult. (U.S.D.A.)

How Grain Becomes Infested

Infestation of grain on the farm may originate either in the field or in storage. Attack by the rice or black weevil and Angoumois grain moth may start in the field, since the adults can fly freely from place to place. In Nebraska, however, infestation usually starts in the bin, and frequently is due to the storing of grain in bins that were already infested. Insects are harbored in old grain left in the bin, in cracks and crevices filled with dust and broken grain, and in milled feeds, such as bran and shorts. Barns frequently contain materials in which such insects breed, with the result that granaries located in or near such buildings are particularly subject to infestation.

Heating and Insect Infestation

Heating of stored grain may be caused by too much moisture in the grain, a condition which is often accompanied by the development of stored-grain pests. As a general rule, the body temperature of insects is near that of their surroundings, but when they are active their temperature rises; and when large numbers of insects cluster together in bins of grain the excess heat and moisture produced by them is absorbed by the surrounding grain and "hot spots" are formed. With the approach of cold weather the surface layer of grain cools off more rapidly than the interior portion, and in infested bins the moisture produced by the insects condenses in the cool surface layers, causing mold and rot. Fumigation will not prevent or stop heating due to excess moisture in the grain, but it will stop heating due to insects.

How to Prevent Infestation

Keep grain cool and dry. Grain infesting insects are not active at temperatures below 40° F. and little breeding occurs until temperatures of 70° F. or more are reached. Also little or no breeding occurs if the moisture content is below 11 per cent and the temperature normal. With grain temperatures around 90° F., however, both weevils and bran bugs are able to develop in grain having a moisture content as low as nine per cent.

Store clean grain. Grain that is free from broken kernels, grain dust, and foreign material is less likely to become infested with insects. Bran bugs breed rapidly in bins full of broken kernels, dust, and other dockage, and their activities produce heat and moisture that puts the grain in bad condition.

Store grain in clean bins. In cleaning a bin, preparatory to putting in new grain, first sweep it thoroughly to get rid of all the grain, dust, and trash that have accumulated on the floor or in cracks, crevices, and burrows in the wood work. These sweepings should be removed and burned or otherwise destroyed immediately, never simply thrown out, because any pests present may crawl back to attack the grain. Wooden bins which have been infested should be sprayed or scrubbed with some disinfesting liquid that will not impart an odor to the stored grain. For this purpose spray with a light, technical grade mineral oil or other refined oil that is free from objectionable odors or use a spray prepared as follows:

Dormant tree spray oil	one gallon
Lye	three ounces
Water	nine gallons

(Mix the lye and water and then add this to the oil.)

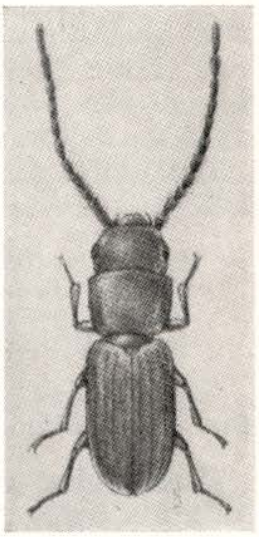


Fig. 7. The flat grain betle, the smallest "bran bug" found in stored grain. (U.S.D.A.)

Enough of the oil or spray should be used to cover the woodwork thoroughly without leaving an excess of the liquid. One gallon is enough

to treat about 50 to 100 square feet of surface. Scrubbing the bin thoroughly with boiling hot lye water made by dissolving a pound of crystal lye in two or three gallons of boiling water, and working this solution into the cracks of the floor and the walls of wooden bins has also been recommended. A treated bin may be used as soon as it has dried or within a day or two after treatment.

How to Control Infestation

In farm storage, fumigation is the only practical method of stopping damage after the grain has become infested with insects. The fumigants that can be used successfully are limited to those heavier than air. Two of these are commonly used at the present time in Nebraska: (1) a 3-to-1 mixture of ethylene dichloride and carbon tetrachloride and (2) carbon disulphide. A number of commercial brands of these products, or combinations containing them, are now on the market.

Ethylene dichloride-carbon tetrachloride mixture. This material, often referred to as the ED-CT mixture, has been found to be best suited for the treatment of farm-stored grain. It is effective, reasonable in cost, noninflammable, and has no adverse effect upon the germination or milling qualities of grain if used as directed. The mixture is a colorless liquid, with an odor resembling that of chloroform. Although the gas is very harmful when breathed in concentrated form, as ordinarily used, the operator is not likely to be exposed to dangerous concentrations. It is more than three times heavier than air and readily penetrates to the bottom of the grain bin or other container. The mixture weighs about 12 pounds per gallon and thep rice is 75 cents to $1.25 per gallon depending upon the quantity purchased.

Amount to use. If properly applied in tight, well-constructed bins the following amounts will give satisfactory control:

Ordinary tight bins	6 gallons per 1000 bushels
Shallow bins with large surface area	8 gallons per 1000 bushels
For smaller quantities of grain	2 quarts per 100 cubic feet
Fifty-gallon barrel, drum, etc.	14 tablespoonfuls (7 ounces)

Caution: Seed to be used for planting may be damaged if exposed more than about 24 hours.

Carbon disulfide. For many years carbon disulfide has been widely used for grain fumigation. From the standpoint of effectiveness, ease of application, availability, and cost, it is one of the most efficient fumigants. When used in moderate concentrations, it is not injurious to the germination of the grain. It is, however, one of the most dangerous to use because the vapor is highly inflammable and explosive; and, furthermore, fire insurance is likely to be voided while carbon disulfide is being used. As a result, it has been replaced to a considerable extent by safer materials. Carbon disulfide weighs about 10½ pounds per gallon and varies in cost from 65 to 85 cents per gallon in large quantities to $2.50 to $3.00 per gallon in one-pound lots. In quantities sufficient for the average farm granary the cost is approximately $1.25 per gallon.

Amount to use.

Bins containing less than 500 bushels	4 gallons per 1000 bushels
Bins containing more than 500 bushels	3 gallons per 1000 bushels
For smaller quantities	1 quart per 100 cubic feet
Fifty-gallon barrel, drum, etc	7 tablespoonfuls (3½ oz.)

Other fumigants. Commercial mixtures of carbon disulfide and other chemicals such as carbon tetrachloride and sulfur dioxide, which are relatively free from fire hazard, are available. Also, a mixture composed of two pounds of chloropicrin in one gallon of carbon tetrachloride applied at the rate of two gallons per 1,000 bushels has been used successfully.

In recent years a mixture made by adding 10 per cent by volume of methyl bromide to the 3-to-1 mixture of ED-CT has come into use. The advantage of this mixture is that it is highly toxic, a two-gallon dose being equivalent to the six-gallon dose of the old mixture. It has the disadvantage, however, of being very dangerous to handle except by experienced workers who have special gas masks.

How to Fumigate

In fumigating stored grain with any of the fumigants mentioned in this circular the following requirements must be met if satisfactory results are to be obtained.

1. **Have the bin tight.** Do not attempt fumigation in poorly constructed, leaky grain bins for the gas must be held within the grain for several hours if the pests are to be killed. Since the average farm bin is not entirely gas tight, a maximum dosage usually must be used to compensate for the leakage.

2. **Level surface.** Before applying the fumigant, level off the grain and leave at least six inches of side wall extending above the grain. This will prevent the gas from flowing over the side and insure uniform penetration. Shallow bins having a large surface area require heavier dosages of fumigant than deep bins with a relatively small surface area.

3. **Cover surface.** In bins that have large open spaces and drafts above the surface of the grain it is advisable to place a tarpaulin or other cover over the grain after the fumigant has been applied. This will prevent loss from surface evaporation.

4. **Break up moldy layer.** A moldy layer caused by webbing of insects or condensation of moisture may form over heavily infested grain, particularly in bins that are "heating." Whenever present, such a layer should be broken up by raking to a depth of several inches and all sprouted or badly molded grain removed.

5. **Temperature.** A grain temperature of 65 to 75° F. is preferable. Satisfactory results usually cannot be obtained when the grain temperature is below 60° F. With high temperatures there is loss through excessive surface evaporation, whereas at low temperatures activity of the fumigant is lowered, penetration is poor, and the insects are more resistant. High winds are unfavorable since they increase the loss of fumigant through surface evaporation.

6. **How to apply.** The best results are obtained when the fumigant is applied evenly over the entire surface. This can be acomplished by means of some form of force pump, such as a small bucket pump or a garden

sprayer, to which a long rubber hose and spray nozzle are attached, thus permitting the operator to remain outside the bin (Fig. 8). Workers who have had extensive experience consider it unwise to enter the bin and apply the fumigant with a sprinkling can. In small bins it is sometimes possible to use a sprinkling can without entering the bin. Twenty-four to forty-eight hours' fumigation is sufficient.

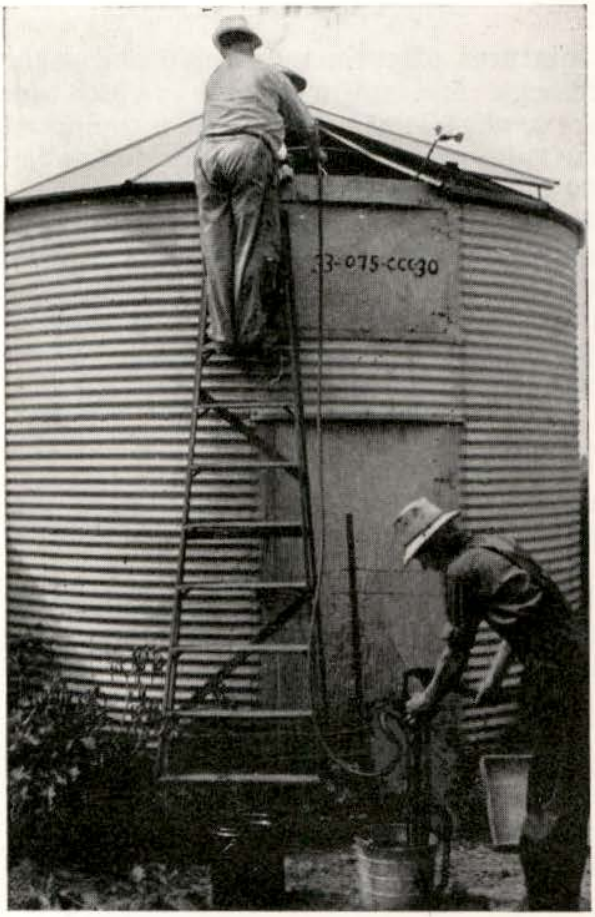


Fig. 8. Applying fumigant to grain with bucket pump. (Ill. Agr. Exp. Sta.)

Caution

The commonly-used fumigants act as anesthetics and are dangerous to handle. Extreme care must be exercised to prevent breathing the fumes. In case of spillage remove any clothing impregnated with the liquid and wash the skin thoroughly. Be sure the room has been well ventilated before entering after fumigation. An approved gas mask should be worn by anyone exposed to the concentrated vapors for more than a brief period. Under no circumstances should fumigation be carried out by a lone individual.

As carbon disulfide vapor is highly inflammable and explosive, fire and sparks must be avoided. Lighted lanterns, tobacco, sparks from electric switches, electricity produced by friction, or sparks made by striking metals together will ignite the gas. Serious damage may result, and even loss of life.