

INSECT POPULATIONS OF FARM WHEAT BINS IN OKLAHOMA AND EXPERIMENTS IN THEIR CONTROL

F. E. WHITEHEAD, Oklahoma A. and M. College, Stillwater

During the late summer and early fall of 1941 an unprecedented number of calls came to the Entomology Department of the Oklahoma Agricultural Experiment Station for assistance in getting rid of insects in farm wheat bins. This unusual demand for control of stored-wheat insects appeared to be caused by a combination of the following circumstances:

1. The insect population of stored wheat was unusually high during 1941. This condition was probably caused by the excessively rainy harvest period resulting in the wheat going into storage with a high moisture content, which is conducive to high insect populations.
2. The amount of wheat stored on farms in 1941 was the largest on record. This was due to a shortage of terminal storage facilities and an unusually large crop.
3. Loans could be obtained from the commodity credit corporation on this stored wheat provided certain conditions were met, one of which was freedom from insect infestation. Because so small a proportion of wheat could be sold, a great many applications for loans were made; and on account of the high insect populations, the bins had to be treated before the loans could be approved. The failure of a high proportion of the attempts to free the bins of insects resulted in calls for assistance.

In order to obtain better information concerning the problem, the writer spent several weeks in Garfield County and surrounding counties investigating the situation and testing control methods.

The investigations indicated that a high proportion of failures in bin fumigations were due mainly to the use of an insufficient amount of fumigant. Other causes of failure were improper method of application and conducting fumigations in buildings insufficiently tight to hold the fumigant. It became apparent that more information was needed concerning fumigation procedure and the species and relative numbers of insects present in the wheat. To obtain such information eleven bins containing from four to six feet of wheat were studied. Such bins were chosen because they may be sampled much more readily with an ordinary grain probe than those containing a greater amount. In sampling, the probe was thrust vertically to the bottom of the bin, filled, closed, and withdrawn, seven times in each quarter of the bin. After each probing the probe was emptied into a row of bread pans in such a manner that each compartment was dumped in the same pan each time. Since the compartments were at six-inch intervals, a sample from each six-inch level of the bin was obtained. In addition, a composite sample consisting of a mixture of the entire contents of five probes from different parts of the bins was taken, and another sample was taken by hand from the surface of the wheat. These samples were labeled and taken to the office of the district federal grain grader, where the grade, moisture content, and weight were obtained and recorded. Each sample was reduced to 1000 grams by passing it through a divider. It was then run through a "Leach Federal Dockage Tester" which sifts out dockage and insects. The pans into which the insects were sifted were then examined and the species and numbers of each species recorded for each sample. In the twelve 1000-gram samples obtained from each of these bins a total of 3447 live insects was found.

SPECIES OF INSECTS FOUND

Fig. 1 shows that the flat grain beetle (*Laemophloeus minutus* Oliv.) was much more abundant than all other species combined. Fortunately, this species is less injurious per individual than any of the other species. Also, the least numerous species found, namely, the rice weevil (*Sitophilus oryza* L.) and the lesser grain borer (*Rhizopertha dominica* F.), were the most injurious. In addition to the species listed on the chart, a very few individuals of other species were found including: hairy fungous beetles (*Typhea sterocera* L.), red flour beetles (*Tribolium castaneum* Hbst.), and rust-red flour beetles (*Laemophloeus ferrugineus* Steph.). These occurred in such small numbers that they were of little if any importance.

RELATIVE ABUNDANCE OF SPECIES

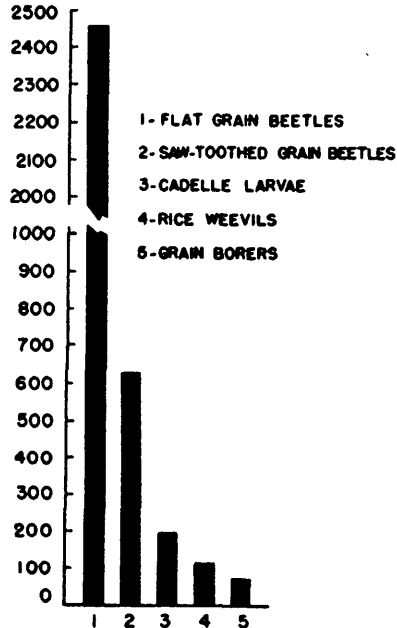


FIGURE 1.

DISTRIBUTION OF INSECTS ACCORDING TO DEPTH

Fig. 2 shows the distribution of all species according to depth. Numbers 1 to 10 inclusive show the populations at successive six-inch levels, starting at the bottom of the bin and progressing upward for five feet. Number 11 shows the population of the composite sample and Number 12 of the sample taken from the surface of the wheat. It will be noted that at the time these data were taken the surface of the wheat had by far the greatest insect population. Data taken later, after the arrival of cold weather, would probably give an entirely different picture of insect distribution.

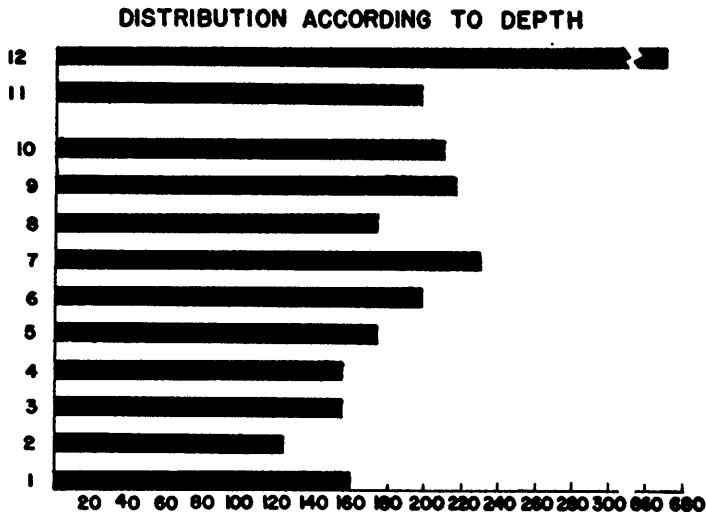


FIGURE 2.

RESULTS OF BIN FUMIGATIONS USING DIFFERENT METHODS

After the samples discussed above were taken, each bin was fumigated with carbon disulphide. In each case the fumigant was used at the rate of four gallons to 1000 bushels of wheat. This is the rate recommended when less than 1000 bushels of wheat are stored in a bin, which was the case in each of the bins studied. Carbon disulphide was selected because it was the only fumigant available in sufficient quantities to fumigate the infested bins, and the object of the experiments was to determine the results farmers might expect when using available material. Forty-eight hours after fumigation, similar samples were taken and analyzed. The percentage of decline in populations after fumigation was recorded as the measure of control obtained. In five of the bins the fumigant was applied either by spraying or pouring it evenly over the entire surface of the wheat. In the remaining six bins, an equal amount of the fumigant was poured into funnels that were shallowly inserted at 48 evenly spaced positions over the surface of the wheat.

With each of these methods of application in some cases the wheat was left uncovered and in others the entire surface of the wheat was covered with building paper immediately after applying the fumigant. Precautions were taken to keep other factors from varying. Fig. 3 shows the percentage of control obtained by each of the methods.

It is particularly interesting that there apparently was no advantage in covering the wheat after applying the fumigant. In literature on the control of stored-wheat insects it has frequently been recommended that carbon disulphide be poured from a sprinkling can on the surface of the wheat and the wheat then covered with a tarpaulin, old blankets, or any other convenient material to prevent the escape of the gas formed by the evaporation of the CS_2 . When this recommendation was first followed by the writer and an assistant, the outside temperature was $100^\circ F$, the temperature in the bin above the wheat $106^\circ F$, and that of the wheat 1 ft.

below the surface 91.5°F. The openings in the spout of the sprinkler had been enlarged to permit more rapid sprinkling; the materials for covering were carefully placed; and each step of procedure was carefully planned so that it could be completed in the shortest possible time. But even with these precautions, the fumes became so strong in the bin before the final steps were completed that both operators became very dizzy and were forced to leave the bin. This experience indicated that had a single individual attempted to follow the same procedure under the same conditions, the risk would have been too great. Therefore such a procedure should never be recommended or even suggested.

INFLUENCE OF METHODS OF APPLICATION

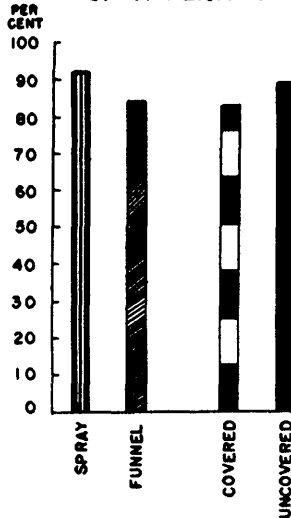


FIGURE 3.

Experience in conducting these experiments also showed that in using the funnel method the fumes never became anywhere nearly so strong in the bin above the grain as when the fumigant was poured or sprayed over the surface of the wheat. When this is taken into consideration together with the fact that the percentage of control was almost as high, the funnel method should be recommended for any occasion where it is necessary to go inside a bin to do the work. If on the other hand a spray pump is available so that the application can be made from the outside of the bin, then the slightly more effective method of spraying on the surface should be used. Under no circumstances should it be recommended that one go inside the bin to cover the wheat after the carbon disulphide has been applied.

EFFECT OF CARBON DISULPHIDE ON DIFFERENT SPECIES

It will be noted from Fig. 4 that 100 per cent of one of the most injurious species, the lesser grain borer (*R. dominica*), were killed in each case. No living individuals of this species were found in any bin following fumigation. It will also be noted that a very poor kill was obtained of the rice weevil (*S. oryza*), another highly injurious species. The low kill obtained in the case of this species is largely accounted for by the fact that in one bin very poor control generally was obtained and most of the individuals of this species were found in this particular bin. The reason of the poor kill in this particular case was undetermined.

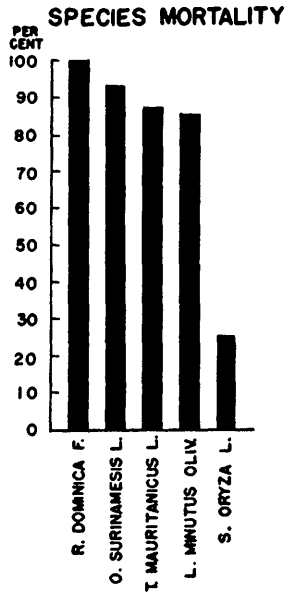


FIGURE 4.

COMPARATIVE MORTALITIES AT DIFFERENT DEPTHS

Fig. 5 shows that fairly uniform kill of the insects in all levels of the bin was obtained. It seems probable that a greater amount of data would have a tendency to level off the differences obtained in this particular respect.

INFLUENCE OF DEPTH ON MORTALITY

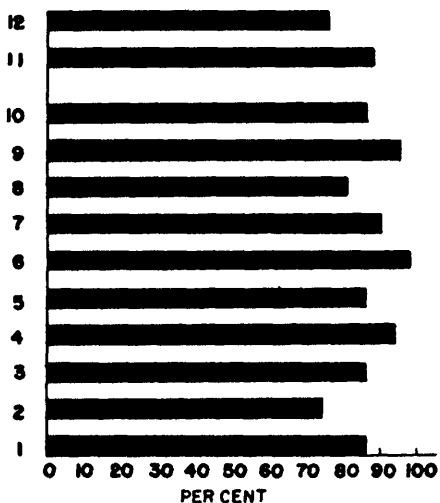


FIGURE 5.