it is necessary to use a shelf. Other than the one row transplanting machine as mentioned above, there are the 2 row and 4 row transplanting machines, and these latter two will be introduced to the market by two manufacturing companies in 1967. The process taken by these two machines is a little different from the one row machine although their mechanism equipped with the seedling box is constituted on the same principle as that of the one row machine. They are characterized only by their transplanting process.

The present situation of the rice seedling transplanting machines now in practical use or about to be used has been stated as above. As they can not be omnipotent to all conditions, it is essential not only to select one from among them in consideration of the condition of the field where seedlings are transplanted and of seedlings to which it is applied but also to have full knowledge of the machine itself and maintain it in perfect condition.

Rodent Control of Stored Grains

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It is well known that rodents damage all commodities everywhere in the world. Therefore, every country has been exerting efforts to control them.

A grain warehouse not only is full of food that is most attractive to rodents, but also provides them with most comfortable living quarters. Besides those warehouses also furnish a chance for them to abrade their incisors when they break through walls of the house from outside. Favored with these conditions of the warehouse, rodents have naturally a wide home range around it.

For controlling rodents in grain storages, there are measures both active and passive : the former being represented by chemicals such as rodenticide and rat repellent while the latter by rat trap to directly catch them. But most effective of all is chemical control. How and what chemicals are used in Japan and how successful is this usage ?

Selection and application of rodenticides

Rodents love to live near where human being live, and their food habits make them devour a large variety of things such as stored grains, structures of buildings, fixtures, clothing, etc., which shows distinctly their polyphagous nature. But they are so careful about any food strange in their home range and they can not be expected to readily eat strange foods. Therefore, the utmost care is required for the preparation of rodend baits.

Studies on 47 kinds of bait[1),2)] have shown that those with higher moisture content are generally effective for feeding. As a result, rodent control has been successfully performed chiefly with water soluble rodenticides in Japan. Now the coumarin-based chemicals[3)] are enjoying the highest popularity among the rodenticides[1),4),5)], which was once held by yellow phosphorus. In addition, sodium monofluoroacetate is also applied fairly widely. As rat repellents are developed, however, they are used combined with rodenticides with success.

Yellow phosphorus

This chemical has long been used for a rodenticide. It is like a paste with a peculiar smell, containing 8-10 percent of phosphor. As it is very toxic to the human body, it is important not to touch it directly when baits are produced from it.

Coumarin-based rodenticide

There are several kinds of coumarin-based rodenticide with different components and

most of them contain 0.5–1 percent of effective component. Some of them are powdered, while others are basified warfarin and water soluble. The latter are generally used for food storage. The water soluble ones are dissolved in water beforehand and then supplied every day in such a portion as rodents have consumed. Thus, the use of this chemical eliminates troubles arising from the preparation of baits. Besides it does not repel rodents.

The coumarin-based chemicals coagulate a rat's blood and kill it a few days after feeding. Although a lethal dose of the chemical is 50 mg per kg if it is given all at once, it can be reduced to 5 mg per kg each of 5 times applications in total. As noted in the latter case, it is a peculiarity of this chemical that the dose can be so much smaller if it is given in several portions.

The water soluble warfarin is on sale in the market in a package of 10 or 20 tablets, and is practically applied by dissolving 10 g or 10 tablets in one liter of water.

Baits made from yellow phosphorus or powdered coumarin-based rodenticide are definitely effective for controlling rats as explained above. But as rats that have eaten dried food want to drink much water, a water soluble rodenticide distributed in grain warehouse can drive all of them into death, even though they may have inflicted some losses to the stores. Thus, the use of this rodenticide is generally recommendable because of the above effectiveness as well as the convenience in handling it. But there is one thing to be noted here. It is that this chemical can hardly promise a complete control of rodents if the warehouse is located near a stream or any other supply source of water available to them. In such a case, however, a powdered rodenticide can be effectively used instead of the water soluble chemical. The chmical powder dusted in the warehouse will stick to some rodents which return home to transmit it to others, thus entailing a mass destruction of them all. The effect of this chemical powder is seen in the appearance of toxic symptoms in that the skin color of the ears and legs of poisoned rodents turns bluish and eyes are closed as if they had fallen asleep. Thus, the poisoned pass away without any sign of agony.

Sodium mono-fluoroacetate

This rodenticide is most poisonous of the kind and kills rodents as soon as they have bit it, that is, they fall to death within several meters from a bait made from this chemical. It is extremely poisonous to human being, too. As there is no toxicide now available, the utmost care should be taken in handling it.

This rodenticide is used for only 2-3 days when rodents have increased suddenly in a grain storage. All victims poisoned to death must be buried deep under the ground or burned to ashes as soon as they are found. The method of application of this rodenticide is to make a 1 to 5–10 solution of it, which is then put in a vessel exclusively used for water soluble rodenticide and distributed on the floor of warehouse. In view of the extremely poisonous nature of the chemical, as mentioned above, it should not be used too often. The rodenticide of sodium monofluoroacetate is officially designated as a special poison, the use of which is strictly controlled by law.

Rodent control by repellent[6),7)]

It is easily understood why rodenticides are used for rodent control but more difficult to understand why rat repellents are used for the same purpose.

The reason for this difficulty is a suspicion that if repellents drive rodents away from their haunt, they will migrate to other places to spread injuries wider. But they will not. Rodents live in groups that keep respectively to their home ranges and if those of one group catch sight of those of another group in their range, they drive them away or extirpate. Thus, the repellent forces rodents to migrate to a strange world with harsh and difficult conditions. The repellent has such effect. But if all rodents evacuate a place, those of another group come to occupy it and establish a new home range. Therefore, in order to clear the place completely of rodents,

it requires application of a repellent together with a rodenticide. And if the repellent is used for a grain warehouse with through knowledge of its effectiveness and application, it is possible to reduce losses inflicted by rodents to grains in storage to a minimum. Various studies have been made on repellents. Among them, an important one was started in the United States of America from around 1940. As a result, cycloheximide was discovered as a byproduct of streptmycin, an antibiotic. It is not only excellent as a fungicide for plant diseases but also unrivalled as a most effective rat repellent, and has wide drawn the attention of the world. It was named "Actidion". In 1950, Robert Tranb and his collegues made public a detailed report on repellence and poisonousness of cycloheximide to rodents. (Actidion)

In Japan, on the other hand, a research institute of one of the leading chemical companies discovered that an actinomycete called Streptmyces naraensis produced a substance to check the growth of enzymes, and named it Cliaciden. Further study was carried on through experiments on its physical and chemical properties to make clear whether it was the same substance as Actidion or not. At last it was evidenced that the two were the same. Thus Naramycin was registered as the trade name for Cliacidin. This trade name is related to Nara, the place where this actinomycete was first discovered.

Effect of cycloheximide

Cycloheximide is a white needle crystalline substance that is tasteless and odorless and gives no irritation to the human skin. It dissolves quickly in alcohol and other organic solvents, but never in petroleum ethers. It dissolves in water only to an extent of about 2 percent. Its stability in water solution varies with pH degrees, being highest at pH 2-5. The water solution of it maintains 89 persent of its efficacy for 50 weeks at 60℃. Heating at 100℃ for an hour never reduces it. The toxity of this chemical varies according to the kinds of rodent as shown in Table 1.

Repellency to rodents

It has not been proved yet whether the repellent repels rodents with its smell or taste. Its smell seems extremely strange to them while its taste is most disgusting. These two properties of repellent in combination supposedly arouse both conditioned reflex and stimulus to rodents.

According to the writer's experiments, a solution of 0.001 percent cycloheximide alone did not show any repellency to rodents, but when it was provided together with a food, it was completely effective though it was so weak a solution. Fig. 1 and Fig. 2 show respectively the relation between intake of baits by dagrees of concentration of applied solution and change in weight of rodents, and

Table 1 Acute toxity of Cycloheximide (LD 50).

Application / Item	Hypodermic injection (S. O.)	Venous injection (I. V.)	Oral application (P. O.)
Jap. house mouse	160 mg/kg 54 mg/kg (48 hrs)	150 mg/kg	133 mg/kg
Jap. house rat	2.7 mg/kg	2.5 mg/kg	1.8 mg/kg
Guinea pig	60.0 mg/kg		65.0 mg/kg
Rabbit		17.0 mg/kg	
Cat		4.0 mg/kg (abdominal injection)	
Dog			65.0 mg/kg

a curve showing a repellency of baits treated with the solution of repellent.

A water solution of 0.2 percent Cycloheximide is generally used for a rat repellent.

Basic problem and effect of rodent control

In controlling rodents damaging grains in storage, which rodenticide to select and how to apply it are very important to achieve the purpose perfectly. If a repellent is used combined with a rodenticide, it can check

Fig. 1 Relation between intake of Naramycin treated baits by concentrations and change in weight.

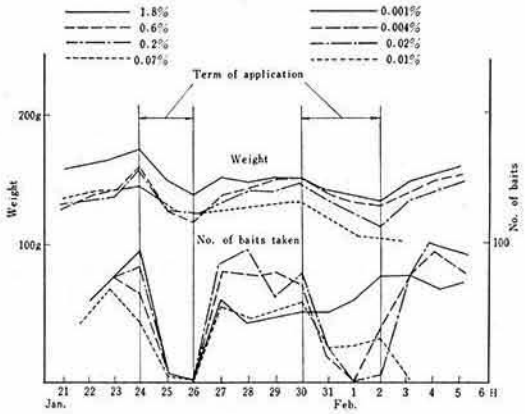

Fig. 2 Repellency of treated baits.

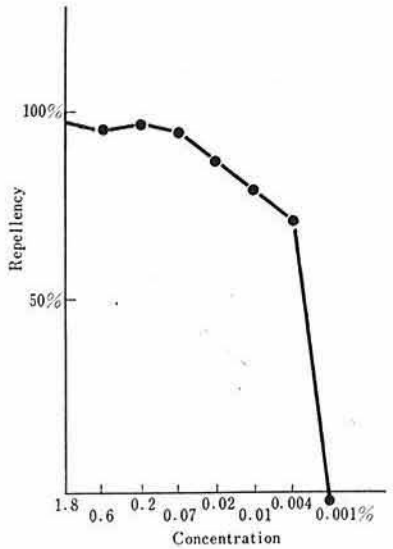

Fig. 3 Effect of rat repellent.
a : Non-treated b : Treated

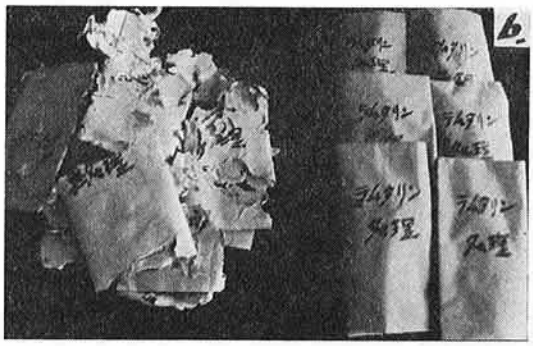

Fig. 4 Application of rodenticide and repellent, Dusting of coumarin-based rodenticide.

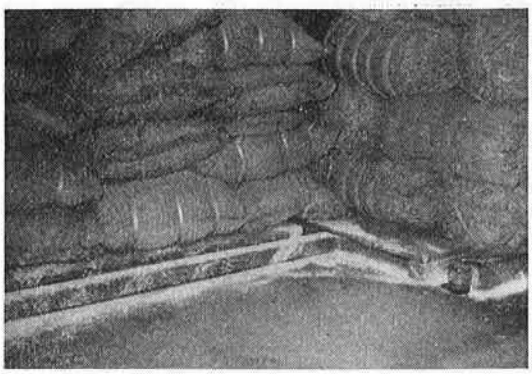

Fig. 5 Container of water soluble coumarin-based rodenticide and rat feeding it.

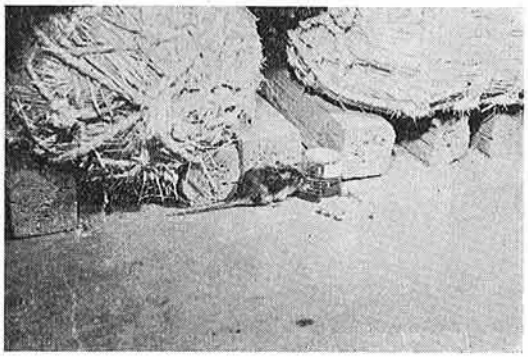

Fig. 6 Application of rat repellent. Applied to a passage of rat.

Applied around ventilation opening under the floor.

their invasion to warehouse. The repellent is applied to warehouse or grains themselves in storage with a great success. In addition, even grain containers are treated with some repellent. In other words, the rodenticide destroys rodents to keep stored grain safe on the one hand and the rat repellent drives away those invading the grain warehouse on the other hand. Furthermore, it will also serve the purpose of controlling rodents to search for a device or rodenticide that makes rodents ready to bite, and to arrange environmental conditions of warehouses inaccessible to them through further studies on their behavior.

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