Suggestions on Improvement of Chemical Application for Controlling Rice Stem Borer and Hoppers

By TOSHIATSU KOYAMA

Chief, Laboratory of Entomology, Central Agricultural Experiment Station

The application of granular insecticides directly into paddy field water has many advantages over spraying or dusting it over the rice plant. Usually it has a longer residual effect, is easy to apply, saves labor, is harmless to parasites and predators and its effectiveness is less susceptible to the influence of rain.

Recently the application of granules has been introduced to tropical countries owing to the fact that its usage does not require complicated equipment and hand application is adequate. Continuous study of this method of application has been pursued in Japan and the information thereof is now disseminated in actual field use.

In the case of BHC it has been shown that the lethal action of the insecticide against the larvae of the rice stem borer (*Chilo suppressalis* WALKER) is attributed to the translocation of γ-BHC by systemic and capillary action after dissolving in the paddy water.[1),3)]

It was presumed that granular formulations of other insecticides would perform similarly against the rice stem borer and even against the leaf and plant hopper.[1),2)]

Further studies were, therefore, made between 1966 and 1970 concerning the lethal action of insecticides applied directly to paddy water to control the smaller brown plant hopper (*Laodelphax striatellus* FALLÉN), the green rice leaf hopper (*Nephotettix cincticeps* UHLER) and the rice stem borer. This paper is a summary of the test results mainly conducted on the smaller brown plant hopper at the Central Agricultural Experiment Station.

Vapor effects of chemical granules

A laboratory test was carried out to study the effects of gas vaporizing from insecticide granules. A 27-liter sealed container was used and from 50 to 150 imagoes and larvae of the smaller brown plant hopper were put into the container for a period of 24 hours. The insects and granules were kept 30 centimeters apart.

The results showed that all the insecticides tested had a lethal effect although the insects were completely separated from insecticide. A 100% kill was observed in the cases of diazinon 3% granules and disulfoton 5% granules at 0.01 and 0.1 grams per container respectively.

However, Meobal® (3, 4-xylyl methylcarbamate), Tsumacide® (m-tolyl methylcarbamate), Baygon® (o-isopropoxyphenyl methylcarbamate), Mipcin® (o-cumenyl methylcarbamate), BHC, carbaryl and dimethoate did not give 100% kill even at 1 gram per container.

In another series of tests, the granules were immersed in 50 ml of water in a petri dish which was placed in the sealed container. This technique was considered much closer to the actual field practice of applying granular insecticides to paddy.

The results showed somewhat less effectiveness compared with dry granular application. Yet all the chemicals tested showed clear effectiveness except for Mipcin® and Baygon® which were considerably less effective.

Fumigant action was observed against the green leaf hopper but a lesser one against the smaller brown plant hopper. Diazinon 3% granules and Mipcin® 4% granules each at 0.1 gram per container gave the higher kill but there was a kill of only 60% against the imagoes of green rice leaf hopper. In general, when the granules were immersed in water, the lethal effect decreased considerably.

A further investigation was conducted to check whether or not diazinon vapor was effective against the first generation stem borer and the second generation smaller brown plant hopper which flies into paddy from wheat and fallow land in the early stage of rice cultivation after transplantation.

For this purpose tapes and gutters were laid out 20 days after transplantation in early June during the stages of egg-laying by the stem borer moth and as the smaller brown plant hoppers were beginning to fly into the paddy.

The tape method involved immersing medical bandages in diazinon solution diluted with acetone liquid and when dry, stretching the bandages between the rows of rice plants. They were set parallel with the plant rows at one meter intervals (Fig. 1). The other method, the gutter, involved setting out gutters, parallel with the rice plant rows at one meter intervals and 20 cm high, supported by bamboo sticks (Fig. 2). Therefore, the tapes and the diazinon granules placed inside the gutters were kept apart, from both the rice plants and paddy water in both methods.

Fig. 1. Tape method

Fig. 2. Gutter method

Both clearly showed fumigant action to at least a degree equal to that of paddy water application. The population of imagoes of the smaller brown plant hopper and damaged stem caused by the rice stem borer were both less than normal in spite of the strong winds dur-

Table. 1. Summary of results of three trials in controlling rice virus diseases by various applications of diazinon granules (1968)

Name of insecticide	Method of application	Active ingredient per ha	Diseased plant %	
			Striped	Black streaked
Diazinon	Gutter	6.5 kg	0.1	0.8
		1.5	0.7	4.0
	Tape	6.0	0.4	0.2
		1.5	1.0	0.6
	Surface of paddy water	1.5	2.3	3.6
Untreated check			6.5	11.7

ing the test period. The occurrence of diseased plants caused by the smaller brown plant hopper was much fewer in the case of both the tape and gutter tests than in that where the paddy water application was used (Table 1). These tests demonstrated the lethal effects of gas which had vaporized from the insecticide.

A similar effect was observed in the case of the larvae of the first generation stem borer and it was concluded that it was due to the absorption of the gas by the plant (Table 2).

The fumigant action of the diazinon and the Salithion® were reconfirmed by using the same gutter method in the field. Living imagoes of the smaller brown plant hopper were kept in net cages hanging over the rice plants and the high mortality rate and the persistence of the vapor were observed as shown in Table 3. The population density of the smaller brown plant hopper imagoes was kept lower using the gutter method than by direct application of the insecticide to the paddy water (Table 3).

In another series of tests, the comparative effectiveness of micro-granules of diazinon was examined in the paddy rice at the head-sprouting stage. The ideal micro-granule was regulated to be capable of passing through a 48–150 mesh of Tyler sieve, equivalent to a granule diameter of 105–297 μ. In fact, for the actual trials the size available was capable of passing through a 50–100 mesh sieve.

The results showed that 20 to 30 per cent of the micro-granules adhered to the rice plants when sprayed by a auto-duster with a polynozzle hose at a rate of 20–30 kg/ha. This compared with only 15% adhesion in the case of powder.

In addition the micro-granular diazinon gave better control than the powder applied to the smaller brown plant hopper and the green rice leaf hopper. It was thought that the better

Table. 2. Number of injured stems caused by the first generation rice stem borer in 720 plants (1968)

Name of insecticide	Method of application	Active ingredient per ha	Discolored stems	Dead hearted stems
Diazinon	Gutter	6.0 kg	275	65
		4.5	677	67
		3.0	1,647	126
		1.5	1,867	135
	Tape	6.0	189	100
		1.5	2,846	392
	Surface of paddy water	1.5	5,729	108
	Untreated check		6,279	857

Table 3. Mortality of imagoes of the smaller brown plant hopper kept in net cage of imagoes living on 120 plants (1969)

Name of insecticide	Method of application	Active ingredient per ha	Mortality of imagoes in the cage				Number of imagoes living on 120 plants	
			1st day		5th day		1st day	5th day
			♂	♂	♂	♀	♂ ♀	♂ ♀
Diazinon (granules 5%)	Water surface	1.5 kg	59	25	17	25	33	18
	Gutter	1.5	100	75	67	10	10	13
Salithion® (granules 5%)	Water surface	1.5	50	10	10	10	35	24
	Gutter	1.5	76	68	40	10	18	29
Untreated check			0	0	0	0	71	58

adhesion characteristic was the reason for this more effective performance.

Systemic effects of chemical granules

A widely used method of investigating the effects of granular insecticides applied to the paddy water has been the utilization of wire netting or cloth cages where plant hoppers are bred. The cages prevent escape and allow mortality checks to be made. The results obtained by this method indicate the mixed lethal effects of both fumigant and systemic activities.

To investigate the systemic effect separately from the fumigant, the writer adopted a globular glass vessel measuring 10 centimeters in diameter with both ends closed by cotton wool stoppers. Plant hoppers were bred inside the globe as shown in Fig. 3.

In this experiment, for example diazinon, at a standard dosage rate of 1.5 kg of active ingredient per hectare showed no lethal effects. On the other hand Baygon® in the case of the smaller brown plant hopper and Mipcin® in the case of the green rice leaf hopper showed high lethal activity when granules were applied to a soil culture at a rate of 3 kg of active ingredient per hectare which was presumed to be the minimum effective rate for both chemicals.

Fig. 3. Glass bottles for breeding hoppers

Systemic effects of Baygon® began to occur from the third day to reach maximum on the tenth day and this lethal effect was maintained for a fairly long period. This was made clear by the trial method by which the images were replaced every 24 hours in the breeding bottle.

An experiment was carried out to test whether the active ingredient of the granules, adhering to the surface of the plant, would permeate the plant tissues directly. Granules were fixed to the rice leaves using vinyl tape. The insects were placed both above and below the place to which the granules were fixed.

Among the many insecticides tested, Tsumacide® and Meobal® showed a high lethal activity against the smaller brown plant hopper and the green rice leaf hopper. Tsumacide® gave the best results—0.5 milligrams per blade gave 100% kill. Baygon® and Mipcin® gave lesser effect against the green rice leaf hopper. An interesting point that emerged was the low rate of kill against the insects below the granules as opposed to the high rate among those above.

Practical application of lethal mechanism

For insecticides which have a high vapor effect, the presence of water is not needed—its presence may only decrease its effectiveness. However, on the other hand, water might be required in order to create uniform vapor effect throughout the paddy field and also it might be helpful to release the insecticide gas gradually for a longer period of time.

At the same time, unnecessity of water will expand the use of granules into the upland crops as top-dressing technique and furthermore, it suggests the use of specially treated tape with insecticide into the paddy or upland crops.

Micro-granules have been developed and were demonstrated to be more effective than regular granules. For example, if micro-granules were applied at the head-sprouting period of the rice plant, 20–30% micro-granules were observed to remain on the rice plant (Fig. 4) and controlled insect through

Fig. 4. Adhered micro-granules of diazinon on the surface of leaves.

the vapor effect, the systemic effect through leaf and stem, and also through contact poisoning which is the same mechanism as insecticide dust. This might further suggest that insecticides which can be used as dust form can also be utilized as micro-granules form. However, details have to be studied in the future. The writer believes that due to the air pollution problem micro-granules will replace the dust application technique within the very near future.

Referenecs

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