CONTROL EFFICACY OF ALTERNATIVES TO METHYL BROMIDE AGAIST TOBAMO-VIRUS GROUP AND FUMIGANT GAS BEHAVIOR IN THE SOIL

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Pepper Mild Mottle Virus (PMMoV) and Cucumber Green Mottle Mosaic Virus (CGMMV), which are in a group of tobamovirus, are of the most destructive pathogen causing serious damage to Capsicum and Cucurbit plants. These viruses are transmitted through soil and seed. Methyl bromide is very effective to both viruses and its use is very easy. However, it could not be produced as soil fumigants in developed countries from 2005. In response of these situations, this study is to survey efficacy of the alternatives to control PMMoV and CGMMV. Fumigation efficacy to PMMoV and CGMMV was tested by the following methods. Five paper disks containing purified PMMoV and cucumber leaf sap infected with CGMMV respectively were put in petri-dishes. These paper disks were fumigated by each fumigant for 24 hours in air pressure reduced glass chamber. To assess fumigation efficacy, treated paper disks were ground in phosphate buffer and inoculated for checking infectivity by counting number of local lesions on tobacco plants for PMMoV and number of infected cucumber plants for CGMMV.
In addition, fumigant gas diffusion in the soil was surveyed with several fumigants to see gas behavior in the soil.

Table 1 shows fumigation efficacy to PMMoV. Methyl bromide was found thoroughly effective with the inactivation of 100% at the dose rate of 10,000 ppm. Chloropicrin was found effective at the dose of 10,000□25,000 ppm and 1,3-dichloropropene was also found effective at the dose rate of 25,000 ppm.

Table 2 shows fumigation efficacy to CGMMV. Methyl bromide was found perfectly effective with the inactivation of 100% at the dose of 10,000 ppm. Chloropicrin was also found effective at the dose from 5,000□25,000 ppm to CGMMV. However, methyl iodide was found far less effective even at the dose of 10,000 ppm. Furthermore, metam sodium at the dose of 5,000 ppm and 1,3 D at the dose of 10,000 ppm were not found effective at all.
Evaluating alternatives in view of these results to PMMoV and CGMMV, ranking

of control efficacy of the alternatives and methyl bromide is expressed as follows:

MB □ CP > MI > 1,3 D = MITC

Table 3 shows gas concentration in the soil of respective alternatives with the dose rate by ordinary pest control practice. Gas concentration of methyl bromide and chloropicrin in the soil differs significantly from each other. For chloropicrin, gas concentration at the point of 15 cm deep in the soil was determined 735.3ppm by the application dose of 33.3ml/m^2 which is almost similar to the ordinary pest control practice. However, as Table 1 shows that chloropicrin gas is effective to control CGMMV and PMMoV at the dose of more than 5,000 ppm. This much of dose could be about seven times more than the dose rate of the ordinary pest control practice, and could be seriously concerned with the adverse effects to plants and environment as well as economic impact to the farmers. For 1,3 D, gas concentration at the point of 15cm deep in the soil was determined 2,020.3 ppm by the application dose of 26.2 ml /m^2 which is similar to the ordinary pest control practice of 3ml per hole. As Table 2 shows that 1,3 D at the concentration of 10,000 ppm is found effective to the control of PMMoV. This much of dose could be about five times more than the dose rate of the ordinary pest control practice, and could be also seriously concerned with the adverse effects to plants and environment as well as economic impact to the farmers.

From these points of view, those fumigants could not be recognized as technically feasible alternatives to methyl bromide. Takeuchi (2000) had an experiment on the effect of soil fumigation with several fumigants on the frequency of soil transmission of PMMoV. Thirty pepper plants were transplanted into each treated soil. Infection of PMMoV was assessed by Id-ELISA 52 days after transplanting. Table 4 shows the results that methyl bromide is found very effective of 6.7 % of infection to PMMoV, while other fumigants are found far less effective.

Consequently, from these trails, there are no technically and economically feasible alternatives to control soil transmission of CGMMV and PMMoV.

Reference

Takeuchi S. (2000) Studies on the Epidemiology and Control Measures of Tobamo-virus Diseases in Capsicum Plants. *Special Bulletin of the Kochi Agricultural Research Center No.3 October 2000*

Table 1 Fumigation efficacy of fumigants to PMMoV

Fumigant	Applied dose (ppm)	No. of local lesions Treated/ Non treated	Inactivity (%)
Methyl bromide	10,000	0 / 2,094	100
Chloropicrin	5,000	738 / 3,167	76.7
	10,000	0 / 2,148	100
	25,000	0 / 3,247	100
1,3 D	5,000	438 / 1,932	77.3
	10,000	200 / 2,546	92.1
	25,000	0 / 3,363	100

Table 2 Inactivation of CGMMV by soil fumigants

Fumigant	Applied dose (ppm)	Inactivation (%)		
		Test site A	Test site B	Test site C
Methyl bromide	10,000	100	—	100
Chloropicrin	5,000	80	80	100
	10,000	80	80	100
	25,000	60	100	100
Methyl iodide	10,000	20	Nt	Nt
MITC	5,000	Nt	0	Nt
1,3 D	10,000	Nt	Nt	0
Non treated		0	0	0

Mark □ means it is unable to assess.
Nt means not tested.

Table 3. Average gas concentration in the soil of six sampling points at 24 hours later of fumigation dose application

Pesticide	Gas monitoring point	Dose rate	Gas concentration in the soil (ppm)
Methyl bromide	15 cm deep in the soil	46.2 g / m^2	9,834.0
Chloropicrin	15 cm deep in the soil	33.3ml/ m^2	735.3
MITC	15 cm deep in the soil	31.2ml/ m^2	166.9*
1,3 D	15 cm deep in the soil	26.2ml/ m^2	2,020.3

* This figure is the average gas concentration of three sampling points.

Table 4. Effect of soil fumigation with several fumigants on the frequency of soil transmission of PMMoV (Takeuchi 2000)

Fumigant	Dosage / m^2	Infection (%)*
Chloropicrin tablet	10 tablets	80.0
Metam sodium	60 ml	50.0
Dazomet	30 g	43.3
Methyl bromide	50 g	6.7
Non treatment	□	16.7