ACTIVITIES OF FUMIGANTS & ANAEROBIC SOIL DISINFESTATIONS UNDER LOW TEMPERATURE.

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There are many soil disinfestation techniques such as chemical fumigations, anaerobic soil disinfestations (ASD), steaming, hot water irrigation, solarization, and so on. In Japan, suitable season for soil disinfestation and crop production is overlapping and many farmers do soil disinfestation in cool season. Cool season is unsuitable for these methods. Solarization doesn't work and steaming and hot water irrigation are not acceptable because they need much more fuel. Because ASDs depend on soil microbial activity, their effects are unstable under low temperature. The effects of chemical fumigations also diminish and residual fumigants under tarps sometimes adversely affect transplants under cool seasons. Thus, there is a large demand for development of modified or new soil disinfestation techniques which work well under low temperature.

Fungicidal activities of chloropicrin and 1,3-dichloropropene (1,3-D) were evaluated under different incubation temperatures. *Fusarium oxysporum*, *Diaporthe sclerotioides*, and *Verticillium dahliae* were grown on potato dextrose agar, and their agar plugs were obtained. The plugs were placed in glass jar and fumigated for 3 to 6 hours at 15 and 5°C. Then, viabilities of the pathogens were confirmed on fresh potato dextrose agar. As the results, viabilities of the pathogens were not affected by 1,3-D but chloropicrin effectively suppressed the pathogens (Table 1-3). Chloropicrin was less effective at 5°C (Table 2). Interestingly, 1,3-D might have additive effect; mixture of 1,3-D and chloropicrin was more effective than chloropicrin alone without 1,3-D (Table 1 & 3).

Effects of ASDs using ethanol and wheat bran on *F. oxysporum* f. sp. *lycopersici* were compared using different soil. Soils (Andosol) were collected from Tsukuba (Ibaraki pref.) and Matsudo (Chiba pref.). For ethanol treatment, 4 kg soil placed in plastic box was inundated with 1 L of 1.0% (v/v) ethanol. For wheat bran treatment, 4 kg soil was mixed with 40 g wheat bran and inundated with 1 L of distilled water. Pathogen inoculum packet was buried in the center of the soil and the soil was incubated at 15°C for 14 days. Then, the packet was retrieved and survival of the pathogen was checked by dilution technique using selective medium. *F. oxysporum* f. sp. *lycopersici* was suppressed by the ASD with wheat bran, the effect was superior in Matsudo soil. This might be caused by differences in organic carbon source content, microbial community, and/or other soil properties. If the ASD effect observed in Matsudo soil could be reproduced in other soils, ASD could be applicable more widely.

As described above, both ASD and chemical fumigations are less effective at low temperature. For chemical fumigations, application of gas impermeable film might facilitate pesticidal effects of fumigants. However, unlike USA and EU, there is no strict regulation for soil fumigation in Japan. Even if a farmer used fumigants without plastic tarp and the gases leaked to adjacent area, there is no substantial penalty. Furthermore there is no requirement to use plastic tarp with 1,3-dichloropropen. Under such situations, use of gas impermeable films has not been established fully in Japan.

For ASD treatment, developments of supplemental materials or new technique that facilitate ASD efficacy at low temperature might be expected through revealing more detailed mechanisms.

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Table 1. Viability of soilborne pathogens exposed to fumigants at 15°C.

Fumigant Concentration (μg/L, mg/m³)		*Fusarium*	*Diaporthe*	*Verticillium*
Chloropicrin	1,3-Dichloropropene	*oxysporum*	*sclerotioides*	*dahliae*
0	0	3	3	3
0	1600	3	3	3
0	1980	3	3	3
0	3960	3	3	-
0	4760	3	3	-
0	5560	3	3	-
0	5950	3	3	-
0	6330	3	3	-
0	6750	3	3	-
1180	0	3	3	1
1460	0	3	3	1
2920	0	2	3	-
3470	0	1	3	-
4100	0	1	3	-
4380	0	3	3	-
4650	0	1	3	-
4930	0	0	3	-
1180	1600	3	3	0
1460	1980	3	3	0
2920	3960	2	3	-
3470	4760	0	3	-
4100	5560	0	3	-
4380	5950	0	3	-
4650	6330	0	3	-
4930	6750	0	2	-

Three agar disks of test pathogens were used. 0: none, 1: one, 2: tow, 3: three of agar disks survived.

Table 2. Viability of soilborne pathogens exposed to fumigants at 5°C.

Fumigant Concentration (μg/L, mg/m³)		*Fusarium*	*Diaporthe*	*Verticillium*
Chloropicrin	1,3-Dichloropropene	*oxysporum*	*sclerotioides*	*dahliae*
0	0	3	3	3
0	1980	3	3	3
0	3960	-	-	3
0	9910	3	3	-
1460	0	3	3	1
2960	0	-	-	0
7250	0	3	3	
1460	1980	3	3	2
2960	3960	-	-	0
7250	9910	3	3	-

Three agar disks of test pathogens were used. 0: none, 1: one, 2: tow, 3: three of agar disks survived.

Table 3. Viability of soilborne pathogens exposed to fumigants at 5°C.

Fumigant Concentration (μg/L, mg/m³)		*Fusarium oxysporum*		*Diaporthe sclerotioides*		*Verticillium dahliae*	
Chloropicrin	1,3-Dichloropropene	3h	6h	3h	6h	3h	6h
0	0	3	3	3	3	3	3
0	7930	3	3	3	3	3	3
0	9910	3	3	3	3	3	3
5800	0	3	3	3	3	0	0
7250	0	3	3	3	3	0	0
5800	7930	3	1	3	2	0	0
7250	9910	3	1	3	1	0	0

Three agar disks of test pathogens were used. 0: none, 1: one, 2: tow, 3: three of agar disks survived.

Table 4. Effect of Anaerobic Soil Disinfestation on *Fusarium oxysporum* at 15°C.

Soil	Treatment		
	Water	Wheat bran	1% ethanol
Tsukuba soil	6.2 (0.1)	3.2 (0.5)	4.7 (0.8)
Matsudo soil	5.5 (0.1)	ND	3.6 (0.3)
	※		n.s.

log CFU/g dry matter (±S.E.) , ※ $p < 0.05$