Soil fumigation with allylisotiocyanate: preliminary results in Italy.

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Introduction

The need of reducing the usage of methyl bromide (MB) stimulates the interest of many researchers to improve new chemical and non-chemical strategies for soil disinfestation. The development of alternatives to MB can start from the observation of natural events. Gamliel and Stapleton (1993) reported the production of different volatiles, among which allylisotiocyanate (AITC), during the application of soil solarization in soil amended with cruciferous residues. In 1998 and 1999 two trials were carried out in order to test the efficacy of AITC industrially synthesized and used in food processing. In our work, the fungicidal effect of AITC applied for soil disinfestation on artificial inoculum of selected pathogens directly exposed to it was studied. Moreover, its efficacy against *Rhizoctonia solani* and *Fusarium oxysporum* f. sp. *basilici* on basil was evaluated.

Materials and methods

Two experimental trials have been carried out at Albenga (Northern Italy) under greenhouse (Table 1). During the first trial, sandy soil was placed in plastic, impermeable containers of 200 litres of capacity and 1,5 m^2 of surface; water suspensions of AITC and metham sodium (MS) were applied by soil drenching. To prevent emissions of the two compounds into the atmosphere, all container were covered with gas impermeable film after the treatment. The soil was artificially infested, prior to the treatment, with 40 g/m^2 of wheat kernels infested respectively with *R. solani* and *F. basilici.*
In order to evaluate the direct effect of AITC and MS on survival of *R. solani, F. basilici, Phytophthora nicotianae* and *Sclerotinia sclerotiorum,* little bags, prepared with a gas permeable net, containing wheat kernels artificially infested with such pathogens, were buried at two depths (5 and 10 cm) in the soil before treatment. After the treatment, the bags were removed and pathogens survival was evaluated in *vitro* as previously described (Minuto *et al.*, 1999). The treated soil was rototilled, placed into plastic pots, irrigated with 30 l/m^2 of water and sown with basil. Basil plants infected by *R. solani* and *F. basilici* were collected and counted. The second trial was carried out by following the same methodology, using benches instead of containers.

Results

AITC compared to MS at the same and at higher rates reduced the survival of *R. solani, F. basilici, P. nicotianae* and *S. sclerotiorum* at both depths (Tables 2, 3). AITC at 160 ml/m^2 provided good control of *R. solani* and *F. basilici* on basil (Tables 4, 5). Only when applied at 640 ml/m^2 AITC caused slight phytotoxicity on basil plants. In conclusion, AITC seems a possible interesting alternative to MB for soil disinfestation. Since it is already used in food processing, no major toxicological risk is expected. However, a possible problem seems related to the strong and irritating smell that AITC produces during its application.

Aknowledgement

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References

Gamliel A., Stapleton J.J. (1993) Phytopathology, 83, 899-905.
Minuto A., Gilardi G., Gullino M.L., Garibaldi A. (1999) Crop Protection, 18, 365-371.

Table 1 Data about experimental trials.

Soil properties	Trial 1998	Trial 1999	General data	Trial 1998	Trial 1999
Sand	82.4%	66.4	Artificial soil infestation*	05/18/98	01/20/99
Loam	12.7%	22.6	Soil treatment	05/21/98	02/04/99
Clay	4.9%	11.1	Unmulching	06/10/98	02/18/99
PH	8.5	7.5	Rototilling	06/2298	02/24/99
Electric conducibility	133 uS/cm	953 uS/cm	1st sowing	06/22/98	02/24/99
Cationic exchange capacity	6.0 meq/100g	47.9 meq/100g	1st control	07/03/98	03/19/99
Organic matter	2.7%	18.4 %	2nd sowing	08/08/98	04/15/99
Nitrogen (total amount)	1.2%◦	4.2%◦	1st control	08/25/98	04/25/99

(*) *F.basilici* e *R.solani* 40 g/m^2 infected kerneks

Table 2 – Effect of AITC and MS on the survival of soil buried pathogens.

Treatment	Rate a.i./m^2	% kernels infected with *R.solani* at depth				% kernelsi nfected with *F.basilici* at depth			
		Trial 1998		Trial 1999		Trial 1998		Trial 1999	
		5 cm	10 cm	5 cm	10 cm	5 cm	10 cm	5 cm	10 cm
-	-	78.3 b*	31.7 b	100.0 b	81.0 b	100.0 B	99.7 b	100.0 b	100.0 b
MS	160 g	8.3 a	0.7 a	3.3 a	2.3 a	0.0 A	0.0 a	0.0 a	0.0 a
AITC	160 ml	2.7 a	1.0 a	0.3 a	33.3 ab	1.7 A	3.3 a	2.3 a	0.0 a
AITC	320 ml	0.0 a	0.0 a	0.0 a	0.7 a	0.0 A	0.0 a	0.0 a	33.3 a
AITC	640 ml	3.5 a	3.5 a	n.t. **	n.t.	0.0 A	0.0 a	n.t.	n.t.

(*) Means of the same column followed by the same letter do not statistically differ following Duncan's Multiple Range Test (P =0.05). ** n.t. = not tested

Table 3 - Effect of AITC and MS on the survival of soil buried pathogens (Trial 1999).

Chemicals	Rate a.i.//m^2	% kernels infected with *P. nicotianae* at depth		% kernels infected with *S. sclerotiorum* at depth	
		5 cm	10 cm	5 cm	10 cm
-	-	15.3 b*	31.7 b	62.3 B	82.7 c
MS	160 g	0.3 A	0.0 a	1.0 A	0.0 a
AITC	160 ml	2.0 A	4.7 a	5.3 A	21.0 b
AITC	320 ml	0.0 A	0.0 a	2.3 A	0.7 a

* See table 2

Table 4 Efficacy of different soil disinfestation treatments against *F.basilici* e *R.solani* on basil (Trial 1998).

Chemicals	**Rate a.i./m^2**	**% healthy plants**		**% plants infected by *F.basilici***		**% plants infected by *R.solani***	
		1st sowing	2nd sowing	1st sowing	2nd sowing	1st sowing	2nd sowing
-	-	28.1 b*	47.1 c*	11.9 b	2.2 B	60.0 b	50.7 c
MS	160 g	97.4 a	97.1 a	0.6 a	2.0 B	1.9 a	0.9 a
AITC	160 ml	94.2 a	69.4 b	3.6 a	0.5 A	2.2 a	30.1 b
AITC	320 ml	95.2 a	96.7 a	0.7 a	0.3 A	4.1 a	3.1 a
AITC	640 ml	96.2 a	97.7 a	2.4 a	0.2 A	1.4 a	2.1 a

* See table 2

Table 5 Efficacy of different soil disinfestation treatments against *F.basilici* e *R.solani* on basil (Trial 1999).

Treatment	**Rate a.i../m^2**	**% healthy plants**		**% plants infected by *F.basilici***		**% plants infected by *R.solani***	
		1st sowing	2nd sowing	1st sowing	2nd sowing	1st sowing	2nd sowing
-	-	38.4 b	56.2 b	50.3 b	41.9 B	11.3 b	1.9 b
MS	160 g	97.1 a	83.1 a	1.2 a	16.8 A	1.6 a	0.1 a
AITC	160 ml	96.9 a	84.4 a	1.9 a	15.2 A	1.2 a	0.5 a
AITC	320 ml	98.0 a	83.8 a	1.5 a	15.7 A	0.6 a	0.5 a

* See table 2