CHLOROPICRIN APPLICATION IN ITALY BY SOIL INJECTION AND DRIP IRRIGATION: EFFECT AGAINST SOIL BORNE FUNGAL PATHOGENS

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The recent restrictions of methyl bromide (MB) usage stimulated the search for chemical alternatives for soil disinfestation, among whose chloropicrin (PIC), a compound not yet registered in Italy. During 1999, four experimental trials have been carried out in Italy to study the efficacy of PIC [Tripicrin, chloropicrin 99%] against soil borne fungi. The fumigant can be applied by soil injection or drip irrigation, according to protocols already adopted in USA (Ajwa and Trout, 1998; Csinos *et al.*, 2000; Winterbottom *et al*., 1998). Four trials were carried out at Albenga (Liguria, Northern Italy) and at Acate (Sicily, Southern Italy) (Table 1). PIC was injected using the same equipment employed for MB cold fumigation, able to mulch the soil and to make beds 80 cm width and 10 cm high. The application by drip irrigation was carried out on beds, mechanically made with the same equipment employed for injection. For drip irrigation, all beds were provided with two drip lines for each bed, equipped with water emitters (flow rate 2.4 l/hour) every 30 cm. In this paper some results about the fungicidal activity of PIC against *Rhizoctonia solani, Fusarium oxysporum f.sp. lycopersici, F. oxysporum f.sp. melonis, Verticillium dahliae and Sclerotinia. sclerotiorum,* directly exposed to the fumigant effect as artificially propagated mycelium, or spores or sclerotia, placed at different depths in the soil, using a technique already described (Minuto *et al.,* 1998), are reported. When PIC was applied trough soil injection (table 2, 3), 19.8 g/m^2 did not provide satisfactory results, particularly against *V. dahliae* at 10 cm depth, and, in general, against fungi tested at 20 cm depth. Interesting results, at 10 and at 20 cm depth, were obtained with 39.6 g/m^2 of PIC. The data collected in Northern Italy and Southern Italy underline the influence of some soil properties as physical composition and organic matter content on PIC efficacy. In soils with high sand content (>80%) and low organic matter (<1%) 19.8 g /m^2 of PIC gave better results, in comparison with soils with low sand content (<75%) and higher organic matter content (>2.5%). The application of 19.8 and 39.6 g/m^2 of PIC trough drip irrigation, with 17 and 20 mm of water respectively, showed statistical differences, in comparison to the untreated plots, at 10 and 20 cm depth against *R. solani* and *S. sclerotiorum* and at 20 cm against *Verticillium dahliae* (table 4). No differences were observed at 10 and 20 cm depth among plots treated or not with PIC against *F. melonis* and *F. lycopersici* and at 10 cm against *V. dahliae*. During the trial carried out in protected crop (table 5), 19.8 and 39.6 g/m^2 of PIC, applied respectively with 20 and 35 mm of water, were effective as MB at 10 cm against *F. melonis*, *R. solani* and *S. sclerotiorum*. The application of 39.6 g/m2 of PIC gave similar results as MB at 20 cm depth against *F. melonis*. On the contrary 19.8 g/m^2 of PIC were not so effective against *F. melonis*. *F. lycopersici*, *R. solani*, *S. sclerotiorum* and *V. dahliae* at 20 cm, while differences among PIC applied at 39.6 g/m^2 and not treated plots were always observed at 10 and

20 cm depth. In conclusion, the direct exposure to the fumigant, applied trough drip irrigation, of several fungi showed the influence of the amount of water applied for distribution. PIC 39.6 g/m^2 gave better results when applied with 35 mm instead of 20 mm of water at both depths.

References

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Table 1 – Soil characteristic at the experimental sites

Site	Acate (Southern Italy)	Albenga (Northern Italy)
Soil	sand 82%, loam 7%, clay 11%	sand 75%, loam 20%, clay 5%
pH	8.3	8.1
Organic matter (%)	0.7	2.5
Cationic exchange capacity m.e.q./100 g of soil	5.0	8.5

Table 2 - Effect of fumigation on the survival of soil buried pathogens. (PIC applied trough injection: Acate, 1999).

Fumigant, g a.i. /m^2	% of kernels infected with									
	F. lycopersici		*F. melonis*		*R.solani*		*S.sclerotiorum*		*V.dahliae*	
depth	10 cm	20 cm	10 cm	20 cm	10 cm	20 cm	10 cm	20 cm	10 cm	20 cm
Control	100 b*	100 b	99 c	97 b	94 c	45 c	49 c	49 b	97 c	95 c
PIC, 19,8	14 a	36 a	57 b	60 b	46 b	24 b	23 b	14 b	62 bc	42 b
PIC, 29,7	4 a	17 a	26 ab	58 b	17 a	12 ab	3 a	6 b	46 ab	37 ab
PIC, 39,6	24 a	45 a	21 a	73 b	19 a	18 ab	21 b	23 b	30 ab	55 b
MB, 60	4 a	20 a	19 a	17 a	7 a	3 a	0 a	7 a	21 a	10 a

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

Table 3 - Effect of fumigation on the survival of soil buried pathogens (PIC applied trough injection: Albenga, 1999).

Fumigant, g a.i. /m^2	% of kernels infected with									
	F. lycopersici		*F. melonis*		*R.solani*		*S.sclerotiorum*		*V.dahliae*	
depth	10 cm	20 cm	10 cm	20 cm	10 cm	20 cm	10 cm	20 cm	10 cm	20 cm
Control	100 b*	99 c	97 b	100 b	34 b	33 c	84 c	72 c	97 b	93 c
PIC, 19,8	72 b	100 c	100 b	96 b	25 b	17 b	51 b	55 bc	80 b	83 c
PIC, 29,7	92 b	84 b	80 b	60 b	19 b	15 b	47 b	41 b	48 a	55 b
PIC, 39,6	22 a	24 a	27 a	22 a	4 a	5 a	15 a	16 a	27 a	23 a

*see table 2

Table 4 - Effect of fumigation on the survival of soil buried pathogens (PIC applied trough drip irrigation: 1st trial, Albenga, 1999).

Fumigant, g a.i. /m2	% of kernels infected with									
	F. lycopersici		*F. melonis*		*R.solani*		*S.sclerotiorum*		*V.dahliae*	
depth	10 cm	20 cm	10 cm	20 cm	10 cm	20 cm	10 cm	20 cm	10 cm	20 cm
Control	100 b*	100 b	100 b	100 b	57 c	55 c	82 c	67 c	94 b	89 c
PIC, 19,8°	94 b	100 b	100 b	89 b	36 b	47 bc	41 b	49 b	70 b	71 bc
PIC, 39,6°°	88 b	100 b	73 b	100 b	25 ab	34 b	35 b	36 b	65 b	61 b
MB, 60	8 a	16 a	16 a	21 a	7 a	7 a	6 a	14 a	6 a	11 a

*see table 2; ° application carried out with 17 mm of water; °° application carried out with 20 mm of water

Table 5 - Effect of fumigation on the survival of soil buried pathogens (PIC applied trough drip irrigation: 2nd trial Albenga, 1999).

Fumigant, g a.i. /m2	% of kernels infected with									
	F. lycopersici		*F. melonis*		*R.solani*		*S.sclerotiorum*		*V.dahliae*	
depth	10 cm	20 cm	10 cm	20 cm	10 cm	20 cm	10 cm	20 cm	10 cm	20 cm
Control	100 c*	100 c	100 b	100 b	67 b	51 b	67 c	43 b	90 c	92 c
PIC, 19,8^	3 ab	78 c	24 a	69 b	36 a	30 ab	38 bc	27 ab	57 b	77 c
PIC, 39,6^^	1 a	26 b	22 a	16 a	24 a	17 a	7 ab	8 a	12 a	36 b
MB, 60	6 b	1 a	13 a	2 a	12 a	11 a	3 a	3 a	7 a	3 a

*see table 2; ^ application carried out with 20 mm of water; ^^ application carried out with 35 mm of water