STUDY OF TWO IMPERMEABLE SHEETS TO REDUCE METHYL BROMIDE DOSAGE AND EMISSIONS FOR CARNATION WILT CONTROL.

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Abstract

The use of barrier films to avoid escape of Methyl bromide (MB) through the cover sheet, during soil fumigation, is one of the techniques proposed in order to reduce dosage and emission, while keeping effectiveness in pest control.

This experiment was carried out in a carnation greenhouse, in which previous crop was severely affected by *Fusarium oxysporum f.sp. dianthi*. The treatments were: (1) Control not disinfested; (2) MB80PE: methyl bromide at 80 gr/m^2 covered with polyethilene (PE) sheet; (3) MB40PE: methyl bromide at 40 gr/m^2 methyl bromide with PE sheet; (4) MB40HT: methyl bromide at 40 gr/m^2 covered with virtually impermeable Hitybar film; (5) MB40LMG: 40 gr/m^2 MB with LMG cover sheet.

Inoculum destruction was monitored both with *F.o. dianthi* chlamydospores, and with root pieces cut from previous crop infested plants. Also CxT product, biomass production, plant health and yield were the parameters taken into account.

In general all parameters studied showed similar results for treatments with normal dose MB+PE cover sheet (2), and half dose + barrier film (4),(5). Treatment half dose + PE (3) is generally in an intermediate place between the best performant treatments and the non treated control (1). Hytibar sheet appears to be very fragile and difficult to handle, with high risk of rip or perforations, this can cause the loss of efficacy. In any case a significant reduction of at least one half of normal Methyl bromide dose can be achieved by using a barrier film as cover sheet.

1. Introduction

Soil disinfestation with Methyl Bromide (MB) at high dosages (usually 80g/m^2 for Carnations in Spain), under PE sheet is the most widely used soil disinfestation technique in this crops, when soil is infested by *Fusarium oxysporum f. sp. dianthi*.. Unfortunately high amounts of MB are emitted to the atmosphere by using such practice. This emissions according to the Montreal Protocol contribute the ozone layer depletion and than must be avoided.

The use of Virtually Impermeable Film (VIF) is proposed to allow a reduction of dosage while keeping effectiveness with the goal of reduction of emissions to the atmosphere. A reduction of more than 70% of methyl bromide applied can be achieved by reducing dose from 60 to 30 g/m^2

under this kind of film (Cebolla V. et al.1996), with similar results. This means a reduction of 86% for the same surface.

This technique was proved effective on the control of *R. solani* on basil, bean and lettuce, and *S. sclerotiorum* on lettuce in Italy (Gullino M.L. et al., 1996), and *P. capsici* in Spain (Cebolla V. et al., 1996). Also highly effective control of propagules of the pathogens *V. dahliae*, *Fusarium oxysporum f. sp. melonis, F.o. f. sp. basilici, Sclerotium rolfsii* and *Pythium* was achieved by MB applied under VIF with reduced dosage of MB (50% of commercially recommended dosage) This technique has been proved effective as well to control Verticillium wilt on potato under commercial conditions (Gamliel A. et al., 1996).

In this research two VIF sheets are compared, at reduced dosages, by monitoring a Carnation crop carried out on an infested soil at Pilar de la Horadada, south of Valencian country (Spain).

2. Material and Methods

The experiment was conducted in a carnation greenhouse in which the previous crop was severely seek by Fusarium wilt disease (*Fusarium oxysporum f. sp. dianthi* (Prill. Et Dell, Sny & Hans).

Methyl bromide with Amyl-acetate, instead of chloropicrine, was used as fumigant to avoid fitotoxicity to the side carnation crops still in progress. As cover sheet were used Low Density Polyethylene (PE) as standard, and two VIF sheets, both coextruded, three layered, with a thin impermeable filling between two polyethylene external layers. Internal layer is EVOH for Hytibar (Belgium) and polyamide for LMG from Lawson Mardon Packaging (UK).

Five treatments were considered:

(1) Control not disinfested.
(2) MB80PE: methyl bromide at 80 gr/m^2 covered with polyethilene (PE) sheet.
(3) MB40PE: methyl bromide at 40 gr/m^2 methyl bromide with PE sheet.
(4) MB40HT: methyl bromide at 40 gr/m^2 covered with virtually impermeable Hitybar film.
(5) MB40LMG: 40 gr/m^2 MB with LMG cover sheet.

All the sheets were buried at 40 cm, deeper than farmers use to do, in order to improve effectiveness. Experimental design consisted in plots of 4x8 m, with 5 replicates. Statistical comparison was done by Duncan multiple range test.

To study the efficacy of this technique, artificial inocula were put into the soil at 20 and 40 cm depth. Wo types of inocula were prepared, one with sandy soil containing chlamydospores of *F. o dianthi* and the other with root pieces of *F.o.dianthi* sick plants cut at about 5 mm long and mixed with sandy soil. Nylon cloth pockets were filled with ten grams of these soil containing inocula and firmly tight by nylon rope at predetermined distances insomuch the pockets remained exactly at 20 and 40 cm under the ground. After the treatment the strings were pulled out and pieces transferred to selective media. Soil containing chlamydospores were evaluated by dilution plate technique. *F. o. dianthi* selective media for both techniques was Komada (Komada, H. 1975).

Disinfestation was done in April, under cold weather, with a duration of 3 days, along this time MB concentration in air was monitored under the sheet with a FUMISCOPE detector, and the product Concentration x Time (CxT) was calculated for each plot. Soil samples were picked up from 0 to 20 cm and 20 to 40 cm depth, to determine the residues left in soil. Emissions were estimated by the mass balance approach.

After disinfestation the center of each plot was planted with 100 cuttings of Lena cv., which is very susceptible to the disease, surrounded by cuttings of differnt resistant cultivars, in order to difficult the spread of the disease from non disinfested edges. Some additional cuttings of Lena cv. were planted to be picked up along the crop for analytical determinations.

Carnation disease monitoring has been done by two methods: a non destructive methods, by classifying the degree of sickness from 1 (first symptoms) to 5 (dead plant), and a destructive method by which the extra plants transplanted in the plots were cut out at ground level, fresh weighed, and the vascular discoloration registered as percent necrotic area of the phloem ring. The second method served also for biomass studies purposes.

Weeds were counted several times along the crop, before pulling them up. Whole yield in each plot was registered, as flowers per plant, along the 68 weeks crop.

3. Results

Methyl bromide concentration into de soil atmosphere increase under VIF as compared with PE for the same reduced rate but these differences are not significant in the deeper horizon. Nevertheless the high dosages used as standard (Table 1) produce a higher CxT in both depths for treatment (2) MB80PE

F. o. dianthi was destroyed up to 20 cm down in the ground by all treatments (Table 2), but reduced dosage under PE fails at 40 cm depth. The results look similar for both kinds of inocula. The high CxT get in standard treatment did not seem to improve control over fungal structures.

Biomass, studied as fresh weight (Table 3) of extra living plants picked up from the plots, do not show differences among fumigated treatments, the size living of plats were similar with the only exception of control. Vascular discoloration of plants cut at ground level showed slight sickness in all treatments, but control. All non disinfested plots showed early symptoms and the whole plants were dead in few months.

Weed control was costly in non treated plots (1) Control, and treatment (3) MB40PE was the worse among fumigated plots.

At the end of the crop (Table 4) treatments (1) and (5) were the best, but no statistical differences were found on disease index, mortality or field for all disinfested plots. Yield from control plots with less than 1 flower per plant was negligible compared to almost 6 flowers in treatment (5)MB40LMG.

Reducing dosage from 80 to 40 g/m^2 of methyl bromide leads to a reduction of emissions (Table 5) of 59% for treatment (4) MB40HT

The VIF sheets used in this experiment are thinner than standard PE, but the film from Hitybar was more fragile when handle to fit on the plots and bury the edges for disinfestation. This sheet in contact with sharp borders of soil aggregates produced small holes and scratches that lead to a dramatic failures in effectiveness.

4.Discussion:

All treatments but (1) Control are efficient from the point of view of disease, mortality and yield. Reduced dosages under PE sheet do not destroy inocula at 40cm depth. Nevertheless in most aspects PE at reduced dosages gives good results, why than high dosages are recommended ? It seems a question of insurance. High dosages assures success in the agricultural outcome even if application was not perfect. In this aspect, VIF can offer security with less dosage.

As bromine holding capacity of a given soil is limited, residues in soil are about the same order, and than it is assumed that a dosage reduction of 50 % will cut down the emissions at least in more than 50%. In our results (Table 5), with a standard dosage of 80 g/m^2 we got a reduction of 59%, while in previous experiments (Cebolla V. et al. 1996) by using a standard dosage of 60 g/m^2 the reduction was about 86%. It is clear than the amount of methyl bromide emitted by this reducing dosages technique is lesser when standard dosage diminish. Other factors as deep bury of the edges and cold weather, which reduces permeability of PE to Methyl bromide, can also contribute to reduce the emissions from the standard treatment..

The results obtained in this work, about the use of VIF sheets, are in line with those obtained in other Mediterranean countries as Italy and Israel. This is a realistic short term solution, that covers the same spectrum of activity than standard MB disinfestation and will allow to meet the restrictions imposed by international regulations. Moreover it is a less contaminant technique which would be obligatory for critical uses after phase out of methyl bromide.

5. Acknowledgments

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6. References

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Table 1. Product of methyl bromide concentration (g/m^3) per Time (Hr) CxT in atmosphere at two depth in soil, along three days of disinfestation.

Treatment	0-20cm	20-40 cm
(2) 80 PE	5809 c	5383 b
(3) 40 PE	2927 a	2745 a
(4) 40 HT	3688 b	3464 a
(5) 40 LMG	3228 ab	3106 a

Table 2. Inoculum destruction %, infected root pieces and Chlamydospores of *F. o. dianthi* into the soil at 20 and 40 cm depth, after fumigation.

	Root Pieces		Chlamydospores	
Treatment	20cm	40cm	20cm	40cm
(2) 80 PE	100 a	100 a	100 a	100 a
(3) 40 PE	100 a	65 c	100 a	99.8 b
(4) 40 HT	100 a	100 a	100 a	100 a
(5) 40 LMG	100 a	90 b	100 a	100 a

Table 3. Carnation plant weight, Necrotic Vascular Discoloration (INV), and weeds after 48 weeks crop.

Treatment	Fresh weight	INV	Weeds per m^2
(1) Control	53.7 a	84.5 a	12.4
(2) 80 PE	154.5 b	5.7 b	1.4
(3) 40 PE	174.0 b	6.9 b	9.2
(4) 40 HT	162.9 b	2.1 b	4.7
(5) 40 LMG	130.9 b	1.1 b	5.0

Table 4. Carnation disease index (INV), Mortality % and Total Yield (Flowers / Plant) at the end of the crop.

Treatment	INV	Mortality %	Yield flowers/plant
(1) Control	100.0 a	100.0a	0.87 a
(2) 80 PE	11.1 b	64.1 b	5.48 b
(3) 40 PE	39.2 b	83.2 b	4.60 b
(4) 40 HT	38.1 b	80.5 b	5.00 b
(5) 40 LMG	18.5 b	63.5 b	5.95 b

Table 5. Soil Residues and emissions calculated by the mass balance approach. Reduction of emission as per cent of standard dosage.

Treatment	Dosage g/m^2	Residues g/Kg		Emissions g/m^2	Emissions reduction %
		0-20cm	20-40cm		
(2) 80 PE	80	25.8	17	66.9	0
(3) 40 PE	40	20.8	11.7	30.1	55
(4) 40 HT	40	26.0	14.3	27.7	59
(5) 40 LMG	40	20.3	14.8	29.3	56