METHYL BROMIDE ALTERNATIVES ON HORTICULTURAL CROPS

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Summary

A very intensive crop rotation, with three to four crops per year, typical in Valencia, frequently includes the earth almond *Cyperus sculentus* (Xufa) that acts as a real weed for the next crop. Methyl bromide (MB) is the preferred fumigant to control both diseases and weeds in this kind of rotation.

The crop rotation begun by an escarole crop (September to January), followed by potato (February to May) and watermelon (May to August).

Disinfestation treatments to compare were: 1) Non fumigated control; 2) Standard MB polyethylene (PE) 60g/ m^2; 3) MB VIF 30g/ m^2; 4) Solarization + Manure 5Kg/ m^2; 5) Solarization + MS (N-Methyl Dithiocarbamate Sodic 40% p/v) 36g/ m^2; 6) Telone C35 Mechanical application 40g/ m^2; 7) Telone II (1,3-Dichloropropene 93%p/p)18g/ m^2 + MS 108g/m^2

All treatments are rather effective in controlling weeds when compared to the non treated control, the increase in cost of removing weeds is particularly high if none treatment is applied.

Only the escarole crop suffered the attack of *Sclerotinia minor* and treatments 2 and 7 gave a very good protection as is revealed by a low percent of debris.

No specific pathogens were found in potato and watermelon crops, nevertheless grafting is confirmed as a very good technique that increases the yield of watermelon.

Solarization treatments did not differ significantly from control in this experiment. Treatment 7 is as good as MB in some of the instances, but disinfestation with MB is absolutely necessary if non grafted plants of watermelon are employed.

Keywords: disinfestation, solarization, manure, Metham-Na, 1.3,Dichloropropene, Chloropicrin, weeds, yield, endive, potato, watermelon, *Solanum tuberosum, Cichorium endivia, Citrullus vulgaris, Cyperus sculentus.*

1. Introduction

Methyl bromide (MB) is used basically as a soil fumigant to control a wide spectrum of soil borne diseases, pests and weeds. Because of its versatility and low cost, so far there is no single chemical alternative that can replace MB in all of its many uses as a soil fumigant. Despite of it, research efforts should be conducted to find new chemical alternatives before its phase out in 2005 because the possibilities of keeping the use of MB as critical for some crops will presumably be very restrictive.

The Spanish Agricultural Department has been funding since 1997 a research project to provide new alternatives to MB as a fumigant for soil disinfestation. In the case of the area of Valencia, the Agriculture Department of Generalitat Valenciana (Valencian Government) gives an additional financial support to carry out trials with particular attention to Valencian characteristics.

Among the possible alternatives, there are:

1. Dosage reduction: Soil Solarization (Katan et al., 1976) combined with low dosages of fumigants such as MB or Metham-Na (MS) is a good technique that improves Solarization (Cebolla et al., 1993, 1994)

The use of Virtually Impermeable Films (VIF) to reduce dosage of MB while keeping its effectiveness is a valuable technique to adapt to the schedule of consumption restrictions up to the MB phase out. (Cebolla et al., 1996).

2. Non chemical: ammonia from high nitrogen containing organic amendments (Lazarovitz, 1997) or isothiocyanates from *Brassica* tissues (Angus et al., 1995) are effective for the control of plant pathogens. The use of some composts, as a source of volatile toxic compounds, in combination with Solarization has been reported (Gamliel et al., 1993, 1999) to improve the control of pathogens.

Grafting varieties of watermelon over cabbage rootstock is also considered a good alternative for MB and is widely used in Valencia (Miguel A., 1995).

1.3. Chemical: Chloropicrin, 1,3-Dichloropropene, Metham-Na (MS) and their mixtures are among the chemicals considered by (MBTOC, 1995,1998) as possible chemical alternative methods. The mixture Telone C17 (1,3-Dichloropropene with 17% Chloropicrin) is also reported to have been used for many years on a variety of crops in North America. Recently a new formulate has been proposed that increases the rate of Chloropicrin up to 35% (Telone C35) with the aim of being more effective against fungi.

Valencian agriculture owns a very old tradition, in which crop rotation is very intensive, with three to four crops per year. One of the crops frequenly included is the earth almond *Cyperus sculentus* (xufa) that is used to make a popular fresh cold beverage called "Orxata". The residual tubers (Nutsedge rhizome) after this crop acts as a real weed for the next one. The goal of this experiment was to find out alternatives to MB for the control of diseases and weeds in order to improve the yield in a typical crop rotation in three consecutive crops such as escarole, followed by potato and watermelon, after a xufa crop. ..

2. Material and methods

We selected a typical farm, flood irrigated, with old history in intensive crop rotation where the last crop was *C. sculentus*. The field was deeply ploughed, and urban manure at a rate of 1.2 Ton/Ha was added in all the experimental field.

Single plot size was established in a relatively large size 8 m wide x 35 m long (280m^2) to have a good approach to reality. Plots were set out in separate blocks, with three replicates.

Disinfestation treatments were as follows:

1 Non fumigated control
2 Standard MB polyethylene (PE) 60g/ m^2
3 MB VIF 30g/ m^2
4 Solarization + Manure 5Kg/ m^2
5 Solarization + MS (N-Methyl dithiocarbamate Sodic 40% p/v) 36g/ m^2
6 Telone C35 Mechanical application 40g/ m^2
7 Telone II (1,3-Dichloropropene 93%p/p)18g/ m^2+ MS 108g/m^2

MB in treatments 2 and 3 was cold technique, applied by hand. VIF sheet was Orgalloy. Treatments 2, 4, 5 and 7 used standard PE (200 gauges) as a sheet for fumigation.

Manure used in treatment 4 was a mixture of 75% sheep and 25% of chicken. It was incorporated to the soil, by a tiller, before covering with plastic for Solarization. .

Treatment 6 Telone C35 was applied by mechanical application, leaving a central corridor not disinfested to allow the border of the plastic to be buried by the machine. In the other treatments, soil was covered by hand with plastic sheet before application of fumigants.

Treatments 4, 5, 7 were irrigated under the plastic sheet, and in treatments 5 and 7 the fumigant were applied through the irrigation water.

In treatment 7 Telone II was applied in the first flood, and one week later MS with a second flood.

Solarization treatments (4, 5) started early in July, and the sheets remained 6 weeks. The other treatments were done at mid July. In the 6 and 7, the sheets were removed after 10 days and in 2 and 3 remained only 5 days.

Some small pieces of roots infested by *Fusarium* were included in small polyamide bags and buried at 10 and 30 cm depth before application of treatments. Once finished the treatment, the bags were opened, and the small roots transferred to Komada (1974) selective medium. The number of *Fusarium* spp. colonies growing in the medium was compared with that of control with the purpose of surveillance the effect on inoculum as percent of survival..

The crop rotation begun by an escarole crop (September to January), followed by potato (February to May) and watermelon (May to August).

Escarole crop was covered, during the last week, with a black plastic sheet for bleaching the plants before cutting off.

In the watermelon crop, grafted (seedless cv. Boston F1 and cv. Dulce Maravilla F1, with seeds) and non grafted cv. Pata Negra F1, were compared in parallel rows in the same plot. As rootstock for both grafted varieties was used *Cucurbita hibrida* cv. FERRO F1.

The incidence of weeds in each treatment was monitored all along the growing seasons by time of removing weeds plus cleaning the plants, expressed in minutes per plant (min/plant). Disease incidence, yield an quality was also registered for each crop.

This research was planned for a long term effect study in which disinfestation will be repeated in the same plots every two years.

Duncan's Multiple Range Test was used, for statistical comparisons among treatments for the different quantitative traits under study.

3. Results

Results on survival of *Fusarium* spp from small pieces of roots (Table 1) show a good control at 10 cm depth for all treatments, but it is not complete at 30 cm in treatments 4, 5 and 6.

During the 1st crop (escarole) the incidence of *C. sculentus* and *C. rotundus* was very high, especially in control treatment. (Table 4) with a cost in time of removing weeds three to six fold higher than the other treatments.

A moist weather at the end of the crop, during bleaching of plants, favoured the progress of *Sclerotinia minor*, that affected the plants and produced an increase of % of debris. Control treatment was specially affected (Table 2) by the rot disease, to the contrary, the best treatments were 2 (Standard MB) and 7 (Tel+MS). Nevertheless individual weight of escaroles (Table 2) did not show differences between Control and MB treatments (2 and 3).

No statistical differences were found with respect to potato yield, as a consequence of the absence of pathogens affecting this crop.

Grafted plants of watermelon (Table 3) are by far more productive than non grafted ones. The grafted cv. Dulce Maravilla did not show any statistical difference among treatments. Treatment 2 (MBVIF) gave a distinct higher yield than control for non grafted cv. Pata Negra and grafted seedless cv. Boston. Treatment 7 (Tel+MS) was very good in the case of cv. Boston. All the other treatments were not significantly different from non disinfested control.

4. Discussion

All treatments are rather effective in controlling weeds when compared to the non treated control, the increase in cost of removing weeds is specially high if no treatment is applied.

Only the escarole crop suffered the attack of a pathogen and treatments 2 and 7 gave a very good protection as is revealed by low percent of debris.

No specific pathogens were found in potato and watermelon crops, nevertheless grafting is confirmed as a very good technique that increases the yield, and eventually makes unnecessary the disinfestation for one variety but not for the other.

VIF treatment, Telone C35 and Solarization treatments failed in the 1st crop but this could be explained in the case of Telone C35 because during the application we left a corridor in the middle between two sheets, without fumigant.

Solarization treatments did not differ significantly from control in this experiment. These results are not consistent with other experiments where Solarization treatments are very effective (Cebolla et al.1999).

The use of two consecutive fumigations with Telone and MS is as good as MB in some of the instances and then we consider this as one of the alternatives to take into account, but disinfestation with MB is absolutely necessary if non grafted plants of watermelon are employed.

The lack of consistency of some results together with the importance of studying the long term effect of the alternatives, makes necessary further research before the phase out of MB.

Table 1 Results on inocula *Fusarium* at a depths of 10cm and 30cm. as percent of survival.

Treatments	Depth of inoculum	
	10cm	30 cm
1 Control	100	100
2 BrPE60	0	0
3 BrVIF30	0	0
4 Sol+ Man	0	31.6
5 Sol+MS	0	2
6 Tel C35	0	10
7 Tel+MS	0	0

Table 2- The effect of soil treatments on yield of escarole (Kg/ unit) and potato (Kg /m2) and percent of escarole debris.

	Escarole Size Kg/unit	Escarole % of debris	Potato Yield
1 Control	1.24 bcd	54.3 d	20.2 a
2 BrPE60	1.32 ab	24.2 a	24.0 a
3 BrVIF30	1.34 ab	32.6 b	22.8 a
4 Sol+ Man	1.18 cd	37.7 bc	23.3 a
5 Sol+MS	1.26 abc	40.0 c	19.4 a
6 Tel C35	1.13 d	34.0 bc	20.5 a
7 Tel+MS	1.37 a	19.0 a	24.4 a

Table 3- The effect of soil treatments yield in Kg/plant, of three watermelon cultivars.

	Watermelon Yield		
	cv. Dulce Maravilla Grafted	cv. Pata Negra Non Grafted	cv. Boston seedless Grafted
1 Control	14.30 a	6.4 a	13.6 a
2 BrPE60	22.63 a	11.78 b	15.0 ab
3 BrVIF30	20.49 a	8.89 ab	21.4 b
4 Sol+ Man	21.57 a	6.81 a	18.6 ab
5 Sol+MS	18.42 a	6.95 a	14.6 ab
6 Tel C35	21.34 a	5.28 a	14.9 ab
7 Tel+MS	20.16 a	6.18 a	21.3 b

Table 4- The effect of soil treatments on cost of removing weeds in time (min/100m^2) in the first crop after *C. sculentus*

	Endive
1 Control	634
2 BrPE60	108
3 BrVIF30	108
4 Sol+ Man	199
5 Sol+MS	188
6 Tel C35	178
7 Tel+MS	131

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