CHEMICAL ALTERNATIVES TO METHYL BROMIDE FOR STRAWBERRY PRODUCTION IN HUELVA (SPAIN). 2003/04 RESULTS.

J.M. López-Aranda (1)*, L. Miranda (2), C. Soria (1), F. Romero (2), B. De Los Santos (2), F. Montes (3), J.M. Vega (3), J.I. Páez (3), J. Bascón (3) and J.J. Medina (2)

(1) IFAPA. CIFA Málaga, CICE-Junta de Andalucía, Churriana, Spain
(2) IFAPA. CIFA Las Torres, CICE-JA, Alcalá del Rio and Moguer, Spain
(3) Servicios Sanidad Vegetal, CAP-JA, Seville and Huelva, Spain

In 2002/03 and 2003/04 a new series of experiments has been initiated in two locations. On each orchard: "Occifresa" (Moguer) and "Cumbres Malvinas" (Palos de la Frontera), a complete randomized block design with 3 replications (78 m^2/rep.) and 10 fumigant treatments was used. Strawberry cv. 'Camarosa' was cultivated following conventional cultivation practices under large plastic tunnels. The 2002/03 results were presented in MBAO International Conference (López-Aranda et al., 2003). The main conclusions obtained were: a) as in previous years, average yield and fruit weight obtained with 1,3D+Pic (61:35) (Telopic^{TM}) and chloropicrin (Pic alone) were satisfactory and similar to those obtained with the standard MB treatment: MB-pic (50-50); b) VIF applications were efficient to improve the performance of chemical alternatives but dosage should be increased to 65-70% of the standard rate applied under LDPE films; c) DMDS^{TM} under VIF performed much better than DMDS under LDPE, but combinations of DMDS^{TM}-Pic under black VIF films would be a good alternative; d) Propylene oxide (Propozone^{TM}) rate (30 gallons/acre) under LDPE was not enough to achieve a good performance in our field conditions.

Conclusions b), c) and d) obtained in 2002/03 were taken into account in treatments for 2003/04 experiments (Table 1). Shank application of MB-pic (50-50) under preformed beds (200 kg/ha, 40 g/m^2 of treated area) was employed as standard MB use in the area. New chemical alternatives incorporated for the first time in 2003/04 experiments were: Calcic cyanamide under LDPE films and combinations of Chloropicrin (Pic) with Metam Sodium (MS) and DMDS^{TM} under preformed beds with VIF films. Fumigations were conducted on mid-September, 2003. Plantings were done on mid-October, 2003.

Soil samples from each orchard were evaluated (Table 2) for fungal presence before and after treatments. No lethal soil-borne fungi were present at the moment of planting, either in soil or plants. In the case of nematodes, only plant samples were examined before planting. No phytoparasitic nematodes were detected. Samples from the same plants per replication used for size (diameter and number of leaves) evaluation were examined at the end of the growing season for soil-

borne fungi and nematodes presence. In spite of the absence of phytoparasitic nematodes in plants before planting, *Pratylenchus penetrans* was detected in plant samples from Occifresa (location 1) and *Meloidogyne hapla* was observed in several plant replications of C. Malvinas (location 2) at the end of the cultivation period (Table 3). Results will be discussed. Also *Cylindrocarpon* sp. and *Rhizoctonia* spp. were detected in all treatments in both locations.

As in 2002/03 experiments, in spite of the presence of soil-borne pathogens (fungi and nematodes), plant survival, other agronomical traits and yields were optimal in both locations (Table 4). Average fruit weight is presented in Table 5. Results will be discussed.

Our results showed that VIF films applications were efficient solutions to improve the performance of chemical alternatives. In this case, dosage increased from 50% to 65-70% of the standard applied under LDPE films and mixtures of chemical fumigants (DMDS^{TM} and MS) with chloropicrin have improved significantly their performance. Propylene oxide (Propozone^{TM}) has evidenced promising yield results under VIF shank-application; however its capacity to control *Pratylenchus penetrans* populations has been weak (Table 3). As in previous years, average yield obtained with Telopic^{TM} and Pic alone has been satisfactory and similar to those obtained with the standard MB treatment; however, in the case of Pic alone (chloropicrin) its capacity to control *Pratylenchus penetrans* populations has been weak (Table 3). In the case of MB alternatives for strawberry fruit production, several chemical fumigant alternatives applied under VIF films could represent an appropriate short and medium-term solution to MB ban in environments with low levels of lethal soil-borne strawberry pathogens, such as Huelva crop area. However, some of these chemicals are not registered yet in Europe and/or Spain and their environment impacts must be studied carefully. For these reasons and others, not only Spain but other article 2º Montreal Protocol important strawberry producer countries have applied for critical use exemption of MB in 2005.

References

López-Aranda, J.M., Miranda, L., Romero, F., De Los Santos, B., Montes, F., Vega, J.M., Páez, J.I., Bascón, J. and Medina, J.J. 2003. Alternatives to MB for strawberry production in Huelva (Spain). 2003 Results. En: Proceedings Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions. November 3-6, 2003, San Diego, CA, USA, 33:1-4. URL: http://www.mbao.org/

Table 1. Treatments applied to soils prior to planting in 2002/03 and 2003/04.

Experiments 2002/03: 2 locations		Experiments 2003/04: 2 locations	
Treatments[1]	Description	Treatments[1]	Description
A: Untreated		A: Untreated	
B: MB+Pic (50-50) LDPE	[2]LDPE film, 200 kg/ha	B: MB+Pic (50-50) LDPE	[2]LDPE film, 200 kg/ha
C: MB+Pic (33-67) VIF	[2]VIF film, 100 kg/ha	C: MB+Pic (33-67) VIF	[2]VIF film, 150 kg/ha
D: Dazomet-rot-VIF	[3]VIF film, 125 kg/ha	D: Dazomet-rot-VIF	[3]VIF film, 200 kg/ha
E : Dazomet-dir-VIF	[4]VIF film, 125 kg/ha	E: MS + Pic VIF	[2]LDPE film, 200 kg/ha (MS) + 125 kg/ha (pic)
F : Telopic VIF (1,3D+pic)	[2]VIF film, 135 kg/ha	F: Telopic VIF (1,3D+pic)	[2]VIF film, 150 kg/ha
G: Chloropicrin VIF (pic)	[2]VIF film, 100 kg/ha	G: Chloropicrin VIF (pic)	[2]VIF film, 150 kg/ha
H: DMDS VIF	[2]VIF film, 200 kg/ha	H: DMDS + Pic VIF	[2]VIF film, 125 kg/ha (DMDS) + 125 kg/ha (pic)
I: DMDS LDPE	[2]LDPE film, 400 kg/ha	I: Calcic cyanamid	[3]LDPE film, 700 kg/ha
J: Propozone LDPE (Propylene oxide)	[2]LDPE film, 250 kg/ha	J: Propozone VIF (Propylene oxide)	[2]VIF film, 250 kg/ha

[1]Treatments in the same row were applied to the same replications each year. [2] Shank-application under pre-formed beds mulched with black film. [3]Broadcast soil surface localization, rotovator and mulching with black film. [4]Localization under pre-formed beds mulched with black film

Table 2. Total CFU x 10^3/g of dry soil, before/after treatments.

2002/2003 (López-Aranda et al., 2003)					2003/2004				
Treatments	Loc. 1 Occifresa		Loc. 2 C. Malvinas		Treatments	Loc. 1 Occifresa		Loc. 2 C. Malvinas	
	Before	After	Before	After		Before	After	Before	After
Untreated	5.4 ab	4.9 ab	5.7 a	0.5 a	Untreated	11.3 a	5.0 a	4.6 a	6.5 a
MB+Pic (50-50) LDPE	8.1 ab	1.0 c	2.9 a	0 a	MB+Pic (50-50) LDPE	10.5 a	1.9 ab	7.7 a	3.5 abc
MB+Pic (33-67)VIF	4.9 b	0 c	2.6 a	0 a	MB+Pic (33-67)VIF	9.0 a	0 b	5.0 a	0.3 c
Dazomet-rot-VIF	4.8 b	0.3 c	3.2 a	0 a	Dazomet-rot-VIF	10.8 a	0 b	5.5 a	1.0 c
Dazomet-dir-VIF	6.0 ab	1.2 bc	5.1 a	0.5 a	MS+Pic VIF	11.6 a	0 b	6.6 a	0.7 c
Telopic VIF	4.9 ab	0 c	3.5 a	1.5 a	Telopic VIF	9.5 a	2.8 ab	4.8 a	2.9 abc
Chloropicrin VIF	4.9 ab	0 c	4.8 a	2.3 a	Chloropicrin VIF	8.7 a	0 b	4.0 a	1.0 c
DMDS VIF	6.1 ab	6.1 a	3.0 a	0.9 a	DMDS+Pic VIF	11.5 a	0.3 b	6.6 a	0.3 c
DMDS LDPE	9.4 a	5.2 ab	4.0 a	2.5 a	Calcic Cyanamid	11.7 a	2.8 ab	6.0 a	5.8 ab
Propozone LDPE	5.7 ab	4.9 ab	3.1 a	2.5 a	Propozone VIF	9.2 a	0 b	6.0 a	2.2 bc
$P \leq 0.05$									

Table 3. Control of nematode populations at the end of the growing season.

2002/2003 (López-Aranda et al., 2003)			2003/2004		
	Loc. 1 Occifresa	Loc. 2 C. Malvinas		Loc. 1 Occifresa	Loc. 2 C. Malvinas
Treatments	*Pratylenchus penetrans*[1]	*Meloidogyne hapla*[2]	Treatments	*Pratylenchus penetrans*[1]	*Meloidogyne hapla*[2]
Untreated	161.5 ab	0.07 a	Untreated	50.1 ab	1.97 ab
MB+Pic (50-50) LDPE	23.2 bc	0.00 a	MB+Pic (50-50) LDPE	6.3 b	0.17 cd
MB+Pic (33-67) VIF	21.8 bc	0.27 a	MB+Pic (33-67)VIF	0.3 c	0.10 cd
Dazomet-rot-VIF	65.3 bc	0.00 a	Dazomet-rot-VIF	112.0 ab	1.40 bc
Dazomet-dir-VIF	124.3 ab	1.00 a	MS+Pic VIF	6.2 bc	1.07 bcd
Telopic VIF	5.5 c	0.00 a	Telopic VIF	9.8 bc	0.00 d
Chloropicrin VIF	110.0 bc	0.00 a	Chloropicrin VIF	83.8 ab	0.00 d
DMDS VIF	2.8 c	0.00 a	DMDS+Pic VIF	12.7 bc	0.00 d
DMDS LDPE	93.5 bc	0.00 a	Calcic Cyanamid	51.5 ab	2.80 a
Propozone LDPE	320.9 a	0.27 a	Propozone VIF	242.0 a	0.70 bcd
P. penetrans[1]: individuals/g roots; *M. hapla*[2]: Severity Index Scale: 0 (No symptoms) to 4 (all roots attacked); $P \leq 0.05$.					

Table 4. Total commercial yield.

2002/2003[1] (López-Aranda et al., 2003)					2003/2004[2]				
	Loc. 1 Occifresa	Loc. 2 C. Malvinas	Two loc. average			Loc. 1 Occifresa	Loc. 2 C. Malvinas	Two loc. average	
Treatments	Total yield[3]	Total yield[3]	Total yield[3]	Relative yield[4]	Treatments	Total yield[3]	Total yield[3]	Total yield[3]	Relative yield[4]
Untreated	791 d	989 a	890 c	84.5 c	Untreated	704 c	897 b	800 c	69.3 c
MB+Pic(50-50) LDPE	1036 ab	1070 a	1053 a	100 a	MB+Pic (50-50) LDPE	1082 ab	1229 a	1155 ab	100 ab
MB+Pic (33-67) VIF	1009 ab	1062 a	1036 a	98.4 a	MB+Pic (33-67) VIF	1047 ab	1283 a	1165 ab	100.8 ab
Dazomet-rot-VIF	994 ab	1034 a	1014ab	96.3 ab	Dazomet-rot-VIF	953 ab	1182 a	1067 b	92.4 b
Dazomet-dir-VIF	965 abc	1084 a	1025 a	97.3 a	MS+Pic VIF	973 ab	1229 a	1101 ab	95.3 ab
Telopic VIF	1081 a	1038 a	1059 a	100.6 a	Telopic VIF	1019 ab	1226 a	1122 ab	97.2 ab
Chloropicrin VIF	1008 ab	1068 a	1038 a	98.6 a	Chloropicrin VIF	1091 a	1295 a	1193 a	103.2 a
DMDS VIF	930 abcd	1071 a	1000abc	95.0 abc	DMDS+Pic VIF	1007 ab	1314 a	1160 ab	100.4 ab
DMDS LDPE	812 cd	986 a	899bc	85.4 bc	Calcic Cyanamid	718 c	910 b	814 c	70.5 c
Propozone LDPE	916 bcd	1055 a	985abc	93.6 abc	Propozone VIF	1045 ab	1201 a	1123 ab	97.2 ab
[1]cumulated until May 21st , 2003; [2]cumulated until May 28th , 2004; [3]g/plant; [4]relative yield in relation to MB standard treatment MB+pic (50-50) = 100%; $P \leq 0.01$									

Table 5. Average fruit weight (g/fruit).

2002/2003 (López-Aranda et al., 2003)				2003/2004			
Treatments	Loc. 1 Occifresa	Loc. 2 C. Malvinas	Two loc. average	Treatments	Loc. 1 Occifresa	Loc. 2 C. Malvinas	Two loc. average
Untreated	23.1 c	26.6 a	24.8 c	Untreated	22.6 c	23.3 a	22.9 c
MB+Pic(50-50) LDPE	26.7 a	27.1 a	26.9 ab	MB+Pic (50-50)LDPE	28.2 a	26.8 a	27.5 a
MB+Pic (33-67) VIF	24.4 abc	27.9 a	26.1 abc	MB+Pic (33-67) VIF	26.7 ab	26.1 a	26.4 a
Dazomet-rot-VIF	25.9 a	28.9 a	27.4 a	Dazomet-rot-VIF	26.2 abc	25.7 a	26.0 ab
Dazomet-dir-VIF	24.7 abc	28.6 a	26.6 abc	MS+Pic VIF	27.2 a	26.3 a	26.7 a
Telopic VIF	25.9 a	28.8 a	27.4 a	Telopic VIF	26.6 ab	27.1 a	26.8 a
Chloropicrin VIF	25.6 ab	26.9 a	26.3 abc	Chloropicrin VIF	27.6 a	26.0 a	26.8 a
DMDS VIF	25.0 abc	27.8 a	26.4 abc	DMDS+Pic VIF	28.1 a	28.3 a	28.2 a
DMDS LDPE	23.3 bc	26.6 a	25.0 c	Calcic Cyanamid	22.9 bc	24.6 a	23.8 bc
Propozone LDPE	24.6 abc	26.3 a	25.5 bc	Propozone VIF	27.2 a	26.3 a	26.7 a
$P \leq 0.01$							