

## STRAWBERRY PRODUCTION IN SPAIN: ALTERNATIVES TO MB, 2008 RESULTS.

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The Spain's Methyl Bromide Alternatives Project (INIA) has allowed 11 years of work for strawberry in Huelva (Spain). In 2007/08 a series of field trials has been conducted in two locations of the coastal area. On each orchard: "Occifresa" (Moguer) and "Cumbres Malvinas" (Palos de la Frontera), a complete randomized block design with 3 replications (78 m<sup>2</sup>/rep.) and 12 fumigant treatments was used. Strawberry cv. 'Camarosa' was cultivated following conventional cultivation practices under high-tunnels. As antecedents, the 2002/03 to 2000/07 results were presented in MBAO International Conference (see MBAO web site [www.mbao.org](http://www.mbao.org)). 2007/08 treatments in both locations were (Table 1): A: untreated control, B: MB+pic (50-50), C: sodium azide (SEP-100<sup>TM</sup>), D: dazomet+dichloropropene, E: EDN (Cyanogen<sup>TM</sup>), F: 1,3D+Pic (61:35) (Telopic<sup>TM</sup>), G: Pic alone, H: DMDS+pic, I: methyl iodide+pic (50-50) (Midas<sup>TM</sup>), J: propylene oxide+pic, K: acrolein, and, L: furfural (Multiguard Protect<sup>TM</sup>). Acrolein was applied for first time in our strawberry field tests.

Soil shank-applications were conducted on August 16-17, 2007 (location 2: Cumbres Malvinas) and September 10, 2007 (location 1: Occifresa). Furfural, sodium azide, acrolein, and dazomet+dichloropropene pre-plant drip applications were delayed to the second week of September, 2007. Plantings were done on October 17, 2007 in both locations.

Soil samples from each orchard were evaluated for fungal presence before (August, 2007) and after (October, 2007) treatments. Several treatments reduced significantly initial fungal population (MB+pic, sodium azide, dazomet +1,3D, EDN, DMDS+pic, MI+pic, and propylene oxide+pic); however, other chemicals were less effective (untreated control, acrolein, and furfural in location 1 and untreated control, 1,3D+Pic, Pic alone, acrolein, and furfural in location 2). Results will be presented and discussed.

Samples from 10 plants per replication used for size (diameter) evaluation were examined at the end of the growing season (May 7, 2008), five plants for soil-borne fungi and five plants for nematodes presence. *Pratylenchus penetrans* was detected in samples from "Occifresa" (location 1) and *Meloidogyne hapla* was

observed in samples from “Cumbres Malvinas” (location 2) at the end of the cultivation period (Table 2). Results will be presented and discussed.

High isolation frequencies of *Cylindrocarpon* spp. in roots and *Fusarium* spp. in crowns, low isolation frequencies of *Rhizoctonia* spp., and increasing isolation frequencies of species of *Pythium* were detected in both locations at the end of the growing season. All of them are important components of black root rot complex. *Macrophomina phaseolina* was detected occasionally in plots of untreated control and furfural in location 1 “Occifresa”. Results will be presented and discussed.

As in precedent growing seasons (2002/03 to 2000/07), plant survival, other agronomical traits and yields (Table 3) were optimal in both locations. Average fruit weight is presented in Table 4. Results and current status of MB replacement in the area of Huelva will be discussed.

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Table 1. Treatments applied to soils in 2007/08.

Treatment	Rate (kg/ha of treated area)	Method of application	Mulch type
A: Control	Untreated	-	Black LDPE
B: MB+pic (50-50)	400	Shank, 2 chisels in bed	Black LDPE
C: Sodium azide (SEP-100™)	120 a.i. <sup>1</sup>	Pre-plant drip irrigation	Black VIF
D: Dazomet+1,3-D	80+400	Pre-plant drip irrigation	Black VIF
E: EDN (Cyanogen™)	400	Shank, 2 chisels in bed	Black VIF
F: 1,3-D+pic (Telopic™)	300	Shank, 2 chisels in bed	Black VIF
G: Pic alone	300	Shank, 2 chisels in bed	Black VIF
H: DMDS+pic	300+100	Shank, 2 chisels in bed	Black VIF
I: MI+pic (50-50) (Midas™)	300	Shank, 2 chisels in bed	Black VIF
J: Propylene oxide+pic	400+200	Shank, 2 chisels in bed	Black VIF
K: Acrolein	180	Pre-plant drip irrigation	Black VIF
L: Furfural (Multiguard™)	510 a.i. <sup>1</sup> +32.5	Pre-plant drip irrigation + monthly drip irrigation	Black VIF
<sup>1</sup> a.i. = active ingredient			

Table 2. Nematode populations at the end of the growing season.

	Loc. 1: Occifresa: <i>Pratylenchus penetrans</i>	Loc. 2: C. Malvinas <i>Meloidogyne hapla</i>		
Treatments	individuals/g of roots	Gall Index: Severity Index <sup>1</sup>	N° eggs+ J <sub>2</sub> /g of roots	females/g of roots
A: Control	175.67 d	3.30 c	13390.00 d	101.00 c
B: MB+pic (50-50)	23.00 ab	0.60 ab	32.00 ab	6.00 ab
C: Sodium azide	102.50 cd	2.30 bc	852.50 abcd	60.00 bc
D: Dazomet+1,3-D	39.50 abc	0.20 a	33.50 ab	9.80 ab
E: EDN	93.00 cd	1.20 abc	640.00 abcd	45.00 bc
F: 1,3-D+pic	33.33 ab	0.20 a	9.50 a	0.10 a
G: Pic alone	139.50 d	0.60 ab	265.00 abc	53.00 bc
H: DMDS+pic	11.85 a	0.50 a	211.50 abc	10.95 ab
I: MI+pic (50-50)	12.50 a	0.20 a	4.70 a	0.50 a
J: Propylene oxide+pic	67.00 bcd	n.d.	n.d.	n.d.
K: Acrolein	85.50 bcd	1.90 abc	5354.00 cd	55.00 bc
L: Furfural	75.00 bcd	2.40 bc	2560.33 bcd	92.00 bc

Values are means of three replicates. Means followed by the same letter in each column were not significantly different ( $0.5 \leq P$ ) by the LSD test. Transformation  $\log(1+x)$ .  
<sup>1</sup>Severity Index Scale: 0 (No symptoms) to 4 (all roots attacked).

Table 3. Total commercial yield in grams/plant and relative yield.

Treatments	Loc. 1: Occifresa		Loc. 2: C. Malvinas		Two loc. average	
	Total yield <sup>1</sup>	Relative yield <sup>2</sup>	Total yield <sup>1</sup>	Relative yield <sup>2</sup>	Total yield <sup>1</sup>	Relative yield <sup>2</sup>
A: Control	865 d	78.2	777 f	76.9	821 g	77.6
B: MB+pic (50-50)	1106 ab	100	1010 cde	100	1058 bcd	100
C: Sodium azide	1007 bc	91.0	968 e	95.8	986 e	93.2
D: Dazomet+1,3-D	1113 ab	100.6	1030 cde	102.0	1072 bc	101.3
E: EDN	1026 bc	92.8	1062 abc	105.1	1044 bcde	98.7
F: 1,3-D+pic	1045 abc	94.5	1101 ab	109.0	1073 bc	101.4
G: Pic alone	1164 a	105.0	1124 a	111.3	1144 a	108.1
H: DMDS+pic	1091 abc	98.6	1098 ab	108.7	1095 ab	103.5
I: MI+pic (50-50)	1045 abc	94.5	1002 cde	99.2	1023 cde	96.7
J: Propylene oxide+pic	1087 abc	98.3	1043 bcd	103.3	1065 bcd	100.7
K: Acrolein	1005 bc	90.9	993 e	98.3	999 de	94.4
L: Furfural	970 cd	87.7	841 f	83.3	906 f	85.6

<sup>1</sup>Cumulated up to May 22<sup>nd</sup>, 2008; <sup>2</sup>Relative yield in relation to MB standard treatment MB+pic (50-50) = 100%;  $P \leq 0.05$ .  
 Values are means of three replicates. Means followed by the same letter in each column were not significantly different ( $0.5 \leq P$ ) by the LSD test.

Table 4. Average fruit weight (g/fruit).

Treatments	Loc. 1: Occifresa		Loc. 2: C. Malvinas		Two loc. average	
	g/fruit	Relative weight <sup>1</sup>	g/fruit	Relative weight <sup>1</sup>	g/fruit	Relative weight <sup>1</sup>
A: Control	23.6 d	93.9	23.7 d	90.8	23.7 d	92.3
B: MB+pic (50-50)	25.2 bc	100	26.1 abc	100	25.6 ab	100
C: Sodium azide	25.9 ab	102.9	25.2 bcd	96.8	25.6 ab	99.8
D: Dazomet+1,3-D	24.5 cd	97.4	25.4 abcd	97.5	25.0 bc	97.4
E: EDN	25.1 bc	99.6	25.9 abc	99.4	25.5 ab	99.5
F: 1,3-D+pic	25.4 abc	101.0	26.8 ab	102.6	26.1 ab	101.8
G: Pic alone	25.3 abc	100.7	24.9 bcd	93.8	25.1 b	98.0
H: DMDS+pic	26.3 a	104.4	26.6 ab	101.8	26.4 a	103.0
I: MI+pic (50-50)	25.9 ab	103.1	27.1 ab	103.9	26.5 a	103.5
J: Propylene oxide+pic	25.1 bc	99.8	27.5 a	105.6	26.3 a	102.7
K: Acrolein	25.3 abc	100.6	25.8 abcd	98.9	25.6 ab	99.7
L: Furfural	23.8 d	94.4	24.1 cd	92.3	23.9 cd	93.4

<sup>1</sup>Relative weight in relation to MB standard treatment MB+pic (50-50) = 100%; P ≤ 0.05.  
 Values are means of three replicates. Means followed by the same letter in each column were not significantly different (0.5 ≤ P) by the LSD test.