STRAWBERRY PRODUCTION IN SPAIN: ALTERNATIVES TO MB, 2006 RESULTS.

J.M. López-Aranda (1)*, L. Miranda (2), F. Romero (2), B. De Los Santos (2), C. Soria (1), R. Pérez-Jiménez (1), T. Zea (1), M. Talavera (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) IFAPA. CIFA Granada, CICE-Junta de Andalucía, Granada, Spain

The National project INIA on alternatives to Methyl Bromide (MB) has allowed nine years of work for strawberry cultivation in Huelva (Spain). In 2005/06 a new 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^2/rep.) and 10 fumigant treatments was used. Strawberry cv. 'Camarosa' was cultivated following conventional cultivation practices under large plastic tunnels. As antecedents, the 2002/03, 2003/04 and 2004/05 results were presented in MBAO International Conference (López-Aranda et al., 2003; López-Aranda et al., 2004; López-Aranda et al., 2005). The main conclusions carried out were: a) yield 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 with dosage around the 65-75% of the standard under LDPE films were efficient to improve the performance of chemical alternatives; c) combinations of DMDS^{TM}+Pic under black VIF films performed much better than DMDS alone.

2005/2006 treatments in both locations were (Table 1): A: Non-treated control, B: MB+pic (50-50), C: Sodium azide (SEP-100^{TM}), D: Dazomet, E: EDN (Cyanogen^{TM}), F: 1,3D+Pic (61:35) (Telopic^{TM}), G: Pic alone, H: DMDS alone, I: Calcic cyanamide+(1,3D+Pic) (Perlka^{TM}+Telopic^{TM}), J: Propylene oxide (Propozone^{TM}). Fumigations were conducted on September 1 ("Cumbres Malvinas") and 6 ("Occifresa"), 2005; except treatment C (pre-plant drip-irrigation) with Sodium azide (SEP-100^{TM}) applied on September 14-15, 2005. This application system will be discussed. Plantings were done on October 17, 2005.

Soil samples from each orchard were evaluated for fungal presence before and after treatments. 10 plants/replication were selected to study plant size six times after planting date (1 to 6 months after transplant: MAT) (Table 2). Samples from the same plants per replication used for size (diameter) evaluation were examined at the end of the growing season (May 4-5, 2006), five plants for soil-borne fungi and five plants for nematodes presence. In spite of the absence of phytoparasitic

nematodes in plants before planting, *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 3). Also *Macrophomina* spp., *Fusarium* spp. and *Rhizoctonia* spp. were detected in crowns and roots in both locations (Figures 1 to 5). Results on soil-borne fungi and nematodes control will be discussed. As in 2002/03, 2003/04 and 2004/05 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 and current status of MB replacement in the area of Huelva will be discussed.

References

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Table 1. Treatments applied to soils in 2005/06.

Treatment	Rate (kg/ha of treated area)	Method of application	Mulch type
Control	Untreated	-	Black LDPE
MB+pic (50-50)	400	Shank, 4 chisels in bed	Black LDPE
SEP-100	125	Pre-plant drip irrigation	Black VIF
Dazomet	400	Rototilled	Black VIF
EDN (Cyanogen)	400	Shank, 4 chisels in bed	Black VIF
Telopic	300	Shank, 4 chisels in bed	Black VIF
Pic alone	300	Shank, 4 chisels in bed	Black VIF
DMDS	600	Shank, 4 chisels in bed	Black VIF
Perlka+Telopic	500+170	Rototilled+ Shank, 4 chisels in bed	Black VIF
Propozone	600	Shank, 4 chisels in bed	Black VIF

Table 2. Plant size (plant diameter in cm), 1, 3 and 6 months after transplant.

	Loc. 1: Occifresa			Loc. 2: C. Malvinas			Two loc. average		
Treatment	1MAT	3MAT	6MAT	1MAT	3MAT	6MAT	1MAT	3MAT	6MAT
Pic	10.9 ab	25.1 a	38.3 a	13.6 a	29.5 a	38.9 a	12.3 a	27.3 a	38.6 a
MB+pic	11.1 a	25.3 a	36.5 ab	11.8bcd	27.4 abc	39.5 a	11.4ab	26.3ab	38.0 a
EDN	10.3 ab	23.6 a	35.7 ab	12.6 ab	28.6 ab	37.9 ab	11.4ab	26.1ab	36.8ab
Telopic	9.8 bcd	24.8 a	35.0abc	12.2abc	27.0 abc	37.9 ab	11.0 b	25.9ab	36.4ab
Dazomet	10.1abcd	22.5 ab	33.8abc	12.7 ab	28.0 abc	38.5 ab	11.4ab	25.2ab	36.2ab
DMDS	10.2 abc	24.0 a	35.5 ab	12.1 bc	24.7 cd	33.7 bc	11.2 b	24.4bc	34.6bc
Calc.+Tel	11.1 a	21.2abc	32.7 bc	11.9 bc	25.6 bcd	35.1abc	11.5ab	23.7bc	33.9bc
Propozone	8.2 e	19.0 bc	32.5 bc	11.2bcd	26.0abcd	35.0abc	9.7 c	22.5cd	33.7bc
SEP-100	9.0 cde	18.0 c	32.3 bc	10.9 cd	23.4 d	32.3 c	9.5 c	20.7 d	32.3 c
Control	8.9 de	18.0 c	30.2 c	10.3 d	23.7 d	32.5 c	9.6 c	20.3 d	31.4 c
$P \leq 0.05$									

Table 3. Nematode populations at the end of the growing season.

	Loc. 1: Occifresa		Loc. 2: C. Malvinas	
Treatments	*Pratylenchus penetrans*[1]	*Meloidogyne hapla*[2]	*Pratylenchus penetrans*[1]	*Meloidogyne hapla*[2]
Control	14.67 a	0.00	0.00	1.60 a
MB+pic	14.07 a	0.00	0.00	0.67 bc
SEP-100	10.60 a	0.00	0.00	1.80 a
Dazomet	18.07 ab	0.00	0.00	0.73 bc
EDN	16.77 a	0.00	0.00	0.40 bcd
Telopic	5.67 ab	0.00	0.00	0.00 d
Pic	7.10 ab	0.00	0.00	0.53 bcd
DMDS	0.07 b	0.00	0.00	0.07 bcd
Calc.+Tel	0.80 ab	0.00	0.00	0.20 bcd
Propozone	13.27 a	0.00	0.00	0.87 b
P. penetrans[1]: individuals/g of roots; *M. hapla*[2]: Severity Index Scale: 0 (No symptoms) to 4 (all roots attacked); $P \leq 0.05$.				

Table 4. Total commercial yield in grams/plant and relative yield.

	Loc. 1: Occifresa		Loc. 2: C. Malvinas		Two loc. average	
Treatments	Total yield[1]	Relative yield[2]	Total yield[1]	Relative yield[2]	Total yield[1]	Relative yield[2]
Pic	987 a	101,0 a	951 a	100,3 a	969 a	100,6 a
MB+pic	977 a	100 a	949 a	100 a	963 a	100 a
EDN	898 ab	91,9 ab	905 ab	95,5 ab	902 ab	93,7 ab
Dazomet	868 b	88,8 b	870 abc	91,7 abc	869 bc	90,2 bc
Telopic	808 bcd	82,6 bcd	913 ab	96,2 ab	860 bc	89,3 bc
DMDS	853 bc	87,3 bc	857 abc	90,3 abc	855 bcd	88,8 bcd
Propozone	759 cde	77,6 cde	834 abc	87,9 abc	796 cde	82,7 cde
Calc.+Tel	739 de	75,6 de	824 bc	86,8 bc	781 de	81,1 de
SEP-100	685 ef	70,1 ef	788 c	83,0 c	736 e	76.5 e
Control	598 f	61,2 f	640 c	67.4 c	619 f	64,3 f
[1]Cumulated up to May 22nd, 2006; [2]Relative yield in relation to MB standard treatment MB+pic (50-50) = 100%; $P \leq 0.05$						

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

	Loc. 1: Occifresa		Loc. 2: C. Malvinas		Two loc. average	
Treatments	g/fruit	Relative weight[1]	g/fruit	Relative weight[1]	g/fruit	Relative weight[1]
MB+pic	28.1 a	100.0 a	28.9 a	100,0 a	28.5 a	100,0 a
Pic	28.7 a	102.0 a	27.4 ab	94.7 ab	28.0 a	98.3 a
EDN	28.1 a	100.0 a	27.5 ab	95.2 ab	27.8 a	97.6 a
DMDS	27.5 a	97.9 a	26.9 ab	93.0 ab	27.2 ab	95.4 ab
Telopic	26.8 ab	95.6 ab	27.3 ab	94.5 ab	27.1 ab	95.0 ab
Dazomet	26.9 ab	95.9 ab	27.1 ab	93.7 ab	27.0 ab	94.8 ab
Propozone	24.1 cd	85.9 cd	27.1 ab	93.7 ab	25.6 bc	89.9 bc
Calc.+Tel	24.9 bc	88.8 bc	25.7 bc	88.9 bc	25.3 c	88.8 c
SEP-100	23.2 cd	82.5 cd	25.3 bc	87.6 bc	24.2 cd	85.1 cd
Control	21.9 d	78.1 d	23.9 c	82.9 c	22.9 d	80.5 d

[1]Relative weight in relation to MB standard treatment MB+pic (50-50) = 100%; $P \leq 0.05$

Fig. 1. Location 1 (Occifresa): % of Isolation, Rhizoctonia spp. (PDAA).

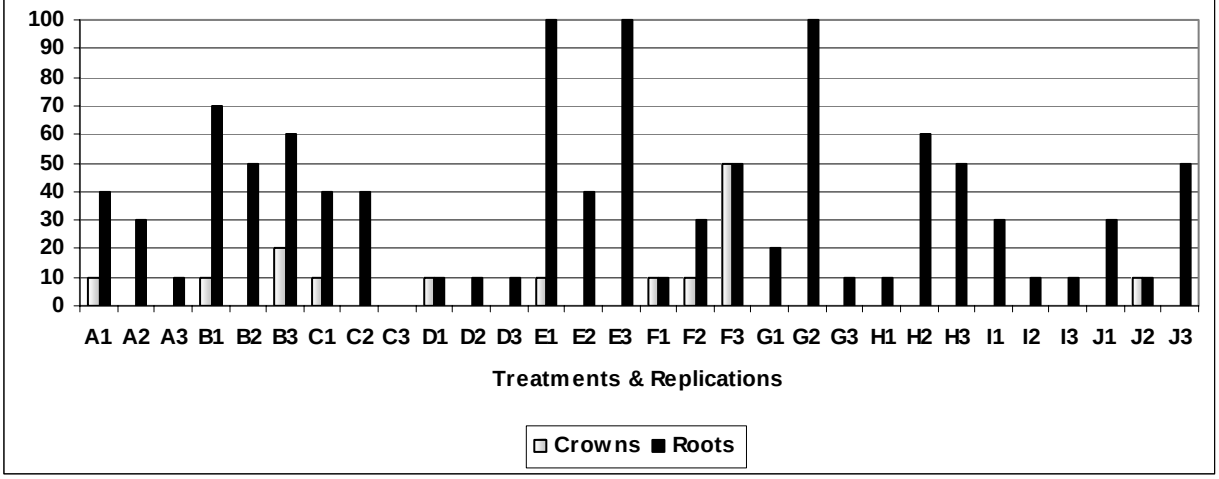

Fig. 2. Location 1 (Occifresa): % of Isolation, Fusarium spp. (PDAA).

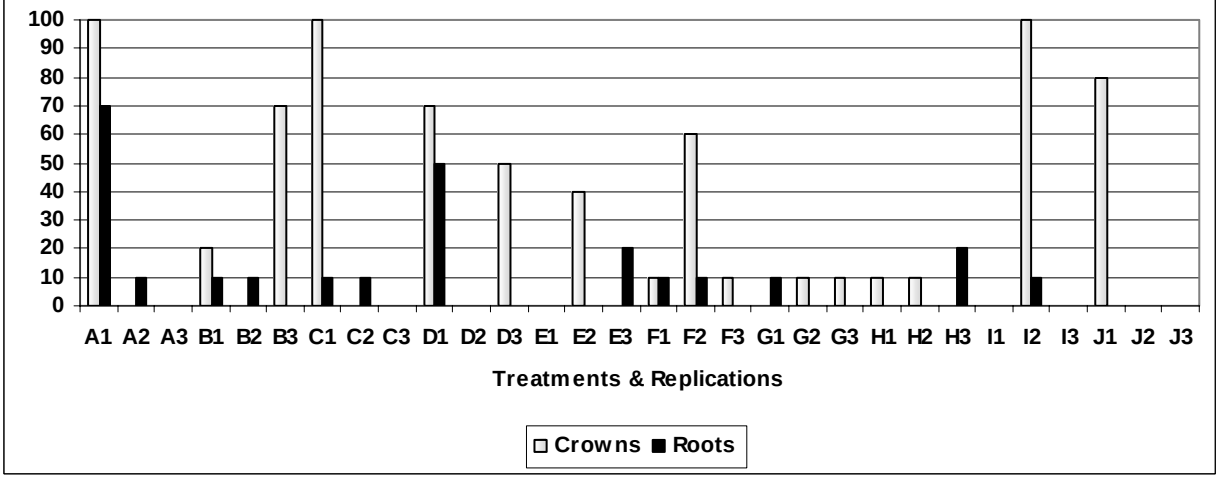

Fig. 3. Location 1 (Occifresa): % of Isolation, Macrophomina spp. (PDAA).

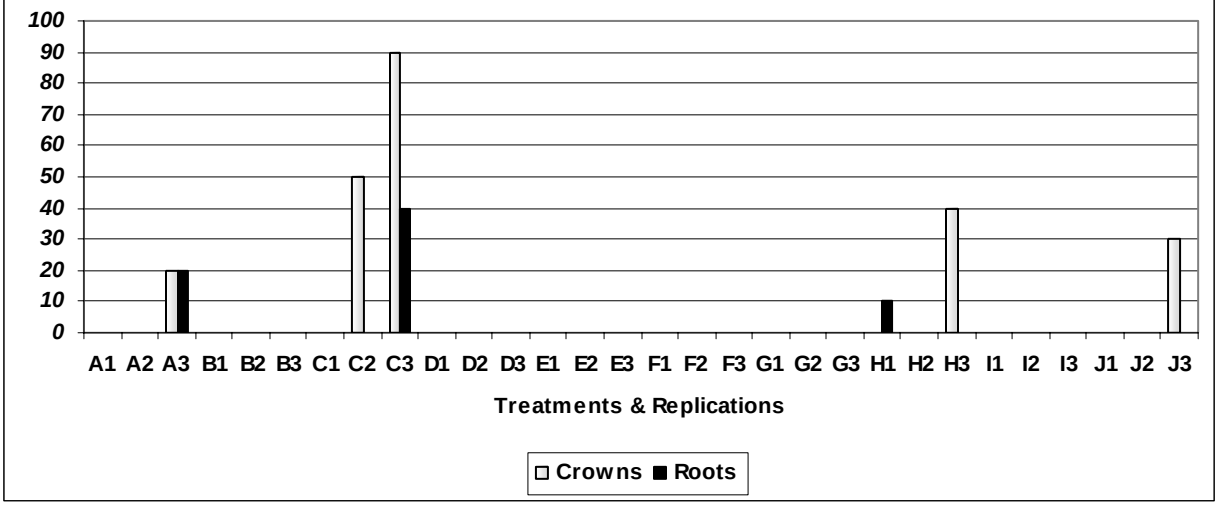

Fig. 4. Location 2 (C. Malvinas): % of Isolation, Rhizoctonia spp. (PDAA).

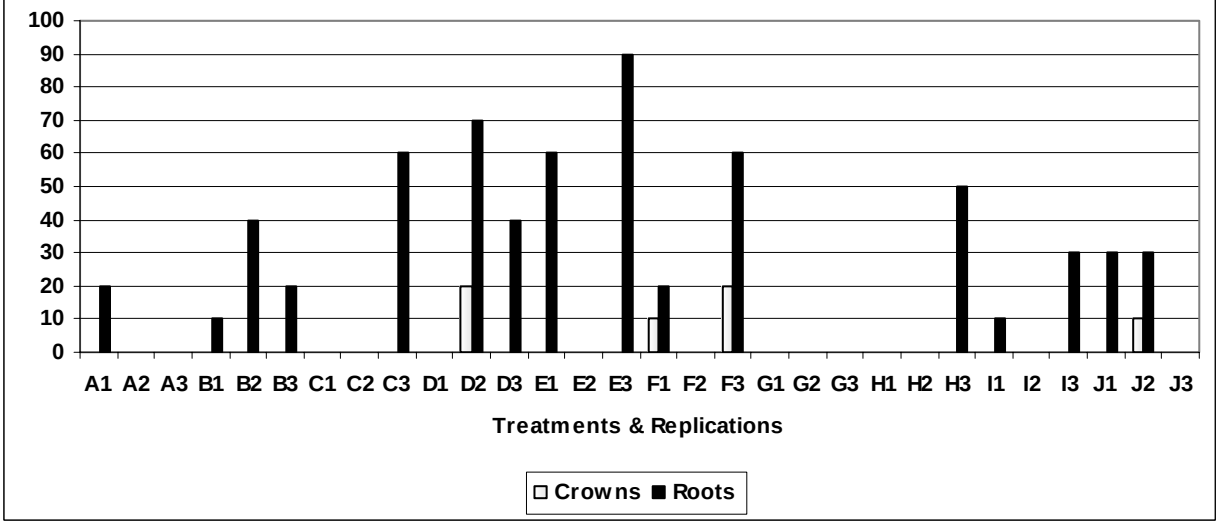

Fig. 5. Location 2 (C. Malvinas): % of Isolation, Fusarium spp. (PDAA).