STRAWBERRY IN SPAIN: ALTERNATIVES TO MB. 2011-2013 RESULTS.

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The National project INIA on alternatives to MB has allowed sixteen years of work for strawberry cultivation in Huelva (Spain). Here, we describe our last three seasons of research carried out between 2011 and 2013. This series of field trials has been conducted in two locations of the coastal area. On each farm: "Occifresa" (Moguer) and "Fres-Gómez" (Palos de la Frontera), a complete randomized block design with 3 replications (78 m^2/rep.) and 12 chemical and non chemical fumigant treatments was used (10 treatments in 2012/13). As antecedents, the 2002/03 to 2008/09 results were presented in MBAO International Conference (see López-Aranda et al., 2003, 2004, 2005, 2006, 2007, 2008, 2009). The 2009/2010 results were presented in Medina-Mínguez et al. (2012a, 2012b).

The 2010/2011, 2011/2012 and 2012/2013 treatments are presented in Table 1. The chemicals were 1,3D:chloropicrin (Telopic®), chloropicrin (Tripicrin®), 1,3D (DD®), Dazomet (Basamid®), DMDS (Atomal®), Methyl iodide (Gold®), and Metam sodium (Laisol®). Non-chemical treatments (biosolarization) and mixed (biosolarization place chemicals) were applied during the second week of July and conducted from mid-July to mid-August. Chemical treatments were applied from mid-August to mid-September and superimposed on the same parcels and replications. 'Camarosa' in 2010/11, 2011/12 and 'Florida Fortuna' ('Florida Radiance') cultivars were cultivated from mid-October until late May every year; following IPM practices under high plastic tunnels.

Ten randomly selected plants from each replication were observed throughout the complete growing season; plant diameter (plant vigour) was determined by taking measurements across the above ground foliage. The incidence of crown and root fungal diseases and nematodes in the plants was assessed at the end of each season (early-May) on the same plants selected for plant vigour. Five plants were used to detect soil-borne fungi and five plants to detect nematodes. For plant fungi isolation and determination methods were according to the literature. Regarding the nematodes, the Gall Index was recorded in a 0-4 rating scale (being value 0 absence of symptoms and 4 all roots attacked). Plant survival, early and total yield (and fruit size were recorded throughout the production season (mid-January to end-May) at both locations for the whole population of plants per replication. Data were submitted to analysis of variance and treatment means were compared

with Fischer's protected least significant difference test at the 5% significance level (Statistix v. 8.0, Tallahassee, Florida, USA).

Nematode populations at the end of the cultivation period are presented in Tables 2a and 2b; *Pratylenchus penetrans* was detected in samples from "Occifresa" and *Meloidogyne hapla* from "Fres-Gómez". Percentage of dead plants are presented in Table 3. Total commercial yield in grams per plant and relative yield are presented in Tables 4a and 4b. Results will be presented and discussed. The current status of soil disinfestation for strawberry in the area of Huelva will be discussed.

References

Medina-Mínguez et al. 2012. Chemical and Non-chemical Alternatives to Methyl Bromide on Strawberry in Huelva (Spain): 2008-2010 Results. Acta Hort. (ISHS), 926: 637-644

Medina-Mínguez et al. 2012. Comparison of Different Chemical and Non-chemical alternatives to Methyl Bromide for strawberry in Huelva (Spain). Journal of Berry Research, 2: 113-121

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Table 1.Treatments applied to soils.

Treatment	Rate (kg/ha of treated area)			Method of application
	2010/2011	2011/2012	2012/2013	
Control	Untreated	Untreated	Untreated	-
Pic alone VIF	300	-	-	Shank, 2 chisels bed
Pic alone	400	400	400	Shank, 2 chisels bed
1,3D:Pic (61:35)	400	400	400	Shank, 2 chisels bed
Dazomet	500	500	500	Broadcast, Spading
Dazomet	-	300	300	Broadcast, Spading
Dazomet:1,3D	200+300	200+300	200+300	Broadcast+Pre drip
Dazomet:DMDS	-	200+300	-	Shank, 2 chisels bed
Dazomet:DMDS VIF	-	-	200+300	Shank, 2 chisels bed
DMDS:Pic	400+130	400+130	-	Shank, 2 chisels bed
DMDS:Pic	400+130	400+130	-	Pre plant drip irrigat.
DMDS:Pic VIF	-	-	300+100	Pre plant drip irrigat.
Methyl iodide:Pic (98:2) VIF	150	150	-	Pre plant drip irrigat.
Biosolarization chicken manure	25,000	25,000	25,000	Pre-plant broadcast
Biosolarization sugar beet vinasse	15,000	-	-	Pre-plant broadcast
Biosolarization chicken:DMDS	-	25,000+ 400	-	Broadcast solarizator
Biosolarization chicken:MS	-	-	25,000+ 400 l/ha	Broadcast+Pre drip
Solarisation:MS	650 l/ha	-	-	Broadcast solarizator

Table 2a. *Pratylenchus penetrans* populations at the end of the cultivation period in Occifresa farm. Individuals/g roots.

Treatment	2010/2011	2011/2012	2012/2013
Control	2200 a	183 a	800 a
Pic alone VIF	483 b	-	-
Pic alone	617 b	113 b	330 bc
1,3D:Pic (61:35)	433 b	47 def	95 c
Dazomet (500 kg/ha)	683 b	47 def	130 bc
Dazomet (300 kg/ha)	-	67 bcde	250 bc
Dazomet:1,3D	767 b	107 bc	138 bc
Dazomet:DMDS	-	53 cdef	-
Dazomet:DMDS VIF	-	-	70 c
DMDS:Pic (shank)	1183 ab	93 bcde	-
DMDS:Pic (drip)	517 b	117 b	-
DMDS:Pic VIF	-	-	127 bc
Methyl iodide:Pic (98:2) VIF	300 b	65 bcd	-
Biosolarization chicken manure	83 b	40 ef	54 c
Biosolarization sugar beet vinasse	267 b	-	-
Biosolarization chicken:DMDS	-	33 f	-
Biosolarization chicken:MS	-	-	46 c
Solarisation:MS	67 b	-	-
Means followed by the same letter in each column not significantly different (0.5 ≤ P) by the LSD test. Transformation log (1+x).			

Table 2b. *Meloidogyne hapla* populations at the end of the cultivation period in Fres-Gómez farm. Gall (severity) Index.

Treatment	2010/2011	2011/2012	2012/2013
Control	2.00 a	0.93 a	1.30 a
Pic alone VIF	0.00 b	-	-
Pic alone	0.00 b	0.07 b	0.00 b
1,3D:Pic (61:35)	0.00 b	0.00 b	0.00 b
Dazomet (500 kg/ha)	0.13 b	0.07 b	0.60 ab
Dazomet (300 kg/ha)	-	0.13 b	0.40 b
Dazomet:1,3D	0.00 b	0.07 b	0.00 b
Dazomet:DMDS	-	0.07 b	-
Dazomet:DMDS VIF	-	-	0.00 b
DMDS:Pic (shank)	0.00 b	0.07 b	-
DMDS:Pic (drip)	0.53 b	0.00 b	-
DMDS:Pic VIF	-	-	0.27 b
Methyl iodide:Pic (98:2) VIF	0.00 b	0.07 b	-
Biosolarization chicken manure	0.00 b	0.00 b	0.00 b
Biosolarization sugar beet vinasse	0.13 b	-	-
Biosolarization chicken:DMDS	-	0.07 b	-
Biosolarization chicken:MS	-	-	0.00 b
Solarisation:MS	0.00 b	-	-
The same letter in each column not significantly different (0.5 ≤ P) by the LSD test. Transformation log (1+x). Severity Index Scale: 0 (No symptoms) to 4 (all roots attacked).			

Table 3. Percentage of dead plants* at the end of the cultivation period (end-May).

Treatment	2010/2011		2011/2012		2012/2013	
	Occifr.	C. Malv.	Occifr.	C. Malv.	Occifr.	C. Malv.
Control	33.6 ab	2.9 a	19.9 a	20.2 a	17.8 a	11.3 a
Pic alone VIF	14.6 cd	0.4 b	-	-	-	-
Pic alone	5.3 de	0.2 b	0.4 cd	0.5 b	1.0 cd	2.1 b
1,3D:Pic (61:35)	5.1 de	0.3 b	0.1 d	0.4 b	1.4 cd	1.5 b
Dazomet (500 kg/ha)	0.6 e	0.3 b	0.5 cd	0.4 b	0.7 cd	0.7 b
Dazomet (300 kg/ha)	-	-	0.3 d	0.1 b	1.9 c	1.5 b
Dazomet:1,3D	0.2 e	0.4 b	0.5 cd	0.1 b	1.1 c	0.8 b
Dazomet:DMDS	-	-	1.0 cd	0.2 b	-	-
Dazomet:DMDS VIF	-	-	-	-	0.6 d	1.6 b
DMDS:Pic (shank)	0.8 e	0.1 b	0.2 d	0.5 b	-	-
DMDS:Pic (drip)	4.1 e	0.4 b	0.0 d	0.2 b	-	-
DMDS:Pic VIF	-	-	-	-	0.8 cd	1.3 b
Methyl iodide:Pic (98:2) VIF	2.0 e	0.1 b	0.1 d	0.0 b	-	-
Biosolarization chicken manure	18.9 bc	0.5 b	4.4 b	0.3 b	4.5 b	1.4 b
Biosolarization sugar beet vinas.	48.1 a	0.6 b	-	-	-	-
Biosolarization chicken:DMDS	-	-	2.4 bc	0.3 b	-	-
Biosolarization chicken:MS	-	-	-	-	1.8 cd	0.7 b
Solarisation:MS	43.9 ab	0.4 b	-	-	-	-
* % of dead plants (mainly caused by *Macrophomina phaseolina, 80%* frequency of isolation*).* $0.05 \leq P$ by the LSD test. Transformation arcsin (sqrt(X/100)) for % of died plants.						

Table 4a. Total commercial yield (g/plant) and relative yield. Occifresa farm.

Treatment	2010/2011		2011/2012		2012/2013	
	Yield	Relat.	Yield	Relat.	Yield	Relat.
Control	612 c	66	720 b	76	767 d	74
Pic alone VIF	917 a	100	-	-	-	-
Pic alone	931 a	101	978 a	104	1022 a	99
1,3D:Pic (61:35)	919 a	100	944 a	100	1030 a	100
Dazomet (500 kg/ha)	903 ab	98	971 a	103	961 abc	93
Dazomet (300 kg/ha)	-	-	1005 a	106	934 c	91
Dazomet:1,3D	932 a	101	949 a	100.5	940 bc	91
Dazomet:DMDS	-	-	960 a	102	-	-
Dazomet:DMDS VIF	-	-	-	-	1008 abc	98
DMDS:Pic (shank)	902 ab	98	926 a	98	-	-
DMDS:Pic (drip)	906 a	99	1000 a	106	-	-
DMDS:Pic VIF	-	-	-	-	946 bc	92
Methyl iodide:Pic (98:2) VIF	836 ab	91	967 a	102	-	-
Biosolarization chicken manure	801 b	87	921 a	98	941 bc	91
Biosolarization sugar beet vinas.	610 c	66	-	-	-	-
Biosolarization chicken:DMDS	-	-	976 a	103	-	-
Biosolarization chicken:MS	-	-	-	-	1010 ab	98
Solarisation:MS	645 c	70	-	-	-	-
$0.05 \leq P$ by the LSD test. Relative yield in relation to 1,3D:Pic (61:35) = 100%						

Table 4b. Total commercial yield (g/plant) and relative yield. Fres-Gómez farm.

Treatment	2010/2011		2011/2012		2012/2013	
	Yield	Relat.	Yield	Relat.	Yield	Relat.
Control	780 d	87	883 b	81	900 b	78
Pic alone VIF	970 a	108	-	-	-	-
Pic alone	927 ab	103	1101 a	101	1154 a	99
1,3D:Pic (61:35)	897 abc	100	1087 a	100	1161 a	100
Dazomet (500 kg/ha)	949 ab	106	1057 a	97	1153 a	99
Dazomet (300 kg/ha)	-	-	1056 a	97	1083 a	93
Dazomet:1,3D	917 abc	102	1092 a	100	1150 a	99
Dazomet:DMDS	-	-	1126 a	104	-	-
Dazomet:DMDS VIF	-	-	-	-	1222 a	105
DMDS:Pic (shank)	900 abc	100	1123 a	103	-	-
DMDS:Pic (drip)	878 bc	98	1094 a	101	-	-
DMDS:Pic VIF	-	-	-	-	1196 a	103
Methyl iodide:Pic (98:2) VIF	907 abc	101	1114 a	102	-	-
Biosolarization chicken manure	906 abc	101	1019 a	94	1143 a	98
Biosolarization sugar beet vinas.	788 d	88	-	-	-	-
Biosolarization chicken:DMDS	-	-	1068 a	98	-	-
Biosolarization chicken:MS	-	-	-	-	1163 a	100
Solarisation:MS	835 cd	93	-	-	-	-
$0.05 \leq$ P by the LSD test. Relative yield in relation to 1,3D:Pic (61:35) = 100%						