STRAWBERRY NURSERIES IN SPAIN: ALTERNATIVES TO MB, 2007 RESULTS.

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The Spain's Methyl Bromide (MB) Alternatives Project (INIA) has allowed ten years of work for high-elevation strawberry nurseries in Spain. The activities reported herein, corresponding to 2007 (named experiments), were carried out in two nurseries: Viveros California Inc. (Tordesillas, Valladolid) and Viveros Rio Eresma Inc. (Navalmanzano, Segovia) in Castilla-Leon (Northern-Central part of Spain). The experimental design on each nursery was a 9 fumigant treatment complete randomized blocks with 4 large replications of 137.5 m^2 (50 x 2.75 m) each. All treatments were broadcast applied and are shown in Table 1. Summaries of 2003 to 2006 results were presented in MBAO International Conference (see MBAO web site www.mbao.org). In general, the alternative treatments incorporated on 2007 experiments were similar to those applied on 2003 to 2008. The new treatments incorporated on 2007 to the program were: Furfural (Multiguard™ Protect) and metam sodium but applied by modern Rotary Spader implement. Preceding crops were leeks and sugar beet in both locations. Fumigation dates were March 27-28, 2007. Cv. 'Camarosa' mother-plants from Californian nurseries were planted during last week of April, 2007. Commercial daughter runner plants were estimated on September 26, 2007.

Beside these experiments, similarly to 2003-2006 period, a field demonstrations program has been carried out by this Spain's MB Alternatives Project (INIA) in two different locations (named demonstrations): Viveros Grufresa Inc. (Cabezas de Alambre, Avila) and Viveros Herol Inc. (Nava de la Asunción, Segovia). Field demonstrations are presented in Table 2. Preceding crops were leeks in Nava de la Asunción and cereals in Cabezas de Alambre. Fumigation and planting dates were similar to those utilized for experiments; but in this case, commercial runner plants were machine-harvested from the whole demonstration field, and trained crews sorted and counted the total number of marketable plants in October 15 (Nava de la Asunción) and October 22 (Cabezas de Alambre).

Soil samples from each field experiment were evaluated before (March, 22, 2007) and after (April, 24, 2007) soil fumigant treatments. Total colony forming units per gram of dry soil (CFU/g) of *Fusarium, Phytophthora, Pythium, Rhizoctonia,* and *Verticillium* were estimated in each replication. Three times (July 24, August 28 and October 9) during the growing period (initial, medium and full running activity), 20 runner plants were randomly chosen in each replication and analyzed to calculate the incidence of diseased plants (%) per treatment. Results on soil borne fungi control and disease incidence (%) in experiments will be discussed.

Areas of 3.5 m^2 were left unweeded in each plot of experiments throughout the duration of each study. Weeds were sampled and removed on five dates, from July until September. At each sample date, weed species present, total weed density and total fresh weight were measured for each treatment. In the case of demonstration fields, two areas of 15 m^2 per demonstration were left unweeded. The most common weeds in the experimental plot at Tordesillas (Valladolid) were *Echinochoa crusgalli*, nightshades *(Solanum spp.)* and common purslane (*Portulaca oleracea),* while in Navalmanzano (Segovia) location, were common lambsquarters *(Chenopodium album),* nightshades and pigweeds *(Amaranthus spp.).* In the experimental fields, treatments that provided significantly better control of the weeds were MB (50-50), Pic:DD, Midas™ and Telopic™, while in demonstrative fields, better results were obtained by MB (50-50) and Telopic™. Tables 3 and 4, show the fumigation treatments effects on weed density.Variance analysis for both type of trials shows significant differences between treatments, also for the interaction treatment x locality for the total number of weeds.

Results regarding fresh commercial plants harvested (field experiments) are in Table 5. As in previous years, the 2007 experiments showed that agronomic results are not consistent enough. Furthermore, field demonstrations showed yield inconsistency (Table 6). Results on strawberry plant production will be discussed. So far, some inconsistency on weed control and yield stability remains for chemical alternatives to MB in strawberry nurseries. Next 2009 season, critical uses for strawberry nurseries in EU will be over.

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Table 1. MB Alternatives 2007. Nursery field experiments.

Treatments	Description	Rate
Control PE	Untreated	-
MB:Pic (50/50) VIF	Methyl Bromide + choloropicrin (50:50)	30 g/m^2
MI:Pic (50:50) VIF. Midas™	Methyl iodide+chloropicrin (50:50).	30 g/m^2
DMDS:Pic VIF	Dimethyl disulfide+ chloropicrin	40+15 g/m^2
Telopic™ VIF	1,3-dichloropropene+ chloropicrin	30 g/m^2
MS:Biofungicide[1] VIF	Metam sodium+biofungicide	50 g/m^2
Furfural VIF. Multiguard™ Protect	Furan-2-carboxaldehyde	40 g/m^2
Pic:DD VIF	Chloropicrin+1,3-dichloropropene	18+12 g/m^2
MS applied with Rotary Spader	Metam sodium	70 g/m^2
[1]Experimental biofungicide developed by SGIT-INIA team (before planting mother plant roots were submerged in a suspension of *Penicillium oxalicum*, 10^7 conidia/ml)		

Table 2. MB Alternatives 2007. Nursery field demonstrations.

Treatments	Demo surface (m^2)
MB:Pic (50:50) 30 g/m^2 VIF	1,000
Pic alone 35 g/m^2 VIF	1,000
Telopic 35 g/m^2 VIF	1,000
MS applied with Rotary Spader 70 g/m^2	1,000

Table 3. Weed density in nursery field experiments. Average comparison for the total number of plants in five samplings for each location.

Treatments	Tordesillas (Va.)	Navalmanzano (Seg.)	Two locations average
MB:Pic (50/50) VIF	9.47 b[1]	2.00 c	5.61 b
Pic:DD VIF	11.07 b	1.56 c	6.16 b
MI:Pic (50:50) VIF	14.80 b	0.62 c	7.48 b
Telopic™ VIF	14.47 b	1.38 c	7.71 b
MS applied with Rotary Spader	13.60 b	9.81 cb	11.65 b
DMDS:Pic VIF	27.50 b	4.75 c	15.37 b
MS:Biofungicide VIF	42.47 b	0.94 c	20.94 b
Control PE	209.78 ba	34.17 ba	116.12 ba
Furfural VIF	312.71 a	38.69 a	166.57 a
[1]Means sharing the same letters within a column are not significantly different according to the Duncan's multiple range test ($P \leq 0.05$)			

Table 4. Weed density in nursery field demonstrations. Average comparison for the total number of plants in five samplings for each location.

Treatments	Cabezas Alambre (Av.)	Nava Asunción (Seg.)	Two locations average
MB:Pic (50:50) 30 g/m^2 VIF	0.83 a[1]	6.25 b	3,93 b
Telopic 35 g/m^2 VIF	0.67 a	3.62 b	2,36 b
MS applied with Rotary Spader 70 g/m^2	15.17 a	12.88 b	13,86 ba
Pic alone 35 g/m^2 VIF	6.00 a	45.75 a	28,71 a
[1]Means sharing the same letters within a column are not significantly different according to the Duncan's multiple range test ($P \leq 0.05$)			

Table 5. Nursery field experiments. Total and relative marketable runner plant production estimation.

Treatments	Tordesillas (Va.)	Navalmanzano (Seg.)	Two locations average	
	Plants/ha	Plants/ha	Plants/ha	Relative[1]
MB:Pic (50/50) VIF	465,000	575,000	520,000	100
Pic:DD VIF	457,500	505,000	481,250	92.5
Telopic™ VIF	402,500	527,500	465,000	89.4
MI:Pic(50/50) VIF	387,500	535,000	461,250	88.7
MS applied with Rotary Spader	330,000	570,000	450,000	86.5
DMDS:Pic VIF	362,500	465,000	413,750	79.6
MS:Biofungicide VIF	315,000	460,000	387,500	74.5
Furfural VIF	187,500	395,000	291,250	56.0
Control	170,000	377,500	273,750	52.6
[1]Relative plant production to standard MB:Pic (50/50) under VIF				

Table 6. Nursery field demonstrations. Total and relative marketable runner plant machine-harvested production.

Treatments	Cabezas Alambre (Av.)	Nava Asunción (Seg.)	Two locations average	
	Plants/ha	Plants/ha	Plants/ha	Relative[1]
MB:Pic (50:50) 30 g/m^2 VIF	591,400	612,500	601,950	100
Pic alone 35 g/m^2 VIF	302,800	301,000	301,900	50.2
MS applied with Rotary Spader 70 g/m^2	360,000	298,000	329,000	54.7
Telopic 35 g/m^2 VIF	411,400	476,300	443,850	73.7
[1]Relative plant production to standard MB:Pic (50/50) under VIF				