CHEMICAL ALTERNATIVES TO MB FOR STRAWBERRY NURSERIES IN SPAIN. 2003 RESULTS.

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The National project INIA on alternatives to Methyl Bromide (MB) has allowed six years of work on chemical alternatives for high-elevation strawberry nurseries in Spain. Results (1998-2002) were presented in MBAO Conference and elsewhere (De Cal et al., 2002, 2004; López-Aranda, 1999; López-Aranda et al., 2002; Melgarejo et al., 2001, 2003;). Up to 2002, high-elevation nursery peculiarities have caused different productivity patterns on each year and location (inconsistent results). The trials reported herein, corresponding to 2003, are the last of a series started in 1998. These trials were carried out in two nurseries: Viveros California Inc. (Vinaderos-4, Avila) and Viveros Rio Eresma Inc. (Navalmanzano-6, Segovia) in Castile-Leon (Northern-Central part of Spain), named as locations 1 and 2, respectively. The experimental design on each nursery was in complete randomized blocks with 4 large replications of 137.5 m^2 each and 10 fumigant treatments (Table 1).

New alternatives, incorporated for first time in Spain on the 2003 nursery experiments, were: DMDS™ and combinations of Metam Sodium (MS) and DMDS with chloropicrin (Pic) broadcast shank-applied under transparent VIF at lower rate than standard with PE film. Also Propozone™ (Propylene oxide) under transparent PE was applied for first time in Spanish nurseries. Preceding crops were vegetables (carrots, asparagus, potatoes) in both locations. Fumigation dates were March 24-25, 2003. Cv. 'Camarosa' mother-plants from Californian nurseries were planted in May 20, 2003. Commercial daughter runner plants were harvested in October 9 (location 2) and October 14 (location 1), 2003.

Soil samples from each nursery were evaluated before (March 20) and after (April 15) treatments in selective media. Total colony forming units per gram of dry soil (cfu/g) of soil-borne fungi *Fusarium, Phytophthora, Pythium*, *Rhizoctonia,* and *Verticillium* were estimated in each replication. A large sample of 400 mother plants from each field experiment was examined before planting. Three times (July 7, September 12, October 9) during the strawberry growing period (initial, full running activity, and just before digging), 20 runner plants were randomly chosen in each replication and analyzed to calculate the incidence of diseased plants (%) for each treatment. To track weeds populations, areas of 3.5 m^2 were left without weeding during the growth season. Sampling was carried out in five dates, from beginnings of July until half September and the estimated variables were the total number of weeds present in each treatment and the total fresh weight, considering all the species as a whole. Results related to the herbicide efficiency of different chemical alternatives, have evidenced that some of those: Telopic^{TM}, MS + Pic, and Dazomet, showed a similar behaviour than standard MB(40) on weed control (Table 2).

Total fungal population was homogeneous in both locations before fumigant treatments, ranging from 0.9 x 10^5 to 2.0 x 10^5 cfu/g of dry soil in Vinaderos-4 (location 1), and from 1.5 x 10^5 to 2.4 x 10^5 cfu/g of dry soil in Navalmanzano-6 (location2). Presence of *Penicillium* spp. was predominant; genera *Alternaria, Fusarium, Cladosporium, Trichoderma, Rhizoctonia* and *Morteriella* were also present. Initial population were: *Pythium* 2.0 x 10^3 and 10^3 cfu/g of dry soil, *Fusarium* 10^3 and 3.0 x 10^3 cfu/g of dry soil, *Verticillium* sp. less than 10^2 and 10^2 cfu/g of dry soil and *Rhizoctonia and Phytophthora cactorum* 10^2 cfu/g of dry soil, in Vinaderos-4 and Navalmanzano-6, respectively. Initial total soil-borne fungal population was reduced significantly after all fumigant treatments. The largest reduction was achieved by Dazomet treatment in location 1 (Vinaderos-4) and DMDS+Pic treatment in location 2 (Navalmanzano-6). Before planting, mother plant samples from Californian nurseries showed 27.2% of plants from Navalmanzano-6 (location 2) and 6.0% of plants from Vinaderos-4 (location 1) with frost damage (due to cold-stored shipment from California). 2.0% and 0.25% of mother plants presented symptoms of disease caused by *Phytophthora cactorum* in Vinaderos-4 and Navalmanzano-6, respectively.

In relation with the incidence of diseased plants (%) during the growing season, after the evaluation of 880 runner plants per date of sampling (3) and location (2), only small problems were observed. The most important problems detected were of abiotic origin, strong storms occurred several times in both locations during the summer caused important flooding in all treatments. In particular two strong hailstorms (July, 15 in location 1 and August, 30 in location 2) caused important flooding and damage in all treatments with subsequent problems of plant stress. The results regarding fresh commercial plants harvested are presented in Table 3.

In general, the number of plants harvested in Navalmanzano-6 (location 2) was lower than in Vinaderos-4 (location 1). Only with MB (40) treatment, standard in strawberry nurseries, yields in both locations were consistent. As in previous years, the two-location 2003 experiments showed that agronomic results are not consistent enough. For this reason, application for critical use exemption for the Spanish high-elevation strawberry nurseries has been presented. Beside these experiments, to enhance transference processes, a demonstration program has been initiated by the National project INIA in two different locations: Viveros

Grufresa Inc. (Avila, Cabezas de Alambre) and Viveros Herol Inc. (Segovia, Navalmanzano-Mudrián). Material and methods will be discussed. As a summary, yield results from of these large scale demonstrations in 2003 supported clearly this inconsistency (Table 4).

References

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Table 1. MB Alternatives 2003. High-elevation nursery trials in Castile-Leon.

Treatments	Description
Control	Untreated
MB(40)	MB-Pic (50-50), 40 g/m^2 broadcast shank-applied under transp. PE
MB(33/67)VIF	MB-Pic (33-67), 20 g/m^2 broadcast shank-applied under transp. VIF
Dazomet	Dazomet, 35 g/m^2 broadcast, rotovator incorporation under transp. VIF
Telopic	1,3D+Pic (61-35), 30 g/m^2 broadcast shank-applied under transp. VIF
Chloropicrin	Pic alone, 30 g/m^2 broadcast shank-applied under transp. VIF
MS+Pic	Metam Sodium (40 g/m^2)+Pic (25 g/m^2) broadcast shank-applied under transp. VIF
DMDS	DMDS, 65 g/m^2 broadcast shank applied under transp. VIF
DMDS+Pic	DMDS (20 g/m^2)+Pic (20 g/m^2) broadcast shank-applied under transp. VIF
Propozone	Propylene oxide, 30 g/m^2 broadcast shank-applied under transp. PE

Table 2. Weed presence[1].

	Total number of weeds		Total fresh weight (g)	
Treatments	Navalmanzano-6	Vinaderos-4	Navalmanzano-6	Vinaderos-4
Untreated control	51.6 a	25.0 a	829.4 a	1071.9 a
MB(40)	1.4 c	3.7 c	17.8 b	58.4 b
MB(33/67)VIF	2.3 c	3.9 c	54.8 b	121.6 b
Telopic	2.5 c	1.4 c	53.3 b	14.3 b
Chloropicrin	4.3 c	4.4 c	67.5 b	169.1 b
Dazomet	3.2 c	2.8 c	83.0 b	40.4 b
DMDS	15.1 b	6.8 bc	282.0 b	242.9 b
DMDS + Pic	3.3 c	2.9 c	124.1 b	81.0 b
Propozone	2.5 c	14.7 b	49.1 b	68.2 b
MS+Pic	1.8 c	1.9 c	12.9 b	56.1 b
$P \leq 0.05$. Duncan test; [1]Areas of 3,5 m^2 per replication without weeding during the growth season				

Table 3. Harvested commercial runner plants per hectare.

Treatments	Vinaderos-4 (loc.1)	Navalmanzano-6 (loc. 2)	Two locations average
MB(40)	697,500 a	575,000 a	636,250 a
MS+Pic	680,000 a	435,000 a	557,500 ab
MB(33/67)VIF	650,000 ab	457,500 a	553,750 ab
DMDS+Pic	582,500 bcd	512,500 a	547,500 ab
Propozone	642,500 ab	427,500 a	535,000 b
Dazomet	580,000 bcd	485,000 a	532,500 b
Telopic	617,500 abc	440,000 a	528,750 b
Chloropicrin	577,500 bcd	405,000 a	491,250 bc
DMDS	532,500 cd	437,500 a	485,000 bc
Untreated control	512,500 d	355,000 a	433,750 c
$P \leq 0.05$. LSD test			

Table 4. 2003 Field scale demonstrations. Harvested commercial runner plants per hectare.

		Locations	
Treatment	Demo surface (m^2)	Cabezas Alambre (Avila)	Navalmanzano-Mudrián (Segovia)
MB-Pic (50:50) 400 kg/ha PE	3,300	446,889	492,528
MB-Pic (50:50) 300 kg/ha VIF	3,300	436,581	481,350
Telopic 600 kg/ha PE	3,300	382,221	426,984
Telopic 300 kg/ha VIF	3,300	372,618	346,962