AGRONOMIC BEHAVIOR OF STRAWBERRY COMING FROM DIFFERENT TYPES OF SOIL FUMIGATION IN NURSERIES.

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The field trials reported herein are part of the RAEA program (Andalusian Network for Experimental Agriculture) and supplements the National Project INIA SC 97-130 on alternatives to Methyl bromide (MB) in several crops. The aim has been to study the agronomical behavior of strawberry plant material (cv. "Camarosa"), coming from our experiments on MB alternatives in high-elevation nurseries located at the area of Castile-Leon (Central-Northern part of Spain), in order to establish the influence of the soil fumigation system utilized in nursery in the subsequent strawberry cultivation field at the area of Huelva (South-Western part of Spain).

Material and methods: Two experiments were carried out at the Experimental Farms "El Cebollar" (Moguer) and "Los Reventones" (Cartaya), both located in the Eastern and Western coastal areas of Huelva, respectively, during 1999, 2000 and 2001. The design of each experiment was in split-plot with 3 replications and 200 plants/ replication. The plant material (cv. "Camarosa") came every year from the harvested experimental units belonging to our experiments on MB alternatives in the collaborating high-elevation nurseries Viveros California SAT and Viveros Rio Eresma SA located in Arevalo (Avila) and Navalmanzano (Segovia), respectively. The sources of variation (factors) in experiments are summarized in Table 1. In both locations of Huelva it was carried out every year the same and standard fresh plant winter cultivation system (plantation dates among the 27th and 31st of October, under small plastic tunnels, mulched with black PE and drip irrigated). Besides the distinct environments of both locations (Moguer and Cartaya), distance 50 km one from the other, the great difference was the selected soil fumigation system. At the Experimental Farm "El Cebollar" (Moguer) it was applied solarization with biofumigation each summer (with transparent PE, between half-July and half-August with simultaneous incorporation of 5 kg/m^2 of chicken manure). At the Experimental Farm "Los Reventones" it was utilized each summer shank application of MB-Pic (50-50) (40-50 g/m^2 under preformed beds). The AOV model statement has been: year loc year x loc rep x year x loc (error) treat treat x year treat x loc treat x year x loc rep x treat x year x loc (error) nurs nurs x year nurs x loc nurs x year x loc treat x nurs treat x nurs x year treat x nurs x loc treat x nurs x year x loc.

Results and discussion: The yield (grams/plant) was classified in two commercial categories: first and second; being the commercial yield the sum of both categories. The external fruit quality was measured as percentage of production of second category inside the commercial yield. The production data are presented as accumulated yield until last February (extra early yield), last March (early yield) and last April (half season), for each factor, in the group of 6 experiments carried out (Tables 2.1 to 2.4). The analysis of the results for the main factor: soil fumigant treatments applied in the nursery phase, showed total absence of significant differences among them (Table 2.1). Equally, the results for the second factor: nurseries of origin (Table 2.4), indicated a total absence of significant differences too. The biggest differences in yield have appeared in the analysis of the factor: year of experiments (Table 2.2), and, mainly, in the factor location of trial (Table 2.3); in this case, the yield obtained at Cartaya location it was very much higher to that of Moguer location.

The number of dead plants was controlled monthly during the growing season; the results of plant survival percentage at the end of March are presented in Table 3. Although significant differences appear in all the factors, these figures of plant survival are normal in this strawberry cultivation system with fresh plants. Finally, in 2000 and 2001, a sample of 10 plants/replication was measured to know plant diameter and number of trifoliate leaves. The analysis of these morphological characters for the main factor: soil fumigant treatments applied in the nursery phase, showed no differences among them (Table 4.1). Once again, the biggest differences were observed in the analysis of the factor: year of experiments (Table 4.2) and in the factor location of trial (Table 4.2); the plant size observed at Cartaya location it was very much higher to that of Moguer location.

In conclusion, these three year of results showed that there is not any relationship between (a) the agronomical behavior of the subsequent strawberry cultivation system in the area of Huelva and (b) the soil fumigation system used in the previous phase of high-elevation nursery multiplication. Of course, provided that plant material had been dug in appropriate sanitary and physiological status. The main influences in the agronomical behavior of the plant material come from the environmental conditions of the different years and of the location factor in the production area. In our case, these differences could be related with the different systems of soil fumigation carried out in each location: namely, solarization + biofumigation in Moguer versus MB shank application in Cartaya.

Table 1. Sources of variation (factors) in experiments.

Nurseries (nurs)	Treatments in nurseries of origin (treat)	Locations (loc)	Replications (rep)	Years (year)
1. Avila	1. Control without fumigation	1. Moguer	1	1. 1999
2. Segovia	2. MB-Pic (50-50) (40 g/m^2)	2. Cartaya	2	2. 2000
	3. MB-Pic (50-50)VIF (20 g/m^2)		3	3. 2001
	4. Dazomet (50g/m^2)(*)			
	5. Telopic (35-40 cc/m^2)			
	6. Chloropic alone (40 g/m^2)			

Table 2.1. Commercial, first category yield (g/plant) and % of second cat. by soil fumigant treatments applied in the nursery phase.

	until End February			until End March			until End April		
Treatments	Com. yield	First cat.	% 2nd cat.	Com. yield	First cat.	% 2nd cat.	Com. yield	First cat.	% 2nd cat.
Control	32 a	22 a	36 a	206 a	169 a	18 b	488 a	413 a	17 bc
MB(40)	31 a	22 a	35 ab	204 a	167 a	18 b	507 a	422 a	17ab
MB(40)VIF	30 a	22 a	32 bc	201 a	168 a	16 b	503 a	428 a	16 c
Dazomet(*)	34 a	22 a	36 a	206 a	162 a	20 a	492 a	405 a	18a
Telopic	30 a	21 a	35abc	204 a	165 a	19 a	488 a	406 a	17ab
Chloropic	29 a	22 a	32 c	207 a	172 a	16 b	510 a	422 a	17 bc

Table 2.2. Commercial, first category yield (g/plant) and % of second cat. by year of experiments.

	until End February			until End March			until End April		
Years	Com. yield	First cat.	% 2nd cat.	Com. yield	First cat.	% 2nd cat.	Com. yield	First cat.	% 2nd cat.
1999	49a	39a	20 c	248a	208a	16 b	545a	435 b	19 b
2000	31 b	20 b	37 b	216 b	161 b	25a	393 b	307 c	22a
2001	13 c	6 c	46a	150 c	132 c	12 c	558a	505a	9 c

Table 2.3. Commercial, first category yield (g/plant) and % of second cat. by location of experiments.

	until End February			until End March			until End April		
Locations	Com. yield	First cat.	% 2nd cat.	Com. yield	First cat.	% 2nd cat.	Com. yield	First cat.	% 2nd cat.
Moguer	31 a	22 a	36 a	173 b	146 b	15 b	393 b	337 b	15 b
Cartaya	31 a	22 a	33 a	234 a	188 a	20 a	603 a	495 a	19 a

Table 2.4. Commercial, first category yield (g/plant) and % of second cat. by nursery of origin.

	until End February			until End March			until End April		
Nurseries of origin	Com. yield	First cat.	% 2nd cat.	Com. yield	First cat.	% 2nd cat.	Com. yield	First cat.	% 2nd cat.
Avila	32 a	23 a	34 a	206 a	169 a	18 a	497 a	417 a	17 a
Segovia	30 a	21 a	34 a	203 a	165 a	18 a	499 a	415 a	17 a

Table 3. Percentage of Plant survival at the end of March.

Treatments	% Plant survival		Years	% Plant survival		Loca-tions	% Plant survival		Nurs. origin	% Plant survival
Control	97.1 b		1999	96.4 b		Moguer	96.2 b		Avila	97.4 a
MB(40)	97.9 ab		2000	99.0 a		Cartaya	98.3 a		Segovia	97.1 b
MB(40)VIF	97.4 b		2001	96.3 c						
Dazomet(*)	98.0 ab									
Telopic	94.4 c									
Chloropic	98.4 a									

Table 4.1. Plant Diameter (cm) and number of Trifoliate Leaves per plant by soil fumigant treatments applied in the nursery phase.

Treatments	End of January		End of February		End of March		End of April	
	PD1	TL1	PD2	TL2	PD3	TL3	PD4	TL4
Control	19.6a	9.0a	25.5ab	16.3a	32.6a	23.1a	36.7a	27.4a
MB(40)	18.8bc	8.8a	25.5ab	16.3a	32.8a	22.0a	37.6a	27.4a
MB(40)VIF	18.4c	8.5a	25.0 b	15.6a	33.3a	22.2a	37.3a	27.9a
Dazomet	19.1abc	9.0a	25.1 b	15.4a	32.1a	21.8a	37.2a	27.2a
Telopic	18.8bc	8.7a	24.9 b	15.6a	32.5a	22.1a	36.1a	27.2a
Chloropic	19.3ab	8.6a	25.8a	15.0a	33.9a	21.8a	38.1a	26.5a

Table 4.2. Plant Diameter (cm) and number of Trifoliate Leaves per plant by year of experiments, location of experiments and nursery of origin.

	End of January		End of February		End of March		End of April	
	PD1	TL1	PD2	TL2	PD3	TL3	PD4	TL4
Years								
2000	19.9a	8.9a	25.9a	16.2a	36.7a	25.0a	42.1a	30.4a
2001	18.1 b	8.6 b	24.8 b	15.2 b	29.1 b	19.3 b	32.2 b	24.1 b
Locations								
Moguer	16.3 b	8.3 b	20.7 b	13.4 b	26.3 b	17.2 b	29.5 b	20.3 b
Cartaya	21.7a	9.2a	29.9a	18.0a	39.5a	27.1a	44.9a	34.2a
Nurseries								
Avila	19.0a	9.3a	25.0 b	16.0a	32.3 b	21.7a	35.8 b	26.3 b
Segovia	19.0a	8.2 b	25.6a	15.3a	33.4a	22.6a	38.5a	28.2a

(*) This treatment was TeloneC-17 in 1998 nursery.
(**) $P < 0.05$