DEMONSTRATION STAGE ON MB ALTERNATIVES FOR STRAWBERRY PRODUCTION IN HUELVA (SPAIN).

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Spain is the second strawberry producer after United States (California). In particular, the cultivation area of Huelva has an acreage of 8,000 ha and 250,000 mt/year for fresh fruit production. These figures confirm clearly that it is the most important strawberry area in Europe. Average yield has been increasing to nearly 45 mt/ha. Harvesting begins in the first week of January and finishes in June. Well-drained and acidic soils with sandy texture, low pressure of soil-borne pathogens, low conductivity of irrigation water and mild climate in fruiting fields are attributes of the Huelva area which make it exceptional for strawberry production. The strawberry industry is the main economic support for important localities in the area (i.e. Lepe, Cartaya, Moguer, Palos de la Frontera. and Almonte).

In relation to alternatives to Methyl Bromide (MB) for soil fumigation, the National project INIA SC 97-130 has finished its fifth year in the 2002 season. After the four-year work in the area of Huelva (1998-2001), our consistent and reiterative results support that short-term alternatives to MB do exist for the strawberry industry in the area (López-Aranda et al., 2000, 2001, 2002) and their economical evaluation is in a cost effective manner (Calatrava and Casado, 2002). These short-term MB alternatives have been developed for strawberry and used at field demonstration stage during the 2002 season in five different locations (strawberry grower companies with adequate size and technological level in cultivation with fresh plant material of cv. "Camarosa" under standard large plastic tunnels). These MB alternatives are chemical, non-chemical and mixed, to fulfill the several types of cultivation systems: conventional, integrated management and organic production. The following possibilities have been established: a) annual shank-application of 1,3 dichloropropene-chloropicrin (61:35) under pre-formed raised beds (40 cc/m^2 of treated area) ("Telopic" or other similar chemicals); also, shank-application with half-dosage (20 cc/m^2 of treated area) under black VIF sheets ("Telopic" VIF); b) annual incorporation of "Dazomet" located under pre-formed raised beds (50 g/m^2 of treated area); c) soil solarization (4 weeks, August) with simultaneous shank application of Metam Sodium (75 cc/m^2 broadcast area) ("Sol.+MS"); soil solarization (4 weeks, August) with simultaneous biofumigation (fresh chicken manure incorporation, 4-5 kg/m^2) ("Sol.+Biof."). Using as control MB-pic (50:50) under pre-formed raised beds (40 g/m^2 of treated area), which it is considered as current standard practice in the whole Huelva area.

The five field demonstration assays were carried out in farms located at Cartaya (Surfruit Inc.), Moguer (Frestaber Inc. and Occifresa Inc.) and Palos de la Frontera (Cumbres Malvinas Inc. and Fresnuria Inc.); these private farms have a similar and habitual history in relation to precedent crops (strawberry) and soil fumigation (MB) for more than 10 years (except Surfruit Inc. demonstration); type and surface of demonstration assays, soil fumigation period, planting date and plant density are represented in Table 1. Soil from each field demonstration and location was analysed before and after treatments; also plant samples were taken during the growing season. The demonstrations sanitary status were normal. In relation to soil-borne fungi (*Verticillium spp.*, *P. cactorum*) and root-knot nematodes (*Meloidogyne* spp.) neither of them appeared. In Table 2 Plant survivals (%), just after plantation dates and at mid growing season (half March, 2002) are presented; these percentages were normal (more than 95%); only in the case of Surfruit Inc. field demonstration with Solarization+Biofumigation, the percentage was lower than normal (92%) and reached a very poor vaule (76.1%) at the end of the growing season. This problem could be related with the incorporation of fresh chicken manure as biofumigant (in this case 5 kg/m^2) simultaneous to solarization practice (in our solarization system, soil strips of 40-50 cm wide remains without disinfestation among P.E. sheets (Medina-Mínguez, 2002)). Also in Table 2 are presented plant diameter and number of leaves, the tendencies observed are very similar to the obtained yields presented in Table 3.

In Table 3, harvesting period (from February to May), early and total commercial yield by plant and by surface and also averaged fruit size are presented. In general, these results (2002) show a productivity tendency similar to our previous four-year work (1998-2001): very similar yields to MB in the case of Telopic, Telopic VIF and Dazomet (Surfruit Inc., Occifresa Inc., Fresnuria Inc. and Cumbres Malvinas Inc.) and lower yields with Sol.+MS (soil solarization with simultaneous Metam Sodium, 75 cc/m^2). In the case of Sol.+Biof. demonstrations (Surfruit Inc. and Frestaber Inc.), the potential productivity was similar to MB in spite of the abnormal abiotic plant mortality observed in Surfruit Inc. demonstration.

These alternatives could suppose an appropriate short and medium-term response to MB ban in environments with low inoculum levels of lethal soil-borne strawberry pathogens, as is the case of Huelva. However, there are very important question marks and remaining challenges for short and, mainly, medium-term that are necessary to rise. The most important ones are related with the national and EU policy on pesticides utilization (in particular with 1,3 dichloropropene and/or chloropicrin utilization) as well as costumers and consumers expectations (EU ban on the agricultural use of big quantities of livestock manure in the case of Sol.+Biofumigation). Due to these reasons, recent applications for critical use exemption made by the Spanish strawberry industry (fruit growers and nurseries) are underway. On the other hand, new field demonstrations in the area and a new three years National Project has been recently started. All these aspects will be discussed.

References

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Table 1. Demonstrations. Preliminary data.

Location (company, area)	Demonst. assays	Plot history	Demo surface (m^2)	Application period	Planting date	Planting density (plant/ha)	Tunnel cover date
Surfruit (Tariquejo, Cartaya)	Telopic	Cereals, never fumigated	2270	Sep, 11-12	Oct, 26	61322	Nov, 30
	Sol+Biof		2270	Jul,25 to Aug, 25	Oct, 26	61639	Nov, 30
	Sol+MS		2270	Jul,25 to Aug, 25	Oct, 26	61322	Nov, 30
	BM		2270	Sep, 11-12	Oct, 26	61322	Nov, 30
Frestaber (Avitorejo, Moguer)		+10 years with MB and strawberry					
	Sol+Biof		2940	Jul,17 to Aug, 16	Oct, 29	62082	Dec, 21
	Sol+MS		2980	Jul,17 to Aug, 16	Oct, 29	62084	Dec, 21
	BM		2940	October, 1-2	Oct, 29	62735	Dec, 21
Occifresa (Avitorejo, Moguer)		+10 years with MB and strawberry					
	Dazomet		2742	Sep, 14	Oct, 26	64398	Nov, 17
	Telopic		2742	Sep, 14	Oct, 26	64464	Nov, 17
	BM		2742	Sep, 14	Oct, 26	63807	Nov, 17
C.Malvinas (Malvinas, Palos F.)		+15 years with MB and strawberry					
	Telopic		2148	Sep, 13-14	Oct, 20-23	7416	Nov, 25
	Dazomet		2148	Sep, 13-14	Oct, 20-23	73408	Nov, 25
	BM		2280	Sep, 13-14	Oct, 20-23	76544	Nov, 25
Fresnuria (Malvinas, Palos F.)		+20 years with MB and strawberry					
	TelopicVIF		1980	Aug, 31	Oct, 19-23	69128	Nov, 27
	Telopic		1980	Aug, 31	Oct, 19-23	69032	Nov, 27
	BM		1920	Aug, 31	Oct, 19-23	68625	Nov, 27

Table 2. Plant survival after re-plant, and plant size.

Location	Demonst.	Plant survival (%)			Plant diameter (cm)			Number of leaves		
		Nov, 7	Mar, 13	May, 20	Dec,20	Feb, 20	Apr, 23	Dec,20	Feb, 20	Apr,23
Surfruit	BM	99.6	99.1	95.9	14.6	25.7	43.5	5.9	13.9	27.3
	Sol+Biof	99.4	92.0	76.1	14.5	24.9	37.6	5.9	13.5	24.5
	Sol+MS	99.7	96.1	88.6	12.7	24.1	38.5	5.5	12.8	25.7
	Telopic	99.6	98.2	93.2	n.d.	n.d.	n.d.	n.d.	n.d	n.d.
		7-Nov	15-Mar							
Frestaber	BM	99.7	99.8	-	16.3	29.3	37.6	5.5	16.7	32.1
	Sol+Biof	99.3	99.9	-	16.1	30.5	39.8	6.4	19.3	32.7
	Sol+MS	99.4	99.9	-	14.6	26.6	37.1	5.3	13.6	28.5
		6-Nov	15-Mar							
Occifresa	BM	99.8	99.8	-	12.1	21.3	32.9	4.6	12.4	22.8
	Dazomet	99.8	99.8	-	12.3	22.1	34.7	4.3	11.1	23.7
	Telopic	99.8	99.5	-	13.6	22.8	33.2	5.1	12.9	25.5
		8-Nov	18-Mar							
C.Malvinas	BM	96.4	95.6	-	16.7	25.1	38.0	5.73	15.0	25.3
	Telopic	99.0	98.7	-	15.1	25.1	37.9	5.80	16.1	24.8
	Dazomet	97.7	96.8	-	14.2	23.5	33.9	4.73	12.0	21.3
		6-Nov	18-Mar							
Fresnuria	BM	99.4	99.5	-	16,7	23.4	39.7	6.67	14.3	28.9
	Telopic	99.5	99.6	-	18.8	23.9	37.4	7.20	17.3	30.8
	TelopicVIF	99.6	99.6	-	19.5	24.7	33.9	7.53	19.1	35.4

Table 3. Harvesting data, commercial yield in g/plant and kg/ha and average fruit size.

Location	Demonst. assays	Harvesting period			Commercial yield (g/plant) until end of (month)			Commercial yield (kg/ha) until end of		Fruit size (g/fr.)
		First	Last	Number	March	April	May	March	May	
Surfruit	BM	Feb, 7	May, 16	32	224	494	632	13757	38745	25,7
	Sol+Biof	Feb, 7	May, 16	32	243	508	643	14983	39609	23,3
	Sol+MS	Feb, 7	May, 16	32	189	432	575	11579	35258	23,4
	Telopic	Feb, 7	May, 16	32	236	504	650	14473	39838	26,9
Frestaber	BM	Feb, 5	May, 23	37	337	726	870	21167	54570	28,4
	Sol+Biof	Feb, 5	May, 23	37	344	705	828	21371	51401	27,3
	Sol+MS	Feb, 5	May, 23	37	296	610	737	18380	45726	27,8
Occifresa	BM	Feb, 7	May, 30	26	256	551	918	16324	58586	26,4
	Dazomet	Feb, 7	May, 30	26	267	576	939	16848	60470	27,3
	Telopic	Feb, 7	May, 30	26	295	651	1040	19037	67025	28,0
C.Malvinas	BM	Feb, 1	May, 25	20	331	638	912	25299	69770	28,3
	Telopic	Feb, 1	May, 25	20	262	542	763	19252	56012	27,9
	Dazomet	Feb, 1	May, 25	20	294	580	814	21806	60363	28,5
Fresnuria	BM	Feb, 5	May, 28	26	401	709	1001	27496	68714	25,7
	Telopic	Feb, 5	May, 28	26	431	765	1066	29741	73551	26,2
	Telopic VIF	Feb, 5	May, 28	26	428	758	1056	29577	72990	27,5