SOIL SOLARIZATION AND BIOFUMIGATION USING SPRAYABLE PLASTIC POLYMERS FOR STRAWBERRY PRODUCTION.

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Field scale demonstrations carried out in 2001/02 with several mixed MB alternatives previously tested in other locations of Huelva (1997/98-2000/01) (Solarization+Biofumigation and Solarization+Metam Sodium) showed some problems in the pattern of productivity and nematode control in comparison with standard MB-Pic and other chemical alternatives to MB (López-Aranda et al., 2002). Additional facts have arisen in relation with MB phase-out in Spain: a) the utilization of chemical fumigants in UE countries is uncertain due to the Directive 91/414/CEE concerning the placing of plant protection products on the market enacting, b) a clear mistrust of strawberry farmers in the area of Huelva to physical and mixed MB alternatives, in particular to open air soil solarization. This fact is related to practical reasons. One of these practical problems is related with the mechanical resistance of the plastic film to meteorological accidents and to the footprints of domestic/savage animals (dogs, hares, etc.). Due to these reasons, it would be interesting to introduce new technologies able to minimize these mechanical problems with the advantages to soil solarization (soil solarization-like). It is the case of the new sprayable plastic polymers (Gamliel et al., 2001). This new technology could be a possible alternative to standard soil solarization with transparent plastic films; moreover it allows simultaneous sprinkler irrigation with chemical fumigantes, i.e., Metam Sodium (MS), formalin and others.

MATERIALS AND METHODS

To start the characterization of this technology in the case of strawberry in Huelva, the Spanish National project INIA planned the first experiment at the Experimental Farm 'El Cebollar' in summer 2003. Black sprayable plastic polymer Solartex™, from Ecotex Soil Mulch Products Ltd (Israel), was employed in a first screening. This compound forms a solidified layer or membrane in contact with the soil, maintaining high soil temperature and humidity like a standard plastic film. For this reason it is possible to practice a soil solarization-like. Moreover, its porosity made possible to apply irrigations (sprinkler) with water or/and fumigants. In our opinion, this technology could be presented as alternative to conventional plastic soil solarization to minimize environmental impacts.

This first screening was planned using 9 treatments in plots of 85 m^2/treatment without replications (Table 1). Treatment B (Sol.+Biof.) represents standard fumigation in the Experimental Farm and treatment C is similar except that plastic LDPE sheets were replaced by Solartex™ (800 l/ha). Fumigant treatments were applied on July 10th 2003, using one mounted implement with conventional tank for phytosanitary applications connected to a bar of treatments with several nozzles. Commercial Solartex™ was diluted in water 2:1 w/w (product/water). Data-loggers to record soil temperature were installed at 10 cm deep in treatments A, B and E. MS was applied by mean of micro-sprinklers in treatments G, H and I on July 24th 2003. Soil treatments finished on August 22nd 2003. Layers of Solartex™ were removed (incorporated on the soil) raking with a disk-harrow. Conventional cultivation system under small plastic tunnels was followed. Planting with cv. 'Camarosa' was done on October 14th 2003 after building and mulching the beds with black LDPE. Harvesting period took place from January 7th to May 18th 2004 (22 harvests). Treatment E (Solartex 800) showed slightly lower soil temperature than treatment B (Sol.+Biof.) and higher than treatment A (Untreated control). Soil samplings before and after the application of soil treatments and plant samplings recorded during the growing season did not show any kind of soil-borne strawberry pathogens. Died plants were recorded three times (mid-November, mid-January and end March), the results are presented as % Plant survival (Table 2). Weeding on the top of beds was recorded (Table 2); in particular, presence of common purslane (*Portulaca oleracea*) was smaller in treatments G, H, I (all of them with additional MS application) and B, C (biofumigated). To estimate plant vigour, ten plants per treatment were selected at the beginning of the cultivation season. Equatorial plant diameter was recorded five times (end of December to end of April). Results are presented in Table 3. Treatment B (Sol.+Biof.) gave the biggest plant diameters during the first part of the growing season (December-February); however, in treatments H and I (Solartex in combination with MS) plant diameters were similar in the medium-final part of the growing season (March-April).

In relation with the commercial yield (pattern of productivity), the results are presented in Table 4. Early commercial yield (harvested up to March 31st 2004) of treatment B (Sol.+Biof.) and C (Solartex 800 + Biof.) were the highest followed by the treatments with MS: G (Solartex 500 + MS 750) and H (Solartex 800 + MS 750). The lowest early yields were observed in treatments with Solartex alone (D, E, F) and in untreated control (A). Regarding the total commercial yield (harvested up to May 18th 2004), treatment B (Sol.+Biof.) and G, H, I (all of them with additional MS application) were the most productive; however, treatment C (Solartex 800 + Biof.) retreated in comparison with its early commercial yield results. In relation with fruit size (in this case fruit weight), results showed a quite similar pattern to the observed for commercial yield (Table 3).

Consistently with our preliminary results, a new series of experiments have recently started (summer 2004) at our Experimental Farm following a randomized block design with two replications and 6 treatments: Solartex 800 l/ha + Biof. (3 kg/m^2 fresh chicken manure), Solartex 800 l/ha, Solartex 800 l/ha + MS 800 l/ha, standard Sol.+Biof., solarization just on pre-formed beds with black LDPE + Biof., and untreated control. Nevertheless, it is necessary to realize that controls with standard MB-Pic are absent in our experiments with sprayable plastic polymers, because internal policy kept out MB utilization in our public Experimental Farm ‘El Cebollar’. For this reason, it is necessary to start with experiments and field scale demonstration of this soil solarization-like technique. One field scale demonstration has been developed for two strawberry cultivars ‘Camarosa’ and ‘Ventana’ in two locations (Occifresa Farm, Moguer and Cumbres Malvinas Farm, Palos de la Frontera), using Solartex 800 + Biof. in comparison with the most promising chemical alternatives to MB (Telopic^{TM}, DMDS^{TM}+pic, and Propozone^{TM}).

References
Gamliel, A., Skutelsky, Y., Peretz-Alon, Y. and Becker, E. 2001. Soil Solarization Using Sprayable Plastic Polymers to Control Soilborne Pathogens in Field Crops. In: Proceedings Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions. November 5-9, 2001, San Diego, CA, USA: 10/1-10/3.
López-Aranda, J.M., Medina, J.J. and Miranda, L. 2002. Demonstration stage on MB alternatives for strawberry production in Huelva (Spain). Proc. 2002 Annual International Conference on Methyl Bromide Alternatives and Emissions Reductions. November 5-8, Orlando, USA: 17/1-17/4.

Table 1. Fumigant treatments applied to soils prior planting.

Treatments	Description
A: Untreated	Control without soil fumigation
B: Sol.+Biof.	Soil solarization in combination with 3 kg/m^2 of fresh chicken manure
C: Solartex 800 + Biof.	Black Solartex 800 l/ha in combination with3 kg/m^2 of fresh chicken manure
D: Solartex 500	Black Solartex 500 l/ha
E: Solartex 800	Black Solartex 800 l/ha
F: Solartex 1100	Black Solartex 1,100 l/ha
G: Solartex 500 + MS 750	Black Solartex 500 l/ha with Metam Sodium applied by sprinklers 750 l/ha
H: Solartex 800 + MS 750	Black Solartex 800 l/ha with Metam Sodium applied by sprinklers 750 l/ha
I: Solartex 1100 + MS 750	Black Solartex 1,100 l/ha with Metam Sodium applied by sprinklers 750 l/ha

Table 2. % Plant survival and weed control estimation.

	% Plant survival			Weed control	
Treatment	Nov., 11	Jan., 19	Mar., 29	Time[1]	Biomass[2]
A: Untreated	100	100	100	1.5	80
B: Sol.+Biof.	100	100	100	1.5	60
C: Solartex 800 + Biof.	100	100	100	1.5	60
D: Solartex 500	100	100	100	2.0	520
E: Solartex 800	99.5	99.5	99.5	3.0	240
F: Solartex 1100	100	100	100	3.0	80
G: Solartex 500 + MS 750	100	100	100	1.5	115
H: Solartex 800 + MS 750	99.5	97.6	97.6	1.5	10
I: Solartex 1100 + MS 750	100	100	100	1.5	0

[1] Time of weeding (min/plot); [2] Weed biomass (g/plot)

Table 3. Plant diameter (cm).

	Date				
Treatment	Dec. 26	Jan. 20	Feb. 25	Mar. 29	Apr. 23
A. Untreated	19.2	20.3	22.6	24.8	25.6
B. Sol.+Biof.	23.3	24.8	25.9	27.1	28.3
C. Solartex 800 + Biof.	19.8	21.2	23.1	25.9	26.1
D. Solartex 500	15.8	19.1	22.0	24.1	26.3
E. Solartex 800	20.4	21.4	23.3	25.2	26.0
F. Solartex 1100	17.3	19.5	21.2	24.5	24.9
G. Solartex 500 + MS 750	17.0	19.5	21.2	24.5	25.7
H. Solartex 800 + MS 750	20.1	22.4	23.5	27.6	27.0
I. Solartex 1100 + MS 750	17.5	19.2	23.0	28.5	28.8

Table 4. Commercial yield (g/plant) and other agronomic traits.

	Early yield (up to March 31)			Total yield (up to May 18)		
Treatment	Yield[1]	% 2nd cat.[2]	Fruit Size[3]	Yield[1]	% 2nd cat.[2]	Fruit Size[3]
A: Untreated	193.3	13.5	30.1	492.0	13.5	29.5
B: Sol.+Biof.	275.5	20.8	32.0	613.1	20.8	29.6
C: Solartex 800 + Biof.	263.2	18.0	27.1	549.5	18.0	26.9
D: Solartex 500	240.6	17.1	29.8	552.0	17.1	28.3
E: Solartex 800	229.0	22.1	29.2	476.2	22.1	28.1
F: Solartex 1100	215.3	18.1	28.9	520.9	18.1	27.3
G: Solartex 500 + MS 750	252.9	15.2	32.2	623.7	15.2	29.9
H: Solartex 800 + MS 750	252.8	18.5	34.2	607.5	18.5	31.8
I: Solartex 1100 + MS 750	232.2	19.0	32.4	602.9	19.0	30.2
[1]g/plant; [2]% fruits of second comercial catefory; [3]g/fruit						