BIOFUMIGATION AS AN ALTERNATIVE TO METHYL BROMIDE FOR THE PRODUCTION OF TOMATOES AND OTHER VEGETABLES

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CSIC

Methyl Bromide (MB)

9th Meeting Montreal Protocol (1997)

Art. 2º Countries:

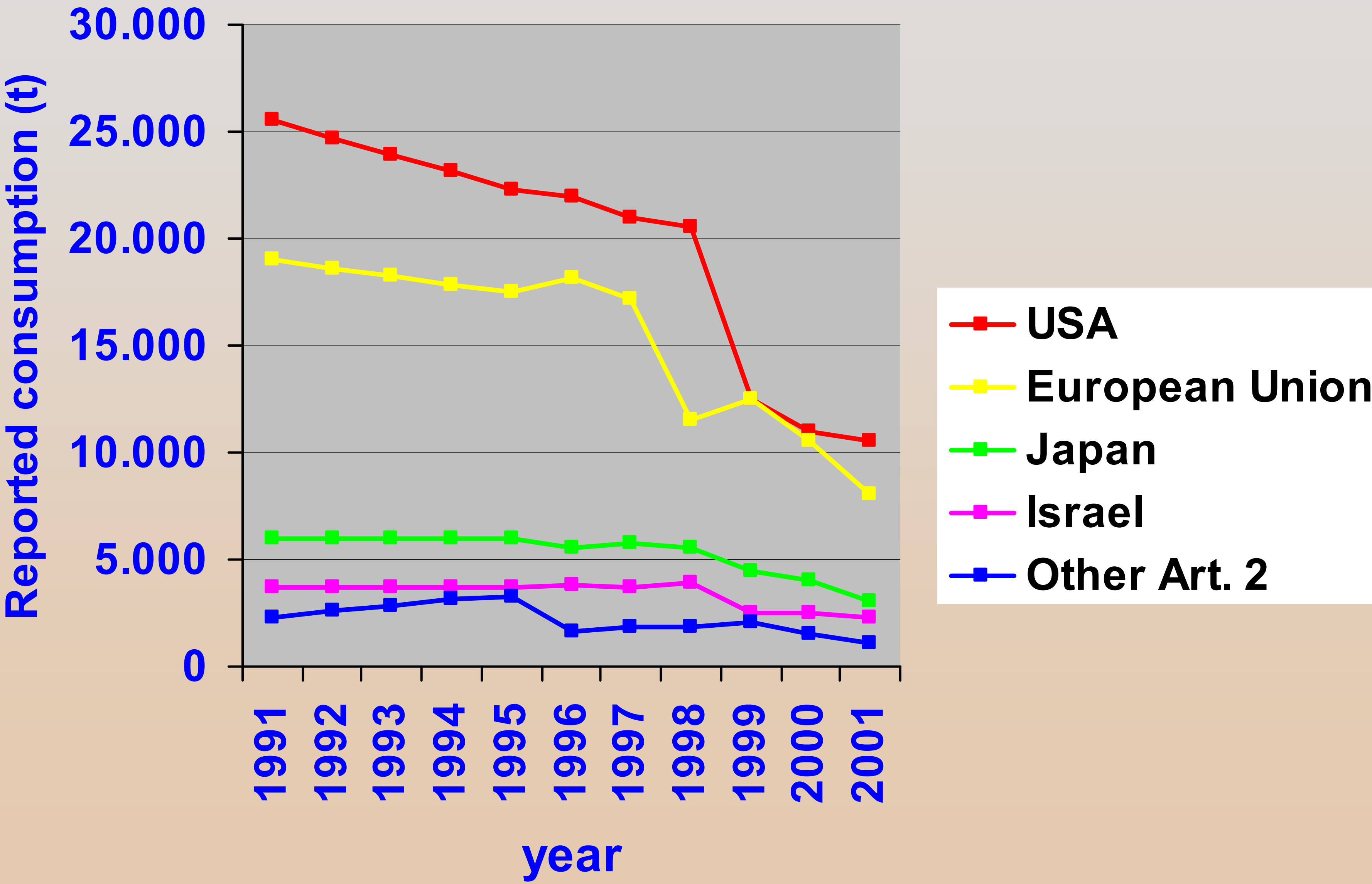
Baseline	1991
70 % reduction	2003
Phaseout	2005

Art. 5º Countries:

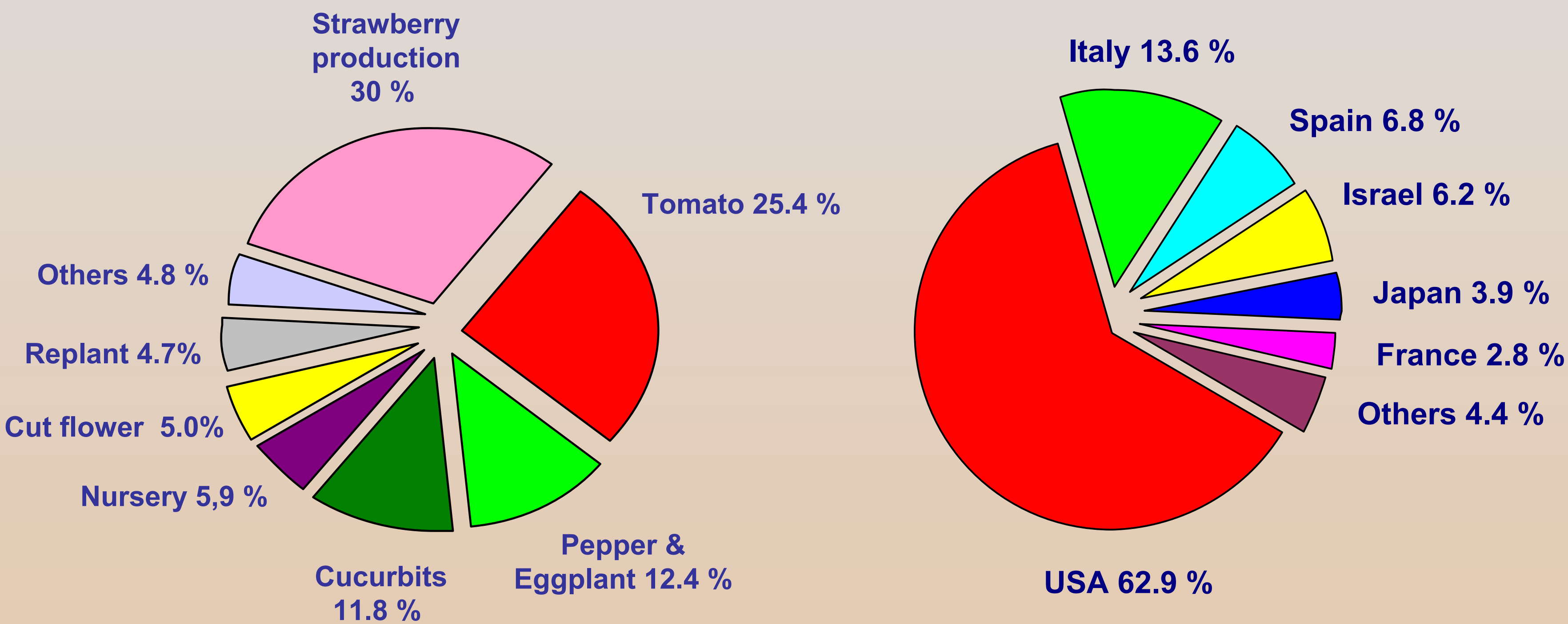
Baseline average	1995-98
Freeze	2002
Rewiew of reduction	2003
20 % reduction	2005
Phaseout	2015

Exception: critical uses, quarantine and pre-shipment

MB consumption in Art. 2º countries



MB critical use in Art. 2 coutries (2005)



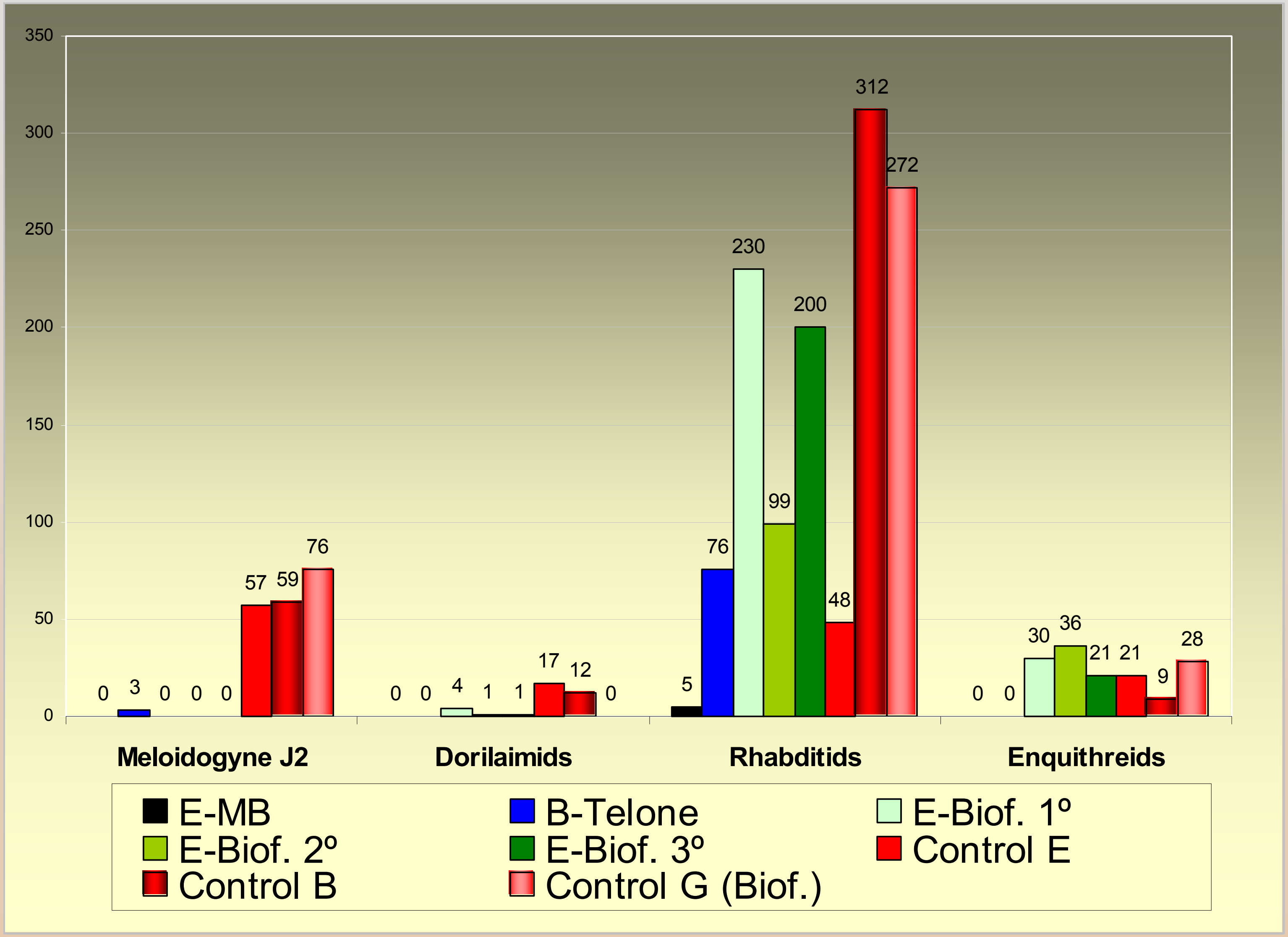
MB Alternatives (MBTOC)

1.1 Integrated Pest Management

1.2 Non-Chemical Alternatives
- 1.2.1 Cultural Practices
- 1.2.2 Biofumigation
- 1.2.3 Sanitation
- 1.2.4 Soil-less Culture
- 1.2.5 Use of Resistant Varieties & Grafting
- 1.2.6 Biological control agents (potential)
- 1.2.7 Solarization
- 1.2.8 Steam

1.3 Chemical Alternatives
- 1.3.1 Chloropicrin
- 1.3.2 Dazomet
- 1.3.3 1,3-Dicholopropene (1,3-D)
- 1.3.4 Metam sodium
- 1.3.5 Combinations of Chemicals
  - 1.3.5.1 Chloropicrin and 1,3-D
- 1.3.6 MB Reduction: formulation, dosis, methods & frequency

Biodiversity & MB alternatives



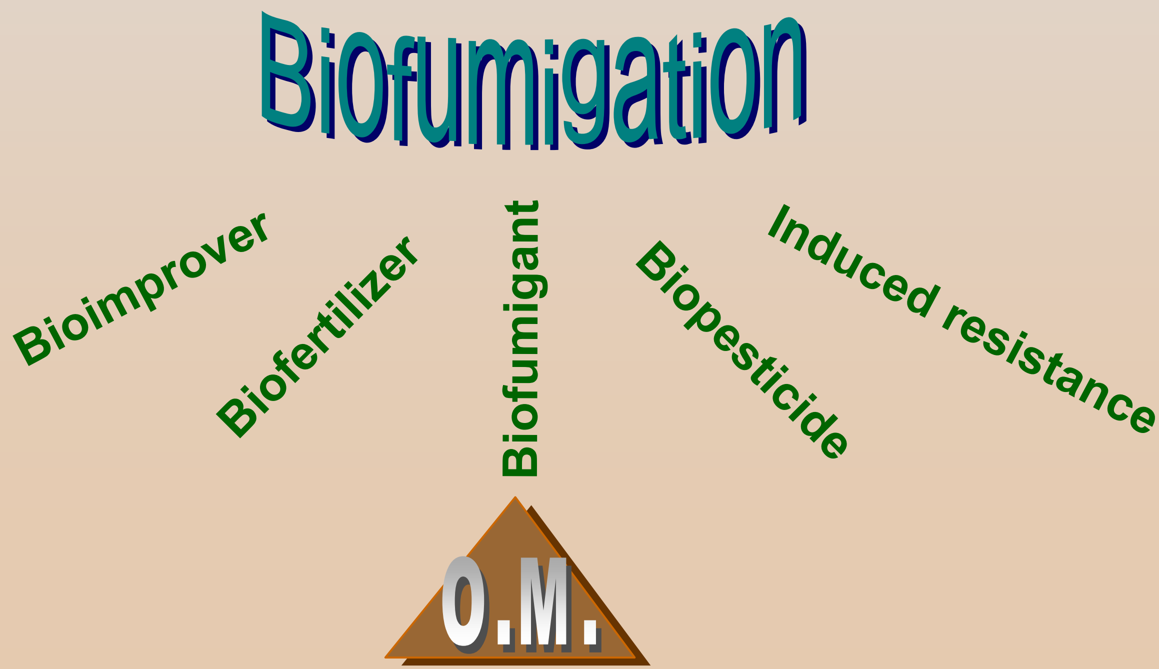
International Enviromental Protocols

- ✓ **Montreal**
- ✓ **Kyoto**
- ✓ **Biodiversity**
- ✓ **Stockholm**

Patogens isolated from soil-less crops

	Patogen	Host plant
Nematode:	*Meloidogyne incognita*	Tomato and pepper
	M. javanica	Pepper
Bacteria:	*Clavibacter michiganensis*	Tomato
	Pseudomonas solanacearum subsp. *michiganensis*	Tomato
	Erwinia spp.	Tomato
Fungi:	*Fusarium oxysporum* f sp. *lycopersici*	Tomato
	F. o. radicis-lycopersici	Tomato
	F. o. melonis	Melon
	F. o. cucumeris	Cucumber
	F. o. radicis-cucumerinum	Cucumber
	Rhizoctonia solani	Melon
	Verticilium dahliae	Tomato
	Phytopthora cryptogea	Tomato, lettuce, cucumber
	P. parasitica	Tomato
	Plasmopara lactucae-radicis	Lettuce
	Pythium spp.	Cucumber, tomato, lettuce
Virus:	Lettuce big vein virus	Lettuce
	Melon neccrotic spot virus	Melon
	Tomato mosaic virus	Tomato
	Cucumber green mottle mosaic virus	Cucumber

"Biofumigation is defined as the action of volatile substances from the biodegradation of organic matter as fumigants to control plant pathogenes. Its effciciency is maintainned in time through its introduction into an integrated crop management (ICP) system. Biofumigants also stimulate the biological activity of the soil by acting as bioimprovers. Biofumigation has been applied to control fungi, insect, nematodes and adventitius plants, an is able to regulate bacterial and viral problems with an efficacy similar to conventional pesticides."



Origin of biofumigant materials

Animal manures

Green manures

Agro-industrial residues

Biofumigation & solarization

SAMPLING POINTS (Indiv. 100 cc^{-1} soil)

Depth	1	2	3	4	5	6	7	8	9	Total	Average
0-20 cm											
live	0	0	0	0	0	2	0	2	0	2	0
dead	28	14	12	6	220	8	12	8	6	306	38
index (*)	0	0	0	0	0	1	0	1	0	1	0.1
20-40 cm											
live	0	0	0	0	0	4	0	28	0	4	1
dead	290	118	6	24	210	0	48	92	16	812	102
index	4	2	1	0	0	1	3	1	1	12	1.5
> 40 cm											
live	0	0	0	0	0	0	0	46	2	2	0
dead	2	0	0	4	10	2	4	152	4	22	3
index	0	1	0	0	1	0	0	2	2	4	0.5

(*) Bridge & Page (1980) experimental index on tomato cv Marmande plant on 300 g of biofumigated soil after one mon

Biofumigation effects in soil and plant

Soil nematodes	*Meloidogyne spp.* Rhabdit. Doril. Monon. Enchyt.
Soil fertility	N (%) OM (%) C (%) pH P_2O_5 K Ca Na Mg
Plant morphology and symptoms	Index (Bridge & Page 1980) Height (cm) Weight (g) (stem root total) number of leaves
Plant composition	N P K Ca Mg Fe Mn Zn Cu

Biofumigation & solarization

Tomato remains


Compost of tomato residues and chicken manure

Material and methods

Green manures

Cucumber

Pepper

Tomato

- Efficient management of horticultural residues
- Use of local resources

Biomass contribution according to crop

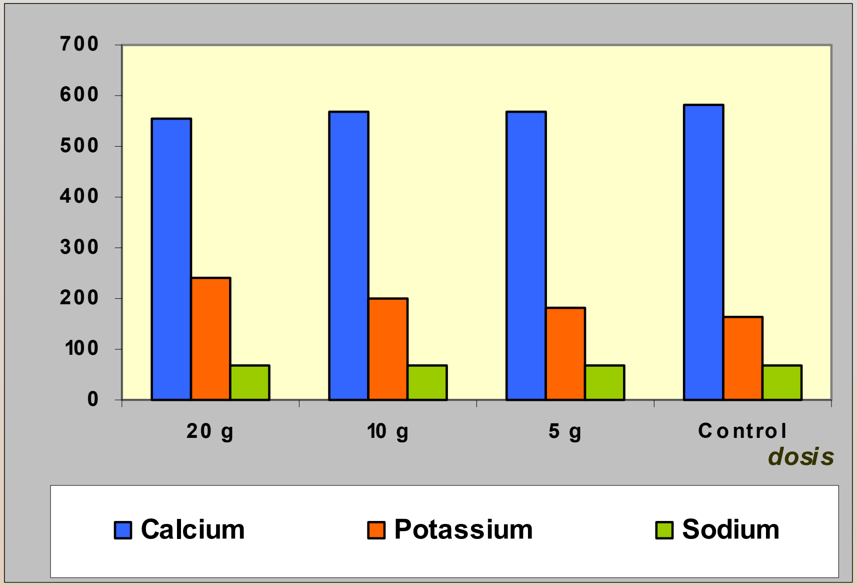
Crop	Stems	Leaves (%)	Fruits	Weight kg/m² (mean)
Cucumber	40	50	10	2,50
Pepper	50	40	10	6,50
Tomato	43	27	30	11,00

Biomass decomposition

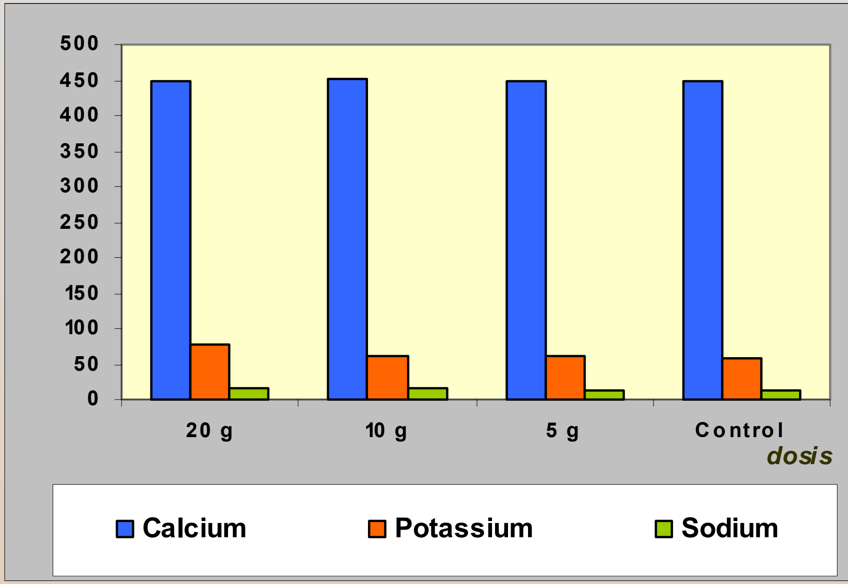
(3 months)

Crop	Stems	Leaves	Fruits	Initial weight
	(%)			(g)
Cucumber	1.6	2.7	0.1	5
Pepper	30.0	5.4	0.3	20
Tomato	5.2	2.4	0.1	20

Biofumigation influence on soil fertility



Pepper



Tomato

Results are mean of 4 repetitions

Biofumigation influence on soil physical properties. Water infiltraton

Biofumigation

Methyl bromide


Different vegetals in the greenhouse

BIOFUMIGATION AND CROP RENTABILITY IN SPAIN

R = + 11 %

R = + 7 %

R =+ 61 %(tom

R = +45(cucum

R = - 5 %

R = + 22 %(bras

R = - 12 % (mus

R = - 22 (sheep m

R = - 5 %

R = - 26 %

R = + 40 %

CONCLUSIONS

The greatest consumption of MB in Art. 2 countries correspond to tomato and vegetable crops (8,180 t),Its use as soil fumigant can be reduced by changes in formulation (50:50 in controlled environment and 70:30 in the open field), dose (20 gm2), frequency (once every two or three years), VIF plastic utilization and strip application.

Alternatives to MB besides being effective, must be compatible with international commitments on Biodiversity, Kyoto Protocols and Stockholm Agreement. One of these alternatives is biofumigation, which is based on ecological criteria and the use of local resources. Moreover, its efficiency is enhanced when included in integrated crop systems.

Cucumber, pepper and tomato crop residues are effective to control M. Incognita populations and weeds, but increasing efficacy with organic residues is recommended. Biofumigation also improves physical and biological soil characteristics. The recommended dose is 100 t/ha for the first year, when the problem is serious, decreasing in subsequent years to 45 t/ha for the fourth year. Higher doses could be reduced by using green manure. No phytotoxic effects are observed, or any other restriction on production. Soil characteristics as well as crop, region and type of organic matter, should be taken into consideration for field application.