MONTREAL PROTOCOL

ON SUBSTANCES THAT DEPLETE

THE OZONE LAYER

UNEP

2006 REPORT OF THE METHYL BROMIDE TECHNICAL OPTIONS COMMITTEE

2006 Assessment

Montreal Protocol on Substances that Deplete the Ozone Layer

United Nations Environment Programme (UNEP)
2006 Report of the Methyl Bromide Technical Options Committee

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Case Study 3. Spain - Phaseout of Methyl Bromide in pepper production

Non-chemical alternatives to MB for soil disinfection in pepper crops have been evaluated and are being increasingly adopted in Spain. They show that integrating practices like biofumigation with fresh pepper crop residues, chicken manure and sheep manure, biosolarisation, and grafting on resistant rootstocks, can be as effective as MB for controlling plant parasitic nematodes and fungi. MB consumption in Spain has been reduced by 96% since 1997.

Initial situation:

About one million tonnes of pepper are produced each year in Spain, accounting for 7.6% of the total volume and 13.5% of the value of vegetables produced in the country. Pepper is grown mainly in Andalusia (64.8% of total production), Murcia (15.0%) and Castilla-La Mancha (5.9%). The total area grown with peppers is 22,388 ha. 98.4% of this area is irrigated; 55.2% is under glasshouse (mainly Murcia and Andalusia) and 44.8% in open fields (MAPA, 2003). In Southern Spain, where most of pepper is grown, the crop season extends from January (transplant) to July (last harvest) and farmers usually grow peppers continuously, without crop rotation.

As a result of the intensive cultivation system and lack of crop rotation, sanitary problems and "soil exhaustion" have become a problem in pepper fields, and causing dramatic losses unless precautions are taken. The main pathogens are root knot nematodes (*Meloidogyne incognita*) and fungi, particularly *Phytophthora capsici.* These two key pests required fumigation with MB until recently; in fact, Spain requested CUN's for pepper crops in recent years.

Actions for replacing MB

Since 1997, several projects coordinated by the Spanish Ministry of Environment with participation of the Ministries of Education and Science and of Agriculture, have been undertaken with the aim of evaluating chemical and non-chemical alternatives to MB. Additionally, ministerial laws have been issued to reduce the dosage and concentration of MB, and awareness-raising activities such as seminars, conferences and workshops on the subject have taken place (Bello *et al.*, 1998; Lacasa *et al.*, 2004).

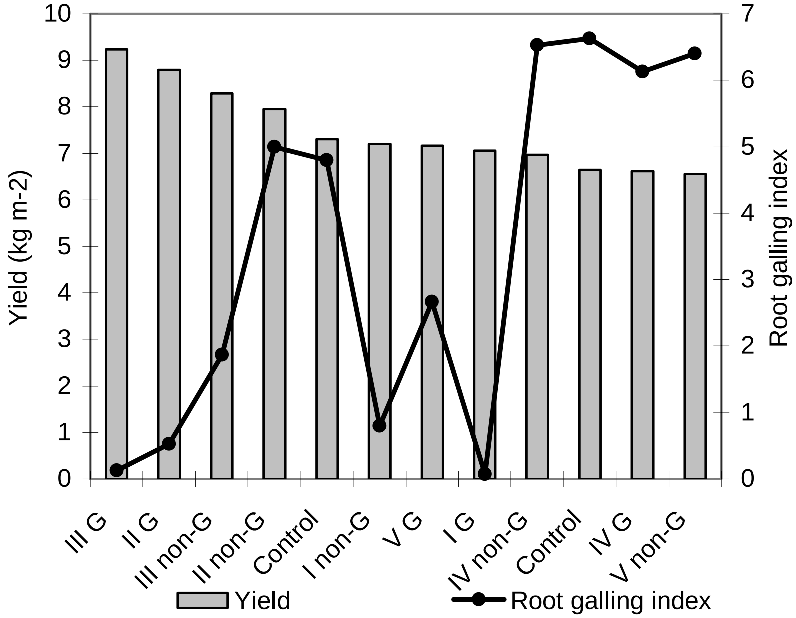
Description of the alternatives implemented:

The following non-chemical alternatives were evaluated: biofumigation with fresh pepper crop residues, chicken manure and sheep manure; biosolarisation; and grafting onto resistant pepper rootstocks (Lacasa *et al.*, 2004; Piedra Buena *et al.*, 2006). These treatments were compared with MB and an untreated control. Each treatment consisted of three replicate plots measuring 3 x 18 m each (54 m^2) and each replicate had two rows: one with susceptible peppers grafted on rootstocks resistant to *M. incognita*, and the other with non-grafted susceptible peppers. The control treatment consisted of non-grafted plants only. Biofumigation was carried out for 12 weeks, from mid-August to the beginning of November, at which time MB was applied. Pepper plants were transplanted two months later. At the end of the cultivation period (August) root galling indices and commercial yields were evaluated.

Results are presented in Figure 10.7. Biofumigation alone (without plastic cover) was not as effective as biosolarisation in reducing root-galling indices. On the other hand, grafting susceptible pepper plants on resistant pepper rootstocks significantly reduced root galling indices, indicating that grafting is a good alternative for nematode control. However, it was also observed that the repeated use of grafted plants in the same field eventually leads to a loss of effectiveness, possibly due to the selection of virulent populations of *M. incognita*. Incorporation of pepper crop residues along with fresh sheep or chicken manures together with solarisation enhanced the biofumigation effect, with satisfactory results as measured through root galling indexes.

Highest commercial yields were obtained from grafted plants grown in soil treated with biosolarisation plus pepper residues, fresh chicken and sheep manure applied for three consecutive years. These yields were not statistically different from non-grafted plants grown with the same treatment or grafted plants in similar circumstances but where treatment had been applied for two consecutive years only. Most of the other treatments produced intermediate yields, statistically different from the highest but similar to the two following treatments. Lowest yields were obtained with the control and with non- grafted plants in soil treated with biofumigation plus fresh pepper residues, fresh chicken and sheep manure applied for two and three years.

Figure 10.1. Commercial yields (kg m^{-2}) of pepper plants at the end of the cultivation period.



Control: no disinfected soil, without grafting and without plastic cover; treatment I: MB 98:2 (30 g m^{-2}) + pepper crop residues, with plastic cover; treatment II: biosolarisation with fresh sheep manure (4 kg m^{-2}) and fresh chicken manure (1.5 kg m^{-2}), for 3 consecutive years; treatment III: biosolarisation with pepper crop residues, fresh sheep manure (4 kg m^{-2}) and fresh chicken manure (1.5 kg m^{-2}), for 3 consecutive years; treatment IV: biofumigation with pepper crop residues, fresh sheep manure (4 kg m^{-2}) and fresh chicken manure (1.5 kg m^{-2}), for 3 consecutive years; treatment V: biofumigation with pepper crop residues, fresh sheep manure (4 kg m^{-2}) and fresh chicken manure (1.5 kg m^{-2}) for 2 consecutive years; G: grafted; non-G: non-grafted.

Commercial yields agree with root galling indexes observed in pepper plants at the end of the crop season. This was particularly true for the three higher and four lower yields, while the intermediate values showed a least consistent relationship with root galling indices.

Results obtained under laboratory and greenhouse conditions show that a system using pepper crop residues (PCR) for biofumigation, combined with nitrogen-rich organic matter such as fresh sheep manure and fresh chicken manure and covered with plastic for solarisation, is an efficient alternative to MB. This is particularly true when the pepper crop is grafted onto rootstocks that are resistant to *M. incognita*. However, it should be noted that repeated use of resistant cultivars could lead to the selection of virulence in *Meloidogyne* populations (Robertson *et al.,* 2006). When necessary, additional control methods for nematodes are used in combination with grafted plants.

<u>Current situation</u>

In 1995, MB consumption in Spain for pepper production totalled 1,176 tonnes in the Alicante, Almeria and Murcia provinces (Bello *et al.*, 1998). In 2007, MB consumption was reduced to about 50 tonnes of MB as a CUE for Murcia and

Alicante. Historical consumption is illustrated in Table 10.7.

Table 10.7. Historical consumption of MB in peppers in Spain

Total MB consumed * (metric tonnes)					Total CUN MB nominated (metric tonnes)			
1997	**1998**	**1999**	**2000**	**2001**	**2005**	**2006**	**2007**	**2008**
1,150	574	581	572	591	150	50	0.07 for research	0.07 for research nominated

* As reported by the Party.

The first strong decline in consumption occurred in 1997 and was due to the compulsory use of VIF, which reduced average dosages from 60 g/m^2 in 1997 to 30 g/m^2 (MB:chloropicrin 98:2 and VIF plastic), and to 40 g/m^2 (MB:chloropicrin 67:33 and VIF plastic) in 1998 and subsequent years. After that, the expanded adoption of biofumigation, biosolarisation, soilless culture, alternative chemicals and other techniques (Lacasa *et al.*, 2004) led to an average replacement rate of 91 tonnes per year.

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