CURRENT SITUATION OF TOMATO GRAFTING AS ALTERNATIVE TO METHYL BROMIDE FOR TOMATO PRODUCTION IN THE MEDITERRANEAN REGION

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Methyl Bromide use for tomato production in the Mediterranean region

Methyl Bromide (MB) is still used for tomato production in many developing (Morocco, Egypt Jordan, Lebanon, Turkey) and developed (Portugal, France, Italy, Greece) Mediterranean countries. This fumigant has never been registered as fumigant for soil disinfestation in Tunisia. It is used only for durables and particularly for date disinfestation. MB has been phased out for tomato production in Spain (Table 1). Spain has the same production system, climate, pest pressure and environment as Portugal, Southern France, Italy or Greece which still consider that MB is important for tomato production.

Table 1
Examples of some Mediterranean countries using and not using methyl bromide for Tomato production

Methyl Bromide	Developing countries	Developed countries
Used	Morocco, Egypt Jordan, Lebanon, Turkey,	Portugal, France, Italy, Greece,
Not Used	Tunisia	Spain

Purpose of grafting

In the Mediterranean region, grafting is one of the most commonly used alternatives to Methyl Bromide for Tomato production. However, the purpose of grafting has been greatly expanded from reducing infection by soil borne pathogens such as *Fusarium oxysporum* f.sp.*lycopersici* , *Verticillium dahliae, Pyrenochaeta lycopersici*, *Meloidogyne spp,* to growth promotion , yield increase, low temperature tolerance, ,growth period extension, improvement of the fruit quality

Tomato rootstocks

In the Mediterranean area, the major tomato soil borne diseases are *Fusarium oxysporum f.sp.lycopersici* (races 1 and 2), *F. oxysporum f.sp.radicis lycopersici*, *Verticillium dahliae* (races 1 and 2), *Pyrenochaeta lycopersici* , *Sclerotinia sclerotiorum*, *Didymella lycopersici* , *Clavibacter michiganense* subsp.*michiganense* and *Meloidogyne* spp. The diseases distribution, incidence and severity vary from one region to another according to many factors such as the cultivars used, the climatic conditions, the soil type, the cultural practices and the diseases control methods used.

Resistant rootstocks provide excellent control of many tomato soil borne pathogens and particularly *Fusarium oxysporum* f. sp. *lycopersici* (races 1 and 2), Verticillium dahliae (race 1), *F. oxysporum* f. sp. *radicis-lycopersici*, *Pyrenochaeta. lycopersici* and *Meloidogyne spp*. This technique, which was considered to be too expensive, is now widely used in many Mediterranean countries.

The most common root stocks belong to the Solanacea family: *Lycopersicum esculentum, Solanum aethiopicum, S.torvum and the hybrid L.esculentum* x *L.hirsutum*. This last hybrid is the most common rootstock. The resistance of these root stocks is reported in table 2

Table 2
Resistance of tomato rootstocks to the most common soil borne pathogens

Rootstock	Pathogens				
	K	V (1)	F (1,2)	N	Fr
L.esculentum x L.hirsutum	+	+	+	+	+
L.esculentum	+	+	+	+	+

K: *Pyrenochaeta lycopersici*, V (1): *Verticillium dahliae* (race 1), F (1,2): *F. oxysporum* f.sp. l*ycopersici* (races 1 and 2), N: *Meloidogyne* spp, Fr: *F.oxysporum* f.sp. *radicis lycopersici*

Resistance to *Pseudomonas (Ralstonia) solanacearum* is provided by *S.torvum* and *S.aethiopicum*. In addition, these two rootstocks are resistant to *Meloidogyne* spp.

Grafting in some Mediterranean countries

Grafted tomato has increased in Spain from less than one million plants 4-5 years ago to about 45 million plants in 2003-2004. Grafted tomato is used in France on about 2,800 ha, to prevent problems such as corky root caused by *Pyrenochaeta lycopersici* . In Italy about 10-12 million tomato plants are grafted annually. In Sardinia, the production of grafted tomato plants increased from almost nil in 1996 to about 1.7 million in 2003. The area of tomato production fumigated with MB in Sardinia has been reduced from 50% in 1992 to about 4% currently, due to agronomic changes which include the adoption of grafted plants and resistant varieties. In Jordan, tomato grafting was introduced by the "MB phase out project" in 2002. In that year, 1 ha of grafted tomato was planted. In Morocco, 20 million tomato plants are grafted, covering a surface of 2000 ha equivalent to 50 % of the total plantations for export. Besides the control of soil borne pathogens, grafting gives greater strength to the plants which allows planting density to be reduced by half (10,000 plants instead of the 20,000 plants/ha). This means the cost of the plants is reduced. Better growth at low temperatures and a longer production cycle are also achieved through grafting. It is expected that within 2-3 years, the whole production in Morocco for export will be using grafted plants.

Combination of grafting with other alternatives

Most of the tomato hybrids used in the Mediterranean area are resistant to most of soil pathogens except to *Verticillium dahliae* race 2., *Meloidogyne hapla*, *Sclerotinia sclerotiorum* and *Clavibacter michiganense*. In addition, the high salinity increases the susceptibility of Tomato to some soil borne pathogens and particularly to *Fusarium* and *Verticillium* wilts. Resistant varieties to these two pathogens become susceptible when the irrigation water has a

high salt content. The resistance to nematodes is also dependant on temperature. At a high temperature, the Mi gene is inactivated when the temperature is around or above 28-30°C.

Therefore, in some particular situations, grafting is combined with other treatments. In Italy, for example, grafted plants are used with alternative fumigants (e.g. 1,3-D or chloropicrin). In Greece, the combination of grafting with solarisation is considered to be a good MB alternative for tomato. While in Morocco, grafted tomato plants are considered to be viable MB alternatives when combined with alternative fumigants (1,3-D+Pic, metham), solarisation, biofumigation or other practices .

Critical use nominations

In 2005, only two Mediterranean countries requested critical use exemptions for tomato production: Greece and a new European country, Malta. All the other Mediterranean developed countries are not any more using MB for tomato production (Table 3).

Table 3
Critical use nominations by Parties to the Montreal Protocol requesting the use of methyl bromide for Tomato production

Crop	2003		2004		2005	
	Tonnage nominated	**Number of nominations (*)**	**Tonnage nominated**	**Number of nominations (*)**	**Tonnage nominated**	**Number of nominations (**)**
Tomato	4,312	5	4,012	3	3,940	4

(*): USA included
(**): 2005: Belgium, **Greece, Malta** (a new EU country) and USA

This reduction of countries requesting critical use exemptions illustrates the availability at a commercial level of efficient alternatives to methyl bromide for these crops. Among these alternatives, use of rootstocks is more and more developing

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