CURRENT SITUATION OF TOMATO GRAFTING AS ALTERNATIVE TO METHYL BROMIDE FOR TOMATO PRODUCTION IN MOROCCO

Mohamed Besri
Hassan II Institute of Agronomy and veterinary medicine
Rabat, Morocco
m.besri@iav.ac.ma

Introduction

The intensification of protected tomato production has led to favoring conditions for the development of many pathogens. Soil-borne disease problems were relatively uncomplicated and of lesser importance in the early years, but increased in importance as intensive cultivation continued. Soil fumigation with Methyl Bromide to control soil borne fungi and root knot nematodes was until recently considered as one of the main factors for the production success in greenhouses.

With the consumers demand for non treated products, the withdrawal of methyl bromide and its availability on the market, tomato growers are increasingly looking for alternative approaches to this fumigant. In addition, there is an increasing market for organically grown tomatoes. Grafting, which does not require major adaptations in farming practices, has been rapidly adopted by the tomato growers in Morocco and in many other countries. Currently, 95 % of the tomato productions in plastic houses in Morocco are cropped with grafted plants. A wide range of rootstocks with multiple resistances to infectious and non-infectious diseases are available on the Moroccan market and the number of available rootstocks is increasing every year driven by the high demand for grafted plants and seed companies interest.

This paper describes the current situation of tomato grafting in Morocco

Phasing out Methyl Bromide in developing countries for tomato production

In Article 5 countries, 86 % of MB is used for soil fumigation of which 20 % is for tomato. To facilitate and promote methyl bromide phase out in developing countries, the Multilateral Fund (MLF) is providing these countries with financial and technical support. Many demonstration and investment projects have been implemented to limit the use of MB on tomato in Latin America (Argentina, Chile, Dominican Republic, Guatemala, Mexico, Uruguay), Africa (Botswana, Egypt , Morocco) , the Middle East (Jordan, Lebanon ,Syria, Turkey) and Asia (China). These MLF projects were implemented by UNIDO, UNDP, World Bank and also by bilateral agencies (Germany, Italy, France...). One of the major alternatives adopted by these countries comprised grafting. Because of the excellent results, a rapid and enthusiastic response came from many developing countries promising an earlier phase out of MB. It is therefore expected that in many developing countries, a total phase out of MB (except for essential use) could be within reach before or during 2010, well in advance of the agreement in the protocol.

History of tomato grafting in Morocco

Grafting is a new technology in Morocco .The first vegetable grafting was done on Melon in the Netherlands in 1947 to control Fusarium wilt (*Fusarium oxysporum f.sp.melonis).* In Morocco, tomato grafting started in 1996 with collaboration between a Dutch nursery "Grow Group" and a Moroccan one. During that year, grafted tomato for 40 ha (400,000 plants, 10,000 plants /ha) had been produced. In 1997,"Nursery International" was created and produced 1 million grafted plants (100 ha). The rootstocks used were Beaufort (De Ruiter) and Heman (S§G). In 2006-2007, 3,990 ha were planted with grafted plants which comprise 95 % of the protected tomato production area (Table 1).

This technology has shown to be a great success in just 10 years and has become very popular. New commercial nurseries were established and in addition big farmers started producing their own grafted plants. However a number of producers continue to use non grafted plants and methyl bromide. To solve this problem and to make the grafted plants available even for the Moroccan small farmers, the Multilateral Fund in 2005 financed an important project comprising modern nursery for grafted plant production, training facilities, experimental plots (root stocks, tomato hybrids..), extension etc. The project is coordinated by the Moroccan Association of Vegetable Producers and Exporters (APEFEL). During the present year, this nursery produced 2.5 millions grafted plants (250 ha). These plants have been distributed to 60 small farmers who were not using this technology

The evolution of tomato grafted plants from 1995 to 2007 is reported in table 1

Table 1
Evolution of grafted tomato area from 1995 to 2007

YEAR	**AREA** (ha)	**PERCENTAGE**
1995-1996 (a)	40	0.9
2003-2004	2520	60
2004-2005	2940	70
2005-2006	3780	90
2006-2007 (b) (Expected)	3990	95

(a): Technology introduction
(b) 44 million rootstock, seeds were sold in 2006

Available root stocks in Morocco

The first two root stocks, Beaufort and Heman, were introduced in Morocco in 1996. Presently many root stocks are found on the market (Table 2) and their number increases yearly. The main root stocks characteristics (vigour, pathogen resistance, salt , cold and drought tolerance, earliness, adaptation to field or to soil less culture, etc.) varies from one rootstock to the other. The root stock choice also depends on the type of tomato produced and on the importing country demand (cherry, grape, plum, globe, lobed tomato). In addition, the climatic conditions (cold

winter, hot summer, and drought) oblige farmers to use grafted plants because the grafted plants are more resistant to these stresses than the non grafted ones.
In 2006, the two root stocks Beaufort and Maxifort were the most popular among the growers (70 %) (Table 2)

Table 2
Available Tomato root stocks and their popularity in Morocco

ROOTSTOCKS	PLANTED AREA (%)
Beaufort, Maxifort (Tomato, eggplant)	70
Brigeor, Heman, King Kong,	10
Spirit, Prosper, Ground Force, Monstro, Fares, Brusli, Arnaud, Magnum, Ground force	10
Others	10

Most of the root stocks are resistant to *F.oxysporum f.sp.lycopercisi* (races 1, 2), *F.o.f.sp;radicis lycopercisi*, , , *Verticillium dahliae*, *Pyrenochaeta lycopersici*, *Meloidogyne* spp.. Some others to Tomato yellow leaf curl virus (Anonymous 2007).
Average of total tomato protected area: 4,200 ha

Total and exported tomato production

The non grafted and grafted tomato plant density per ha are respectively about 20,000 (one stem per plant) and 10,000 plants/ha (2 stems/plant). When grafted plants are used, the same or a higher yield is obtained with the lower grafted plant population. The 2005 and 2006 experiments in Agadir area have confirmed that the total production is much higher with grafting and MeNa than with non grafted plants and MB .The quality of the tomato production expressed as percentage of exported production was also higher (Table 3). These results confirm our previous experiments

Table 3
Total and exported production of grafted tomato plants in combination with Metam sodium and non grafted tomato in combination with Methyl Bromide (Daniella / Maxifort KNVF) (2005 and 2006 experiments)

Tomato (*)	Nb Plants	Total production (T)			Exported production T/ha	%
		2005	2006	Average		
Non grafted + MeBr	20,000	105	112	108.5	85.2	78.5
Grafted + MeNa	10,000	139.6	156.7	148.2	139.3	94.9

(*): non grafted tomato: 20,000 plants/ha (one stem/plant), grafted tomato: 10,000 plants/ha (2 stems/plant)
Metam sodium was applied by drip irrigation

Registered fumigants for tomato production in Morocco

Grafting is not considered as a single absolute alternative to Methyl Bromide (MB). This technology is considered as a component of an IPM program and is, in general, associated with other fumigants (Table 4).

The fumigants registered in Morocco for tomato production are reported in Table 4

Table 4

Registered fumigants in Morocco for tomato production (2006)

Trade Name	Composition	Application	Rate of Application	Chemical company
DD 92 *	1,3 Dichloropropène +1,2 Dichloropropane	Injection	170 litres /ha	AMAROC
DD90	1,3 Dichloropropène (1,113 g/l)	Drip irrigation	150 litres /ha	SIPP
CONDOR F	1,3 Dichloropropène (930 g/l)	Drip irrigation	90 - 150 litres /ha	PROMAGRI
FLASH SOL	1,3 Dichloropropène (55,4 %) + Chloropicrine (32,7 %)	Drip irrigation	450 Kg /ha	AGRIPHARMA
TELOPIC 35*	1,3 Dichloropropène 65+ Chloropicrine 35	Injection	500 Kg /ha	BRAGA
TELODRIP	1,3 Dichloropropène (60,3 %) + Chloropicrine (33 ,3 %)	Drip irrigation	500 Kg /ha	BRAGA
TRIPICRINE	1,3 Dichloropropène + Chloropicrine (Variable)	Drip irrigation	1,3 D and Pic are mixed on the farm 500 Kg /Ha	Comptoir Agricole du Souss
NEMAPROP	Metam sodium 510 g/litre	Drip irrigation	800 - 1200 litres / Ha	CPCM
NEMASOL	Metam sodium 510 g/litre	Drip irrigation	800 à 1200 litres / Ha	CALIMAROC
RAISON 50	Metam sodium 50%	Drip irrigation	800 à 1200 litres / Ha	PROMAGRI

*: These fumigants are not associated with solarisation because they can not be used by drip irrigation

Conclusion

In Morocco, tomato grafting is applied at a large commercial level. In 2006: 95 % of the total tomato protected area (4,200 ha) were planted with grafted plants. Many rootstocks are available on the market and their number is increasing yearly. Grafting is not used alone but as a component of an IPM program which includes other control methods such as fumigation, sanitation, pathogens free seeds and seedlings, weed control, improvement of plant growing conditions etc… The non grafted and grafted tomato plant population per ha are respectively about 20,000 (one stem per plant) and 10,000 plants/ha (2 stems/plant). When grafted plants are used, a higher yield is obtained with this half density population. In 2006 and 2007, the total

production of grafted plants was significantly higher than non grafted plants. The quality, expressed as % of exported production was also higher.

Selected References

Anonymous, 2007, Portes greffes, assurer une bonne compatibilité. Agriculture du Maghreb, 20,58-60

Besri M.2002, Alternatives to Methyl Bromide for tomato production in the Mediterranean area. Proceedings of International Conference on Alternatives to methyl Bromide, Seville, Spain, 5-8 March200., 162 – 166.

Besri M., 2003. Tomato grafting as an alternative to Methyl Bromide in Morocco. Proceedings of the international research conference on methyl bromide alternatives and emissions reductions, November 3-6, 2003, San Diego, California, 12.

Besri M., 2004 .Leading Methyl Bromide alternatives in commercial use for tomato production in different geographic regions except the United States. Proceedings of the Fifth International Conference on Alternatives to Methyl Bromide, Lisbon, Portugal 27-30 September 2004., 127-131

Besri M., 2004. Progress in phasing out Methyl Bromide for Tomato Production in developing and developed countries. Proceedings of the international research conference on methyl bromide alternatives and emissions reductions, October 31- November 3, 2004, Orlando, Florida, 24-1 24-3

Besri M, 2005.Current situation of grafting as alternative to Methyl Bromide for tomato production in the Mediterranean region. Proceedings of the international research conference on methyl bromide alternatives and emissions reductions, October 31- November 3, 2005, San Diego, California, 47-1 47-3

Besri M, 2007. Economical aspects of grafting tomato in various regions. Annual international research conference on Methyl Bromide alternatives and emission reductions. , San Diego, California, October 28-31

Ouzizi S, Les alternatives au Bromure de Méthyle, 2007. Pack info, 59, 48-53
UNEP, 2006. 2006 report of the Methyl Bromide Technical options committee (MBTOC), 2006 Assessment, 453 pp