ECONOMICAL ASPECTS OF GRAFTING TOMATO IN SOME MEDITERRANEAN COUNTRIES

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Introduction

Grafting, which was considered at one time too expensive, is now widely used on a commercial level in Morocco and in other Mediterranean countries. Resistant rootstocks provide excellent control of many soil borne tomato pathogens and particularly *F.oxysporum* f. sp. *lycopersici*., *F. oxysporum* f. sp. *radicis-lycopersici*, *Verticillium dahliae*, *Pyrenochaeta lycopersici* and *Meloidogyne* spp. In addition to soil borne pathogen control, tomato grafting has also many other advantages such as growth promotion and yield increase, low temperature tolerance, growth period extension and fruit quality.

The non grafted and grafted tomato plant densities 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 can be obtained with this half density plant population (table 1). In 2005 and 2006 experiments, the production of grafted plants was significantly higher than of the non grafted ones. The quality, expressed as percentage of the exported production, was also higher (table 1). These results confirm the results obtained in the previous years.

In 2006-2007 , 95 % of the 3,990ha of the protected tomato producing area (4,200 ha) were planted with grafted plants. In 2006, about 40 million grafted plants tomato (10,000 plants, /ha) with double stems were used

Total and exported tomato production from grafted plants in Morocco

Grafting is not considered as a single alternative to Methyl Bromide (MB). This technology is always associated with other chemical pesticides such as Metham Sodium (MeNa) . The comparative total yields and exported production are reported in table 1: The total production and the exported productions are much higher with grafting and MeNa than with non grafted plants treated with MB

Table 1
Total and exported production of tomato from grafted plants in combination with Metam sodium and non grafted tomato in combination with Methyl Bromide (Daniella / Maxifort KNVF) in Morocco

TOMATO (*)	NB PLANTS/HA	TOTAL PRODUCTION (T/HA)			EXPORTED PRODUCTION T/HA	%
		2005	2006	Average		
Non grafted + MB	20,000	105	112	108.5	85.2	78.5
Grafted+MeNa	10,000	139.6	156.7	148.2	139.3	94,0

(*): 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

Comparative costs of Tomato grafted plants + MeNa and non grafted plants + MB in Morocco

The comparative costs of grafted tomato in combination with Metam Sodium and non grafted plants with Methyl bromide are reported in table 2. The cost of grafted plants +Metam Sodium (USD 6,138) competes favourably with the cost of MB fumigation (USD 5018). The small additional cost (1,120 $US/ha) explains why grafting is getting more and more popular among the farmers.

Table 2
Comparative costs (USD /ha) of grafted (in combination with Metam sodium) and non grafted Tomato plants (with Methyl Bromide) in Morocco

Non grafted plants (farmer's nurseries)+ MB (USD/ha)		Grafted plants (commercial nurseries)+ MeNa (USD/ha)
Seeds: (80 g x 22 US$)=	1,760	Grafted plants (*): 3,600
Peat :	320	Seeds of the tomato hybrid (**): 40g x 22= 880
Alveolar plates:	250	
Black plastic:	35	
Watering cans:	28	
Workers:	75	
Methyl Bromide (300 Kg/ha x 8.5 US $) 2.550, black plastic 40µ included		Metam Sodium (1.21US$ x 400 Kg = 484 US $) + black plastic 40 µ (300 Kg x 2.3=690)= 1,174 US $
Total: 5,018		6,138

(*) 10.000 grafted plants x US$ 0.36 = US $ 3,600. The grafted plants are not produced on farm, but bought from specialized nurseries.
(**) seeds for the root stocks are supplied by the nursery

Prices of some tomato and root stocks seeds

The price of tomato grafted plants varies with the tomato rootstocks, the tomato variety or hybrid characteristics, the nursery size and the market importance.

Table 3
Prices of some Tomato hybrids and root stocks

TOMATO HYBRIDS (US $/KG)	TOMATO ROOTSTOCKS (US $/HA)
Gabriella:30,108	0.06 -0.12/seed , 600 -1,200/ha (10,000 plants/ha) according to the root stock characteristics: resistances, germination rate , vigor, etc..
Calvi: 0.14 / seed or 42,000/Kg (1)	
Pristyla: 0.27/seed or 81,000 /Kg (2)	
Pitenza: 0.29/seed or 87,000/kg (3)	

(1) 300 seeds /g * 1000 * $ 0.14= 42,000 US $/Kg, (2) 300 seeds /g * 1000 * $ 0.27= 81,000 US $/Kg
(3) 300 seeds /g * 1000 * $0.29= 87,000 US $/Kg
Seeds quantity/ha: Non grafted plants: 70g/ha, Grafted plants: 34-35 g/Kg

In Morocco, the first grafted plants were sold at US $ 0.8 / plant. The grafted plant is sold now at about US $ 0.4 (Daniella or Gabriella/Beaufort). This price is 2-4 times less that in

some European countries e.g. , Greece (US $ 0.9), Spain (US $ 1.32). The Tomato rootstock and the variety/hybrid used in these countries are unknown

Many Moroccan nurseries are exporting grafted plants to Europe and Africa because of the price and quality

Profit generated by grafting in Morocco

The extra cost of grafting, the extra exported production and the global profits are reported in table 4;

Table 4
Compared profits of grafted (in combination with Metam Sodium) and non grafted tomato plants (in combination with Methyl Bromide) (2005-2006 experiments in Morocco)

Tomato	Extra cost of grafted tomato + MeNa (USD)	Extra exported production of grafted plants + MeNa (T)	Profits (USD)
Non grafted *	0	0	0
Grafted	1,120	54.1	31,827

54.1 T x USD 609 = USD 32,947, Global profit: 32,947- 1,120= USD 31,827
*: soil fumigation with MB

Comparison of Tomato crop yield using MeBr fumigation + non grafted plants with grafted plants + alternative fumigant, grafted plants alone and non grafted plants in some Mediterranean countries

The comparison of tomato crop yield is reported in table 5. This table shows that the tomato crop yield is always higher when grafted plants are combined with other fumigants

Table 5
Comparison of Tomato crop yield using MB fumigation + non grafted plants (MB +NG), grafted plants + alternatives fumigants (G+F), grafted plants alone (G) and non grafted (NG) plants in some Mediterranean countries

MB + NG (T/HA)	G+F (T/HA)	G (T/HA)	NG (T/HA)	REFERENCES
248	300	255	156	Ganz et al 2005
	265-305	220-290	130	
112	138	129	-	Bogoescu et al 2004
	133	122	97	
108	148	-	-	Besri 2007
-	122	-	97	Minuto 2003

Comparative costs of grafting alone or in combination with chemical in some Mediterranean countries

The comparative costs of grafting alone or in combination with chemicals in some Mediterranean other countries are reported in table 6

Table 6
Comparative costs of grafting alone or in combination with chemicals in some Mediterranean countries (USD)

Country	MeBr /ha	Grafting (G) with or without fumigant (F) (USD/ha)	Alternative / MeBr	References.
Greece	5, 650	-	Despite their high cost (0,8-0;9 US $ /plant) grafting (alone) provides net revenue about 10% higher than MB.	Vos (2006)
Lebanon	6,500	1,3 D (3,400)+ G (3,150) = 6,550	The cost of grafted plants + 1,3 D (US $ 6,550) competes favourably with the cost of MB fumigation US $ 6,500. The net revenue from G+F is higher than from MB fumigation	Hafez, 2006
Morocco	5,018	6,138 G + MeNa	The cost of grafted plants + MeNa (US $ 6,138) competes favourably with the cost of MB fumigation USD 5,018. The net revenue from Grafted plants + MeNa is USD 31,827 higher than from MB fumigation	Besri 2007
Spain	7,920	10,692	Grafting cost: 10, 01 $/m2 .The additional cost of the grafted plant is USD 2,772 .The net revenue is higher.	Miguel 2004

1 €=1,32 $US 1 US $= 0.75 €

Conclusion

In Morocco, grafting is applied on a wide commercial level on 95 % of the total protected tomato producing area (4,200 ha).. The total yields and export quality production are much higher with grafting and MeNa than with non grafted plants and MB. The cost of grafted plants + Metam Sodium (USD 6,138) competes favourably with the cost of MB fumigation (US $ 5,018). The 2005-2006 experimental results have shown a global profit of USD 31,827. The negligible additional cost, the increased production quality expressed as export percentage and the high global profit explain why grafting is more and more popular amongst farmers. The prices of tomato grafted plants varies with the tomato rootstocks, the tomato variety or hybrid characteristics, the nursery size and the market importance In many other Mediterranean countries, the situation is similar. Tomato crop yield is always higher when grafted plants are combined with other fumigants. The cost of grafted plants + fumigant competes favourably with the cost of MB fumigation. The net revenue from grafting combined with a chemical alternative is always higher than from MB fumigation without grafted plants

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