

# CUCURBITS GRAFTING AS ALTERNATIVE TO METHYL BROMIDE FOR CUCURBITS PRODUCTION IN MOROCCO

Mohamed Besri  
Hassan II Institute of Agronomy and veterinary medicine  
Rabat, Morocco  
[m.besri@iav.ac.ma](mailto:m.besri@iav.ac.ma)

## Introduction

Grafting is a method of asexual plant propagation that joins plant parts for them to live together. So they will grow as one plant. Normally the method has been largely applied to propagate trees that will not root well as cuttings or whose own root systems are not strong enough or resistant to several soil-borne pathogens. Now the method is used for other crops, as vegetables, such as solanaceous plants (tomato, eggplant and pepper) and cucurbits (melon, cucumber and watermelon).

The intensification of protected and open field cucurbits production has led to favoring conditions for the development of many pathogens. On Cucurbits, 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 some soil borne pathogens was until recently considered as one of the main factors for the cucurbits production success.

Grafted cucurbits are commonly grown in various Mediterranean, Asian and European countries, but only rarely in North America.. In Morocco, cucurbits grafting is considered as one of the main alternative to Methyl bromide for the control of some soil borne pathogens particularly Fusarium wilts

This paper describes the current situation of cucurbits grafting in Morocco

## History of vegetables 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. Cucurbits grafting started in 1998. Plants are grafted onto various rootstock species and varieties,

With the consumers demand for non treated products, the withdrawal of methyl bromide and its availability on the market, cucurbits growers are increasingly looking for alternative approaches to this fumigant. In addition, there is an increasing market for organically grown vegetables. Grafting, which does not require major adaptations in farming practices, has been rapidly adopted by the cucurbits growers in Morocco and in many other countries. Currently, most of the melon and water melon grown in plastic houses and in the open air for export are grafted. . Grafting of

cucurbits for the local market is also rapidly developing.. A wide range of rootstocks resistant to Fusarium wilts 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 company's interest. Grafting technology has become very popular. New modern commercial nurseries were established and in addition big farmers started producing their own grafted plants.

## Purposes of Cucurbits grafting

### *Disease tolerance*

One of the major advantages of using grafted plants is the control of many pathogens: Fusarium wilts, *Phomopsis sclerioides*, *Monosporascus cannonballus*.(Table 1,3) .

*Grafting for Fusarium wilt control:* Grafting is common in several Mediterranean and Southeast Asian countries mainly for the control *Fusarium* wilts.

*Grafting for Monosporascus control:* Recently, grafting of melons on *Cucurbita* spp. was also shown to be an effective strategy against the sudden wilt disease of melons caused by *Monosporascus cannonbolus*

*Grafting for Meloidogyne spp.cControl:* The predominant root-knot nematode species infecting cucurbits in Morocco are *Meloidogyne incognita* and *M. javanica*. Both of these species cause dramatic galling on the roots and very low initial populations can result in considerable yield losses . Soil disinfestation with methyl Brolmide has been considered as the way of success for cucurbits production. As a result, alternative approaches for managing cucurbits root-knot nematodes are needed.

**Table 1**  
**Pathogens controlled by grafting**

Pathogens	Melon	Cucumber	Watermelon
<i>F.oxysporum</i> f.sp. <i>melonis</i> (melon Cucumis melo))	+	-	-
<i>F.oxysporum</i> f.sp. <i>niveum</i> (water melon Citrillus lanatus)	-	-	+
<i>F.oxysporum</i> f.sp. <i>cucumerinum</i> (cucumber Cucumis...)	-	+	-
<i>Phomopsis sclerioides</i>	-	+-	-
<i>Monosporascus cannonballus</i>	+	-	+
Melon Necrotic Spot Virus (MNSV)	+	-	+

adapted from Miguel, 2004

### *Yield increase*

In many countries, yield increase has been reported. In Spain, more than 90% of watermelon plants are grafted, using different *Cucurbita* hybrids (*C. maxima* x *C. moschata*) as rootstocks. In Morocco, experiments have been conducted in the main cucurbits producing areas to compare yields of grafted and non grafted melon and water melon. The average yields of grafted plants

were much more higher than the yields of the non-grafted plants (Table) : The yield increase is 44 % and 84 % respectively for melon and watermelon

**Table 2**  
**Comparative yields of grafted and non grafted melon and water melon**

Crop	Treatment	Average yields (T/ha)	% increasae
Melon (Cucumis melo)...	Grafted	62	44,2
	Control	43	
Water melon (Citrillus lanatus ...)	Grafted	120	84
	Control	65	0

Melon: Tezac (Poloni) /Shintoza (Tokita seeds)

Water melon: Crimson (Nunhems)/ Shintoza (Tokita seeds)

### ***Low temperature tolerance***

In Morocco, and particularly in the most important horticultural region of the country, the temperature can be as low as 0°C, particularly during the cucurbits production for export. . The transplanting seedling for protected cultivation is usually done in early to mid winter (à verifier) and fruit harvesting is usually finished by the nd of April. . Plastic houses are not heated .

### ***Rootstocks choice***

All the available rootstocks are susceptible to *M.incognita* and *M.javanica*. Some root stocks e.g. Wax gourd (*Benincasa hispida* ), African horned cucumber (*Sicyos angulatus*) have been reported resistant to *M.hapla* (Table 3). This species is not common in the Mediterranean countries. Therefore, in our conditions, no resistant rootstocks to the prevalent *Meloidogyne* is commercially available and when vegetable soils are infested by *M.incognita* and *M.javanica*, grafting should be combined with others chemical alternatives (1,3 D, 1,3 D+Pic, Metam Sodium, 1,3 D+metam) or non chemical alternatives (biofumigation, solarisation..):

The most widely used rootstock is “Shintoza” , an interspecific hybrid between *Cucurbita maxima* and *Cucurbita moschata*. The hybrid exerts strong resistance to the three f.sp of *Fusarium* (*niveum*, *cucumerinum*, *melonis*,) and good graft compatibility with water melon, melon and cucumber.

The rootstock choice depends on the scion to be used: Bottle gourd (*Lagenaria siceraria*) is exclusively used for water melons and does not have good compatibility with melons, *Cucurbita ficifolia* possessing excellent tolerance to low soil temperature , is the preferred rootstock for greenhouse cucumbers and is used as a rootstock for spring production in winter . A modification of the fruit quality (shape, appearance, taste, coloration, internal decay...) have been observed on grafted plants. For example, inferior quality of water melon has been observed when grafted to squash

**Table 3**  
**Available root stocks for cucurbits grafting (Lee, 1994)**

Crop	Rootstocks (species)	Purpose
Water Melon (Citrillus lanatus)	Bottle gourd ( <i>Lagenaria siceraria</i> ) <i>Interspecific hybrids F1 (C.maxima x C. Moschata)</i> , Wax = white gourd ( <i>Benincasa hispida</i> ) Pumpkin ( <i>Cucurbita pepo</i> ), Squash ( <i>Cucurbita moshata</i> ), <i>Sicyos angulatus</i>	1,2 1,2,3 1,2 1,2,3 1,2,3 5
Cucumber (Cucumis..)	Figleaf ( <i>Cucurbita ficifolia</i> ), <i>Interspecific hybrids F1 (C.maxima x C. Moschata)</i> , Cucumber ( <i>Cucumis sativus</i> ) <i>Sicyos angulatus</i> ,	1,2,3 1,2,3 1,2 2,5
Melon (Cucumis melo)	<i>Cucumis melo</i> Squash ( <i>Cucurbita moshata</i> ) Interspecific hybrids ( <i>C.moschata x C.maxima</i> ) Wax = white gourd ( <i>Benincasa hispida</i> )	1,3,4 1,2,3 1,2,3 1,2

1: Fusarium wilts, 2: growth promotion, 3: low temperature, 4, growth period extension, 5: nematodes resistance

**Table 4**  
**Rootstocks commercially available for Melon and water melon in Morocco**

Crop	Seed companies	Varieties
Melon	Tokita seeds Sakata Royal Sluis Tezier	Shintoza Squash n°3 RS 84 148
Water melon	S § G Tokita seeds Nunhems Sakata VOLTZ Fito Semillas	Strong Tosa Shintoza Camel Force Squash n° 3 Forza Fantazia

## Grafting technology

### *Grafting calendar and grafting steps*

The grafting calendar generally adopted for water melon are:

- Day 0: Variety sowing (January)
- Day 7: Root stock sowing
- Day 14: Grafting
- Day 24: Plant transplanting
- Day 45: Field planting (February)

The main grafting steps are: sowing the root stock, sowing the variety to be grafted, , grafting, fusion, potting and spacing

***Sowing the root stock:*** The sowing date depends on the chosen rootstock, the variety to be grafted and on the sowing and greenhouse conditions. In general, the sowing date for the rootstock varies between 2 days and 7 days before the sowing date of the variety. Seeds are sown in peat plugs at 240 cells per tray . After sowing, seed are covered with small medium gauge vermiculite. . Trays are placed in warm , light area immediately after sowing. Trays are covered with clear plastic to avoid dehydration of the seed. Plastic is removed as soon as the very first green spot is visible. Humidity must be kept high as the seedling will otherwise dry out.

***Sowing the variety to be grafted:*** The variety is sown 2-7 days after the root stocks. , in the same conditions as the rootstock

***Grafting:*** The best time for grafting is when the rootstock and variety stems have the same thickness.. All the rootstocks on a tray are cut at 45° angle. Cutting are done underneath the cotyledons, though the stem should be at least 2-3 cm long . Clips are then placed on each rootstock of the tray. The variety (scion) is cut at the same angle as the root stock and placed in the clips of the prepared rootstocks . The plates are placed directly in the tunnel for healing and acclimatation. It is recommended to use new razor blades after every break or between different varieties or rootstocks. During grafting, hands and the razors should regularly be disinfected with a disinfectant e.g. Dettol or Vircon

***Fusion:*** To facilitate fusion between the root stock and the scion, it is important to avoid sunlight on the plants and to maintain uniform climate. Shading is important particularly in the Moroccan conditions.. Tents are kept closed for 5 days . On the fifth day, , the tunnel is ventilated slightly

***Potting and spacing:*** After day 7, normal plant raising procedures are followed. Transplanting is recommended from day 9 to 10 days after grafting , once the rootstock and the variety are firmly joined.

## **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

- López-Glarza, J., San Bautista, A., Pérez, D.M., Miguel, A., Baixaulil, C., Pascual, B, Maroto, J.V. and Guardiola, J.L. (2004). Effects of grafting and cytokinin-induced fruit setting on colour and sugar-content traits in glasshouse-grown triploid watermelon. *Journal of Horticultural Science and Biotechnology* 79, 971-976.
- López-Perez, J.A., Arias, M., Sanz, R. and Escuer, M. (2003<sup>a</sup>). Evaluation of alternatives to Methyl Bromide to control *Meloidogyne incognita* in cucumber - Abstracts. *Nematropica* 33, 189 -196.
- Cohen, R., Burger, Y., Horev, C., Porat, A. and Edelstein M. (2005). Performance of galia-type melons grafted on to cucurbita rootstock in *Monosporascus cannonballus*-infested and non-infested soils. *Annals of Applied Biology* 146, 381
- Koren, A., (2002). Grafting vegetable transplants in Israel, International Methyl Bromide Compliance Workshop, December 8-13, 2002, Israel. 46 pp.
- Edelstein, M., Burger, Y. Horev, C., Porat, A., Meir, A. and Cohen, R. 2004. Assessing the effect of genetic and anatomic variation of *Cucurbita* rootstocks on vigour, survival and yield of grafted melons. *J. of Hort. Sci. & Biotech.* 79: 370 – 374.
- Edelstein, M., Cohen, R., Burger, Y. and Shriber, S. (1999), Integrated Management of sudden wilt in melons, caused by *Monosporascus cannonballus*, using grafting and reduced rates of Methyl Bromide. *Plant Disease*. 83, 1142-1145.
- Edelstein, M. and M. Ben-Hur (2006). Use of grafted vegetables to minimize toxic chemical usage and damage to plant growth and yield quality under irrigation with marginal water. *Acta Horticulturae* 699: 159 - 167
- Lee J.M., 1994. Cultivation of grafted vegetables. I- Current status, grafting methods and benefits. *Hortscience*, 29,4,235-239d
- Lee J.M., 2003. Vegetable grafting: advances in vegetable grafting . *Chronica Horticulturae*, 43, 2, 13- 19
- Oda M. 2002. Grafting of vegetable crops. *Scientific Reports, Agricultural and Biological Sciences, Osaka Prefecture University* 54:49–72.