THE ADOPTION OF GRAFTED PLANTS IN ITALY: HIGHLIGHTS AND CRITICAL ASPECTS

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Introduction

Since 1st of January 2008 methyl bromide (MB) was definitively banned for use as a soil fumigant in Italy. Italy, first in Europe and second in the world for the use of MB in horticultural crop production, completely replaced MB uses both by adopting chemical and not chemical solutions. Moreover new strategies were adopted by combining several control methods including grafting commercial cultivars onto resistant rootstocks. Grafting vegetables represents a feasible alternative, technically and economically accepted by growers in several growing conditions: 54% and 81% of vegetables grown in Japan and in Korea are grafted (Rivero *et al*., 2003). In Mediterranean countries Greece, Spain, Netherlands, France, Cyprus, Malta and Italy rapidly increased the adoption of grafted plants (Traka-Mavrona, 2000; Diánez *et al*., 2007; Minuto *et al*., 2007). In Italy more than 25 millions of grafted plants were produced in 2005 including melon, watermelon, tomato and eggplant.

The advantages of the adoption of grafted plants

Grafting vegetables onto resistant rootstocks offers numerous advantages including: greater tolerance against low and high temperatures and salt stress; higher plant vigour and improved yield represent the major ones. Nevertheless resistance to soil pathogens, in particular *Verticillium* and *Fusarium* (Lee, 1994) is one of the most important reason that after MB ban increased the use of grafted plants.
Several rootstocks are available for grafting of both tomato and eggplant, the most common being tomato hybrids (i.e. Energy, Kyndia) and interspecific hybrids of *L. esculentum* and *L. hirsutum* (i.e. He Man, Beaufort, Maxifort, Trifort). Eggplant is now prevalently grafted onto *Solanum torvum* particularly when transplanted in sandy soils and/or in non-heated greenhouses. Melon and water melon are commonly grafted on interspecific hybrids of *Cucurbita maxima* x *C. moschata*.

The limitations of the adoption of grafted plants

Soilborne disease: among the major constraints and limitations of grafted rootstocks is that resistance may break down under high pathogen population pressure, that new races of the pathogen may evolve, and, under some environmental conditions e.g. high temperature and salinity, the plants may collapse. Moreover minor pathogens can become major pathogens on the rootstocks, particularly when soil fumigants are not used in combination with this technology. In Italy since 2002 novel root rots were repeatedly observed on Beaufort, He Man and Energy rootstocks being used for grafting tomatoes and eggplant to control Fusarium and Verticillium wilts (Garibaldi and Minuto, 2003). The symptoms were most evident on older roots where tissues became grey to black. Isolations from such tissues revealed that *Colletotrichum coccodes* was the cause of these symptoms (Garibaldi and Minuto, 2003). Although *C. coccodes* was previously reported to infect *L. hirsutum* rootstocks, it was never observed on *L. lycopersicum* x *L. hirsutum* hybrids, the most widely used rootstock for grafted tomatoes.
Grafted hybrids of *L. lycopersicum* x *L. hirsutum* (cvs Beaufort, He Man) and of *L. lycopersicum* (cv Energy) were found to be infected by *Phytophthora nicotiane* and *Rhizoctonia solani* accompanied by some plant stunting and rarely by leaf discoloration (Minuto *et al*., 2007).

Moreover in 2003 eggplants (cv Black Bell and Mirabell) grafted onto rootstock of *S. torvum* that confer a high degree of nematode tolerance, were found to exhibit symptoms of Verticillium wilt in several greenhouses in Sicily (Garibaldi *et al*., 2005)
Experiments conducted in open fields with heavy natural infection of *V. dahliae* (non grafted eggplant: 80-100% of infected plants) confirmed that *S. torvum* conferred only partial wilt resistance (30-50% of infected plants), while *L. lycopersicum* x *L. hirsutum* and *L. lycopersicum* hybrid rootstocks always showed low infection (7-10 % infected plants) (Minuto *et al*., 2007).

*Physiological disorders***:** in Northern Italy sudden collapsees were reported on protected and open field tomatoes (cv Cuore di Bue and cv Marmande-Raf) grafted on cvs He-Man and Energy (Garibaldi and Minuto, 2003). The plants wilt suddenly before or after fruit setting, particularly during spring and summer growing season with an incidence varying from 15% to 70 % or more. In Southern Italy sudden collapses were reported on cv Iride, Naomi, Cuore di Bue, and Marmande-Raf grafted on cvs He-Man, Energy and sometimes on Beaufort, without a direct relationship with the growing season or the phenological stage (Garibaldi and Minuto, 2003).
The collapse does not seem to be caused by plant pathogens, but is a direct consequence of incompatibility between scion and rootstock and, particularly in Northern Italy, is related to the climatic conditions during fruit setting and fruit ripening.
Eggplants grafted onto *L. lycopersicum* x *L. hirsutum* and *L. lycopersicum* hybrids may show graft incompatibility during all phases of the growing season and particularly when plants are transplanted in cold seasons (autumn, winter and early spring) and in not-heated greenhoses, resulting in plant dieback (Minuto *et al*., 2007).
Catara *et al*. (2001) found a widespread dieback of eggplant (cv Mission Bell), grafted onto the interspecific hybrid (cv Beaufort) and on tomato hybrid (cv Energy) in not-heated grenhouse. Dark brown to black lesions were observed just above the graft zone. Water-soaked, soft, dark green to brown lesions were observed on the upper stem. Extensive discoloration of vascular tissues and breakdown of the pith and stem hollowness was observed. Non grafted eggplant seedlings, grown in the same greenhouse, did not show any symptoms. From symptomatic tissues, numerous bacterial colonies were obtained, and were identified as *Pectobacterium carotovorum* subsp. *carotovorum* and *P. carotovorum* subsp. *atrosepticum* and confirmed to be pathogenic (Catara *et al*., 2001). Ginoux and Laterrot, (1991) recognized these same symptoms as a graft incompatibility enhanced by low temperature and heavy leaf guttation particularly in not-heated protected crops.
On the contrary *S. torvum* provides the best results as an eggplant rootstock during warm seasons, while in cold season and/or in not-heated greenhouses this rootstock may reduce plant vigour and never showing graft incompatibility. Since the wide scale large adoption of *S. torvum* for eggplant grafting, this type of plant dieback is no longer considered to be important.

Conclusion

The adoption of grafted plants is expected to rapidly increase in the near future. The advantages are still considered preponderant compared with the disadvantages. Nevertheless the cost of grafted plants is still the major constraint to their wide adoption together with large availability of skilled nurseries and the risks of unexpected plant dieback caused by biotic and/or abiotic factors.

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