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RESEARCH ARTICLE

Grafting affects yield and phenolic profile of *Solanum melongena* L. landraces

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Abstract

The influence of grafting on agronomical and qualitative characteristics of four Sicilian eggplant landraces was investigated. Grafted and ungrafted plants were compared in the open field in the northern coast of Sicily. *Solanum torvum* seedlings were used as rootstock. Regardless of genotypes tested, grafting significantly increased total fruit production, marketable production, and number of marketable fruits, but did not affect weight of marketable fruits and waste production. Landrace 2 (Sciacca), with black epidermal tissue and pyriform fruit shape, when grafted onto *S. torvum* not only gave a higher yield performance than ungrafted plants, but also showed a higher phenolic antioxidant content. Landrace 4 (Sicilia), with black epidermal tissue and small cylindrical fruits also benefited, when grafted onto *S. torvum*, from a substantial increase in antioxidant fruit content. As consumers' demand for fruits and vegetables rich in compounds important for human health is steadily increasing, these landrace/rootstock combinations should deserve more attention by plant nurseries involved in grafted seedling production and interested in the valorization and conservation of eggplant biodiversity.

Keywords: eggplant, propagation technique, yield, polyphenols, HPLC analysis

1. Introduction

Sicily, the largest Mediterranean island located in southern Italy, is a cultural and a commercial port and one important centre of origin and differentiation of vegetables (D'Anna and Sabatino 2013). During the centuries, the farmers obtained many genotypes for each species, adapting them to the pedoclimatic requirements, and maintained them as local populations and landraces. For this reason, it was estimated a presence of 2 650 taxa (Raimondo *et al.* 1992) in Sicily on an extension of 26 000 km^2. By selecting to local pedoclimatic requirements, farmers obtained a large intra- and inter-specific variability perfectly adapted to the local agricultural environments and displaying particular characteristics, including organoleptic ones (Schiavi *et al.* 1991). Modern breeding depends on the availability of genetic variability which was enlarged by the farmers along the times (Schippmann *et al.* 2002). Consumption of fruits and vegetables is associated with lower incidence and lower mortality rates of cancer in several human cohort and case-control studies (Steinmetz and Potter 1996), as well as with a decrease in blood pressure (Dauchet *et al.* 2009). The health protective effect of fruits and vegetables is attributed to various antioxidants they contain, especially vitamins and phenolic compounds (Kaur and Kapoor 2001).

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Solanum melongena L., commonly known as aubergine, eggplant, melanzana, garden egg, brinjal, and patlican, produces fruits widely consumed in various parts of the world. Cao *et al.* (1996) ranked eggplant amongst the top ten vegetables in term of oxygen radical absorbance capacity due to its phenolic compounds. More recently, Huang *et al.* (2004) reported the antioxidant activity of various vegetables including eggplant. Several studies have showed that the quantity and quality of phenolic compounds present in eggplant is significantly influenced by genotype (Stommel and Whitaker 2003; Raigon *et al.* 2008), environment and soil type (Savvas and Lenz 1996; Hanson *et al.* 2006), storage conditions (Concellon *et al.* 2004; Luthria and Mukhopadhyay 2006), cultivation systems (Singh *et al.* 2009; Todaro *et al.* 2009; Raigon *et al.* 2010).

Due to recent policy environmental regulations, vegetable grafting is considered a feasible alternative for control of soilborne pathogens. *Solanum torvum* Sw. is one of the recommended rootstocks for eggplant as it confers tolerance to a wide range of telluric pathogens (*Verticillium dahliae* Klebahn, *Ralstonia solanacearum* (Smith), *Fusarium oxysporum* (Schlechtend: Br) f. sp. *melongenae* Matuo and Ishigami, and *Meloidogyne* spp. root-knot nematodes) (Singh and Gopalakrishnan 1997; Bletsos *et al.* 2003; Daunay *et al.* 2008; King *et al.* 2010).

As the demand for eggplant grafted plug plants is growing rapidly, more research is being focused on the effects of the rootstock/scion combination on plant performance in terms of yield and fruit quality. According to Gisbert *et al.* (2011) and Moncada *et al.* (2013) grafting can also influence eggplant phenolic fruit content. However, these authors provided no information on the influence of grafting on individual phenolic concentrations. Maršič *et al.* (2014) report changes of a wide range of phenolics in the fruits of 3 commercial eggplant varieties and one landrace grafted on tomato rootstock. However, their results were inconsistent mostly due to changes in environmental trial conditions. The aim of this study is to evaluate the influence of grafting on agronomical and qualitative characteristics of four eggplant landraces cultivated in Sicily.

2. Results

Regardless of the landraces (Landrace Bianca L1, Sciacca L2, Marsala L3 and Sicilia L4) tested, grafting significantly increased total fruit production, marketable production, and number of marketable fruits (Table 1), but did not modify average weight of marketable fruits and waste production. The higher marketable production of grafted plants (6.6 kg m^{-2}) was obtained *via* a higher number of marketable fruits (19.1 fruits m^{-2}). When compared landraces, L1 was the most productive (9.4 kg m^{-2}) and L4 the least productive (5.0 kg m^{-2}) together with the highest waste production (18.2%). Landrace 2 had a good level of total production (7.9 kg m^{-2}) together with the lowest waste (7.9%) and did not significantly differ in terms of marketable production from L1 landrace. The number of marketable fruits per m^2 differed significantly among landraces, with the greatest number obtained for L4 (30.3) and the lowest for L3 (10.4); no significant differences were found between landraces 2 and 3 in terms of number of marketable fruits. Average marketable fruit weight was the highest for the round-shaped-fruits landraces L1 and L3 (676 and 624 g, respectively) and the lowest for the cylindrical L4 (166 g). No significant interaction was found between landraces (L) and grafting/ungrafting technique (T) in terms of fruit yields and characteristics.

The results of high performance liquid chromatography (HPLC) analysis of major polyphenols in fruit peel extracts for the four landraces grafted and ungrafted are presented in Table 2. Individual phenolic phytochemicals were grouped in: phenylamides (PhA), chlorogenic acid derivates (Cad) and other esters of quinic acids (Oeq). We found the following PhA: N-caffeoylputrescine, N-caffeoylputrescine derivatives and hydroxycinnamoyl amide.

Regardless of propagation technique, total PhA were significantly higher in L2 (9.89 μg mL^{-1}) than in L4 (4.40 μg mL^{-1}) and L3 (3.67 μg mL^{-1}) which in turn was significantly higher than in L1 (1.35 μg mL^{-1}). Total PhA content in

Table 1 Yield production of four landraces of eggplant grafted and ungrafted

		Total production (kg m^{-2})	Marketable production (kg m^{-2})	Number of marketable fruits m^{-2}	Weight marketable fruit (g)	Waste production (%)
Treatment	Ungrafted	6.7 b	5.8 b	16.1 b	502.6 NS	14.3 NS
	Grafted	7.7 a	6.6 a	19.1 a	487.5 NS	14.6 NS
Landrace[1)]	L1	9.4 a	8.0 a	14.1 bc	676.0 a	15.2 c
	L2	7.9 b	7.3 a	15.5 b	515.0 b	7.9 d
	L3	6.4 c	5.4 b	10.4 c	623.7 a	16.5 b
	L4	5.0 d	4.1 c	30.3 a	165.5 c	18.2 a
Interaction		NS	NS	NS	NS	NS

[1)] Landrace Bianca L1, Sciacca L2, Marsala L3 and Sicilia L4. The same as below.
In each column and for each fixed factor, values followed by same letters are not statistically different according to Duncan test ($P \leq 0.05$). Interactions are not significant (NS) at $P=0.05$.