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Interspecific hybrids of wild *Cucumis* species ('Fian' and 'Fimy'): new rootstocks for melon highly resistant to biotic soil stress

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Abstract

Two hybrids, 'UPV-FA' and 'UPV-FMy', hereinafter 'Fian' and 'Fimy', were obtained by crossing the wild *Cucumis* species *C. ficifolius* with *C. anguria* and *C. myriocarpus,* respectively. These species are known to be resistant to nematodes. The hybrids have been tested against the main melon soil borne and aerial fungal pathogens. Both were highly resistant to *Macrophomina phaseolina* and to *Fusarium oxysporum* f. sp. *melonis* (Fom) race 1.2 (wilting isolate), and moderately resistant to Fom 1.2 (yellowing isolate) and to *Monosporascus cannonballus.* 'Fimy' was highly resistant to powdery mildew races 2 and 5, and 'Fian' was highly and moderately resistant to these races, respectively. These hybrids were previously evaluated as rootstocks for melon in greenhouses and experimental fields with good results (adequate compatibility, growth development and production, and no negative impact on fruit quality). This behaviour has been now confirmed in commercial fields. The same grafting combinations were used: as scion the muskmelon cv. 'Vendrantais', a Charentais type, and the cv. 'Finura', a Piel de Sapo type, and as rootstocks 'Fian', 'Fimy' and two commercial rootstocks 'Cobalt' (*Cucumis maxima* x *Cucumis moschata*) and '64-376' (*Cucumis melo*). As in previous assays, fruit from plants grafted onto 'Cobalt' yielded larger fruits, with wider seminal cavities. In fruit harvested from plants grafted onto 'Fian', 'Fimy' or onto the other *Cucumis* rootstock some mild differences that do not affect the market quality of fruit were found. All these results confirm the suitability of both hybrids as rootstocks for melon: they show good grafting performance, with reduced impact on fruit quality compared to *Cucurbita* rootstocks, and better resistance to the fungal pathogens that limit melon production worldwide.

Keywords: *C. ficifolius*, *C. anguria*, Piel de sapo, Charentais, grafting.

INTRODUCTION

Grafting plants onto resistant rootstocks is used worldwide to cope with biotic and abiotic stresses, such as soil-borne diseases, drought, salinity, and extreme temperatures. The most common rootstocks used for Cucurbitaceae crops, are the interspecific hybrids *Cucurbita maxima* Duchesne x *Cucurbita moschata* Duchesne (Davis et al., 2008) due to their good emergence performance (with long and thick hypocotyls that facilitate grafting) and their tolerance to biotic and abiotic stresses. Cucurbita hybrids have, however, some important shortcomings: they are not resistant to nematodes (Cohen et al., 2014; Ozarslandan et al., 2011); their excess of vigour cause sometimes a delay in scion flowering and fruit ripening (Soteriou et al., 2016), and often, cause negative impacts on fruit quality (Leonardi et al., 2017). In melon (*Cucumis melo* L.), an increase of fruit size and seed cavity (Verzera et al., 2014) or modifications of flesh firmness (Colla et al., 2006; Zhao et al., 2011) as a result of grafting have been described. Vitrescence (Jang et al., 2014), flesh colour variations, and

changes in pH and soluble solids content have also been reported (Colla et al., 2006; Verzera et al., 2014).

We obtained two new interspecific *Cucumis* hybrids: 'UPV-FA' (*C. ficifolius* x *C. anguria*) and 'UPV-FMy' (*C. ficifolius* x *C. myriocarpus*) (Cáceres et al., 2017) herein after, 'Fian' and 'Fimy' with good characteristics to be used as melon rootstocks (Cáceres et al., 2017). Both were highly resistant to *Macrophomina phaseolina* and to *Fusarium oxysporum* f. sp. *melonis* (*Fom*) race 1.2 W (wilting pathotype), and moderately resistant to *Fom* 1.2 Y (yellowing pathotype) and to *Monosporascus cannonballus.* 'Fimy' was highly resistant to powdery mildew races 2 and 5, and 'Fian' was highly and moderately resistant to these races, respectively. These hybrids were previously evaluated as rootstocks for melon in greenhouses and experimental fields with good results (adequate compatibility, growth development and production, and no negative impact on fruit quality). The aim of this work was to confirm their *Fusarium oxysporum* resistance and evaluate their performance under commercial field conditions.

MATERIALS AND METHODS

Plant material: As rootstocks. 'Fian' and 'Fimy' and the commercial rootstocks 'Cobalt' (*C. maxima* x *C. moschata*) and '64-376' (*C. melo*) were used. The cvs. Finura (Piel de Sapo) and cv. Vedrantais (Charentais) were used as scions. Plants were grafted in a commercial nursery using the cleft procedure and were transplanted to soil in a field for commercial production of Valencia.

Inoculations: Plants of 'Fian' and 'Fimy' were artificially inoculated with both conidial suspension of 3 x 10^6 cel/mL of *Fom*1.2 W and *Fom*1.2 Y isolates. Inoculation was carried out by 2 min of root immersion of plantlets at two expanded cotyledons stage (12 plants per accession). They were taken to the growth chamber for 30 days at 26 °C. Response of plants was evaluated at 7, 14, 21 and 28 dpi, measuring the degree of symptomatology of the seedlings. A visual scale from 1 to 4 was employed: 1= no disease; 2= stunting and leaf damages up to 50%; 3= plant yellowing and wilt, root damages; 4= dead plant. Plant score as 1 was considered to be highly resistant, between 1 and 2 were considered resistant and those with scores higher than 2 were considered susceptible. 'Charentais T' was used as susceptible control to both *Fom*1.2 pathotypes. Dead plants were collected to be taken to the laboratory and processed, to check the cause of death and fulfill Koch's postulates.

Quality analysis: Marketable fruit were collected and analysed for fruit quality parameters (Table 1) as described in Cáceres et al. (2017).

RESULTS AND DISCUSSION

'Fian' and 'Fimy' were resistant and highly resistant to Fom1.2 W, respectively (1.4 ± 1.1 for 'Fian' and 1 ± 0.0 for 'Fimy') (Fig. 1). Also, when 'Fian' and 'Fimy' were tested against *Fom*1.2 Y, both hybrids were evaluated as resistant with values of 2.0 ± 1.5 and 1.9 ± 1.4, respectively. As expected, the susceptible genotype 'Charentais T' behaved as susceptible to *Fom*1.2 W and *Fom*1.2 Y.

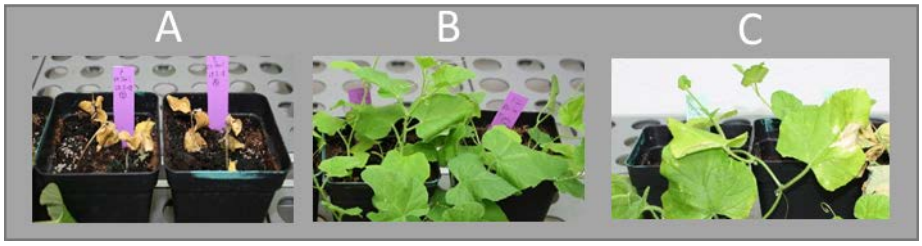

Figure 1. Plants of A) 'Charentais T', B) 'Fimy', C) 'Fian' inoculated with *Fom*1.2 W isolate after 28 days of inoculation.

Data of fruit quality are shown in Table 1. Regarding fruit quality of 'Finura' (Piel de Sapo), larger fruits were found when the *Cucurbita* hybrid 'Cobalt' was used as rootstock. These fruits also displayed wider seed cavities in comparison with fruit from ungrafted plants, as reported in other works that used Cucurbita hybrids (Verzera et al., 2014. This effect also occurred in fruit collected from the two new wild *Cucumis* rootstocks. The commercial melon rootstock '64-376' did not caused more impact than a firmer flesh.

Similarly, larger fruits of 'Vedrantais' with wider seed cavities were observed in plants grafted onto 'Cobalt'. The cantaloupe scion was more affected by the Cucurbita rootstock than the Piel de sapo scion, since fruits with thicker, but softer rind were produced. The effects of the *Cucumis* rootstocks onto the 'Vedrantais' fruits were also less important. Despite all rootstocks significantly reduced Brix degree of 'Vedrantais' fruits, they were still sweet enough for commercial purposes.

Table 1. Quality traits of melon fruit cv. 'Finura' (Piel de Sapo) and cv. 'Vedrantais' (Charentais) harvested from ungrafted and plants grafted onto Cobalt (*C. maxima* x *C. moschata*); '64-376' (*C. melo*); 'Fian' (*C. ficifolius* x *C. anguria*) and 'Fimy' (*C. ficifolius* x *C. myriocarpus*); NG: non-grafted.

Scion	**'Finura'**				
Trait/Rootstock	**NG**	**'Cobalt'**	**'64-376'**	**'Fian'**	**'Fimy'**
Fruit weight (g)	2174.00a	2490.28b	2151.40a	2264.82ab	2154.77a
Fruit length (cm)	21.15ab	21.77b	20.78a	21.42ab	20.61a
Fruit width (cm)	14.55a	14.76a	15.6b	14.92ab	14.96ab
Rind thickness (mm)	4.72a	4.90a	4.61a	4.66a	4.58a
Flesh thickness (mm)	37.15a	37.59a	36.23a	44.26a	35.19a
Cavity width (mm)	59.14a	68.82b	63.19ab	65.97b	66.47b
Rind firmness	13	13	13	13	13
Flesh firmness	2.78ab	2.62a	3.15c	2.58a	2.97bc
Total Soluble solids (ºBrix)	14.88ab	14.80ab	14.41a	15.39b	14.81ab
pH	5.92a	5.90a	5.94a	5.95a	5.96a
Hunter L	62.60a	63.30a	63.61a	64.00a	64.21a
Hunter a	-2.62a	-2.48ab	-2.44ab	-2.14b	-2,66a
Hunter b	9.43a	8.98a	9.18a	9.14a	9.62a
Scion	**'Vedrantais'**				
Trait/Rootstock	**NG**	**'Cobalt'**	**'64-376'**	**'Fian'**	**'Fimy'**
Fruit weight (g)	646.10a	743.80b	682.83ab	645.8a	625.40a
Fruit lenght (cm)	9.88a	10.13a	10.07a	10.19a	10.00a
Fruit width (cm)	11.00a	11.67a	11.16a	10.86a	10.87a
Rind thickness (mm)	2.99a	2.99a	3.07a	3.07a	2.99a
Flesh thickness (mm)	25.54a	26.88b	26.71b	25.44ab	25.68ab
Cavity width (mm)	50.73a	54.58b	48.96a	49.11a	48.56a
Rind firmness	12.26b	11.18a	12.36b	12.70b	12.60b
Flesh firmness	1.95a	1.93a	1.65a	1.68a	1.90a

Total Soluble solids (ºBrix)	14.44 b	13.77a	13.45a	13.59a	13.41a
pH	6.11a	5.92a	6.16a	6.13a	6.14a
Hunter L	56.58bc	56.96c	54.71ab	55.60abc	54.37a
Hunter a	11.88a	12.24a	11.75a	12.00a	12.12a
Hunter b	24.46abc	24.92c	23.60a	24.55bc	23.81ab

CONCLUSION

The results obtained in this assay confirm those obtained previously in experimental fields and the suitability of both hybrids 'Fian' and 'Fimy' as rootstocks for melon. In comparison to *Cucurbita* and *Cucumis* commercial rootstocks, a reduced impact on fruit quality and better resistance to fungal pathogens were found in the new wild *Cucumis* hybrids.

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