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Short Communication

Rootstocks resistant to *Meloidogyne incognita* and compatibility of grafting in net melon

Francine de Souza Galatti[1], Alexandre Junqueira Franco[1], Letícia Akemi Ito[2], Hamilton de Oliveira Charlo[3], Lucas Aparecido Gaion[1], Leila Trevisan Braz[4]

ABSTRACT

Due to the few studies about grafting in net melon, in order to obtain better control of soil pathogens, the aim of the present study was to evaluate 16 genotypes of Cucurbitaceae: *Benincasa hispida*, *Luffa cylindrica*, pumpkin 'Jacarezinho', pumpkin 'Menina Brasileira', squash 'Exposição', squash 'Coroa', pumpkin 'Canhão Seca', pumpkin 'Squash', pumpkin 'Enrrugado Verde', pumpkin 'Mini Paulista', pumpkin 'Goianinha', watermelon 'Charleston Gray', melon 'Rendondo Gaucho', melon 'Redondo Amarelo', cucumber 'Caipira HS' and cucumber 'Caipira Rubi', regarding to compatibility of grafting in net melon and resistance to *Meloidogyne incognita*, based on the reproduction factor (RF), according to Oostenbrink (1966). To assess resistance, the seedlings were transplanted to ceramic pots and inoculated with 300/mL eggs and/or second stage juveniles of *M. incognita*. At 50 days after transplanting, the plants were removed from the pots and the resistance was evaluated. The compatibility between resistant rootstock and grafts of net melon was determined by performing simple cleft grafting, in a commercial net melon hybrid of great market acceptance and susceptible to *M. incognita* (Bonus no. 2). The genotypes *Luffa cylindrica*, pumpkin 'Goianinha', pumpkin 'Mini-Paulista', melon 'Redondo Amarelo', watermelon 'Charleston Gray' are resistant to the nematode *M. incognita*. The better compatibilities occurred with the rootstocks melon 'Amarelo', which presented 100% of success, followed by pumpkin 'Mini-Paulista' with 94%. On the other hand, Sponge gourd, watermelon 'Charleston Gray' and pumpkin 'Goianinha' showed low graft take percentages of 66%, 62% and 50%, respectively.

Key words: *Cucumis melo* var. *reticulatus*, plant diseases, cucurbitaceae, nematode.

RESUMO

Porta-enxertos resistentes a *Meloidogyne incognita* e compatibilidade de enxertia de melão rendilhado

Devido aos poucos estudos realizados com enxertias em melão rendilhado, visando um maior controle de patógenos do solo, este trabalho teve por objetivo avaliar 16 genótipos de cucurbitáceas quanto à resistência a *Meloidogyne incognita* e a compatibilidade da enxertia do melão rendilhado. Foram avaliados 16 acessos de cucurbitáceas: Benincasa hispida, Bucha, Abóbora 'Jacarezinho', Abóbora 'Menina Brasileira', Moranga 'Exposição', Moranga 'Coroa', Abóbora 'Canhão Seca', Abóbora 'Squash', Mogango 'Enrrugado Verde', Abóbora 'Mini Paulista', Abóbora 'Goianinha', Melancia 'Charleston Gray', Melão 'Rendondo Gaúcho', Melão 'Redondo Amarelo', Pepino 'Caipira HS' e Pepino

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‘Caipira Rubi’, quanto à resistência ao nematóide *M. incognita*, com base no fator de reprodução (FR), segundo Oostenbrink (1966). Para avaliação da resistência, as mudas foram transplantadas para vasos de cerâmica e foram aplicados 300 ovos ou juvenis de segundo estádio/mL de *M. incognita*, num total de 10 mL por vaso. Aos 50 dias após o transplantio, as plantas foram removidas dos vasos e realizou-se a avaliação da resistência. Para a compatibilidade entre os porta-enxertos resistentes e enxerto de melão rendilhado, foram realizadas enxertias do tipo garfagem fenda simples, em híbrido comercial de melão rendilhado de grande aceitação comercial e suscetíveil a *M. incognita* (Bônus N° 2). Os genótipos Bucha, Abóbora ‘Goianinha’, Abóbora ‘Mini-Paulista’, Melão ‘Redondo Amarelo’, Melancia ‘Charleston Gray’, foram resistentes ao nematóide *M. incognita*. As melhores compatibilidades ocorreram com os porta-enxertos Melão ‘Amarelo’, o qual teve 100% de pegamento, seguido da Abóbora ‘Mini-Paulista’ com 94%. Já Bucha, Melancia ‘Charleston Gray’ e Abóbora ‘Goianinha’, tiveram baixas porcentagens de pegamento: 66%, 62% e 50% respectivamente.

Palavras-chave: *Cucumis melo* var. *reticulatus*, doenças de plantas, cucurbitáceas, nematóides.

INTRODUCTION

The net melon (*Cucumis melo* var. *reticulatus* Naud.) belongs to the botanical group *Cantalupensis* of the Cucurbitacea family, and it is characterized by the netting on the husk, round to oval shape and color of pulp varying between clear green and salmon (Rizzo & Braz, 2001). Unlike the others on the market, due to its appearance, aroma and higher level of soluble solids, this melon shows competitive advantages compared to other varieties, because it has a good market value and allows production in small areas with good yield (Factor *et al.*, 2000).

Besides, light and relative humidity, temperature is the main climatic factor that affects melon crops, from the germination of the seeds, up to the final quality of the product (Costa *et al.*, 2002), and for these conditions to be better controlled and to increase production, it is recommended to grow melons in a greenhouse.

According to Peil (2003), intensive growing of vegetables in greenhouse has caused serious problems with infestation by soil pathogens, such as root-knot nematodes, and salinization, which are increasingly difficult to be solved by traditional control methods. Therefore, grafting has become an alternative of necessary cultivation in contaminated areas, to prevent contact of the sensitive plant with the pathogenic agent.

Another problem which has limited the production of net melon under protected conditions is the incidence of nematodes of *Meloidogyne* group, which cause disruption of roots’s cells resulting in galls and yellowing of leaves, leaves reduction, poor fruit quality and decrease of production. The gall nematodes also interact with bacteria and fungi causing complex diseases (Zitter *et al*, 1996). According to these authors, the environmentally safe and economic method of control is the use of resistant plants. *Cucumis metuliferus* is highly resistant to *M. hapla*, *M. incognita*, *M. javanica* and *M. arenaria*, but the development of hybrids with *Cucumis* spp has failed. Resistance to *M. incognita* and *M. arenaria* was identified in *Cucumis anguria* and others wild cucurbits.

Grafting of melons is little known and used in Brazil, due to the existence of not contaminated areas, but it is a technology utilized in many parts of the world, with the purpose of overcoming these problems (Martínez-Ballesta *et al.*, 2010).

Grafting is a very effective practice for controling diseases caused by soil pathogens such as nematodes; this technique requires specialized procedures, high costs and longer times for seedlings to reach an ideal stage for transplanting. However, according to Goto *et al.* (2003), the cost-benefit ratio can make this technique feasible, and even reduce very high costs.

Therefore, the aim of the present study was to evaluate 16 genotypes of Cucurbitaceae regarding to resistance to *Meloidogyne incognita* and grafting compatibility of resistant rootstocks with net melon.

MATERIAL AND METHODS

The experiments were carried out in a greenhouse at the School of Agricultural and Veterinary Sciences (FCAV-UNESP), Campus Jaboticabal.

Sixteen genotypes of Cucurbitaceae were evaluated: *Benincasa hispida*, *Luffa cylindrica*, pumpkin ‘Jacarezinho’, pumpkin ‘Menina Brasileira’, squash ‘Exposição’, squash ‘Coroa’, pumpkin ‘Canhão Seca’, pumpkin ‘Squash’, pumpkin ‘Enrrugado Verde’, pumpkin ‘Mini Paulista’, pumpkin ‘Goianinha’, watermelon ‘Charleston Gray’, melon ‘Redondo Gaucho’, melon ‘Redondo Amarelo’, cucumber ‘Caipira HS’ and cucumber ‘Caipira Rubi’ with regard to resistance to the nematode *Meloidogyne incognita*.

The seedlings were obtained by first seeding in Styrofoam trays, and 15 days after sowing, the seedlings were transplanted to pots. On the day of transplanting, 10 individual seedlings of each genotype were inoculated with eggs and/or second-stage juveniles of *M. incognita*, which consisted of the replicates. Inoculation was performed using a 10-mL graduated pipette to transfer the suspension of 300 eggs and/or second-stage juveniles / mL, henceforth referred to as the initial population (IP).

At 50 days after transplanting, the seedlings were removed from the pots, the aerial part discarded and the roots washed for the determination of the reproduction factor.

The resistance of the materials was defined based on the reproduction of the nematode in each genotype, in accordance with the concept of Roberts *et al.* (1998), where the resistance of a plant to a nematode is measured by the ability of the plant to suppress the development or reproduction of the pest. Thus, evaluation of the genotypes resistance to *M. incognita* was evaluated according to the reproduction factor (RF), as described by Oostenbrink (1966).

The population obtained for each root system, designated the final population (FP), was divided by the number of eggs and juveniles according to the stage injected into the plants (IP), where the mean reproduction factor (RF) values are determined for each genotype. Genotypes were considered resistant if they showed an RF<1. All genotypes that exhibited an RF>1 were considered susceptible.

The Cucurbitaceae genotypes that were resistant to *M. incognita* were utilized as rootstocks for the net melon 'Bonus no. 2'.

Cleft grafting was used as described by Yamakawa (1982), because according to Choe (1989), cleft grafting can promote to the seedlings a graft take rate of up to 93%. After grafting, the seedlings were placed in a humid room until local healing, when the percentage of graft take was evaluated.

RESULTS

Based on the reproduction factor (Table 1), only 25% of the treatments were shown to be resistant. The genotypes *Luffa cylindrica*, pumpkin 'Goianinha', pumpkin 'Mini Paulista', melon 'Redondo Amarelo' and watermelon 'Charleston Gray' showed a reproduction factor (FR) <1, being 0.67, 0.59, 0.32, 0.34 and 0.24, respectively, thereby allowing them to be considered resistant to *M. incognita*.

All the other genotypes evaluated, such as the hybrid Bonus no.2, showed a reproduction factor >1, being considered susceptible to *M. incognita.* Cucumber 'Rubi' showed the highest reproduction factor of 6.26, followed by the squash Coroa with 5.12.

Among the rootstocks considered resistant, grafting compatibility between them and the scion (melon 'Bonus no. 2') can be seen in Figure 1, where melon 'Redondo Amarelo' showed the highest graft take rate, at 100%.

After melon 'Redondo Amarelo', the pumpkin 'Mini-Paulista' had a graft take percentage of 94%, also showing good compatibility between scion and rootstock. Therefore, these two rootstocks appear to be very compatible with netmelon 'Bonus no. 2'.

The rootstocks Sponge gourd, watermelon 'Charleston Gray' and pumpkin 'Goianinha' had low graft take percentages: 66%, 62% and 50%, respectively, showing that, despite being resistant to *M. incognita*, they would not be so interesting for use as rootstocks.

DISCUSSION

There are numerous studies with rootstocks aimed to achieving resistance to *M. incognita*. Despite the large diversity among the Cucurbitaceae family, which include 118 genera and 825 species, only 23 species are cultivated as vegetables in many regions of the world (Almeida, 2002). Thus, it is difficult to compare studies that utilize the same species as possible rootstocks.

Singuenza *et al.* (2005) demonstrated the possibility of using *Cucumis metuliferus* as rootstock for melon in the control of *M. incognita*. Xingfang *et al.* (2006) used *Sicyos angulatus* L. as rootstock for cucumber in soils with *M. incognita*, observing little effect on the height of the plant and taste of fruits. Chandra *et al.* (2010) evaluated the pathogenic potential of *M. incoginta* in four species of Cucurbitaceae: *Lagenaria siceraria*, *Cucumis sativus*, *Momordica charantia* and *Cucurbita pepo*, and all were highly or moderately susceptible to the phytonematode, which limited the water and nutrients translocation in the plant.

Santos *et al.* (1999), working with another variable of resistance to nematodes in which grades were attributed based on the presence or absence of galls, evaluated 54 experimental genotypes of melon regarding to *M. incognita* resistance and only two of them were considered resistant, while the others were considered moderately resistant, susceptible and highly susceptible. In the present study, the melon 'Redondo Amarelo' was considered resistant, however, differently from observed by Santos *et al.* (1999) this melon is commercial and not a genotype in study.

In the present study, it was not possible to count galls, since the roots showed high infestation and the galls were almost invisible to naked eyes, making it difficult to count them. Therefore, the parameter used was the reproduction factor described by Oostenbrink (1966).

Table 1. Results of the resistance and susceptibility of 16 Cucurbitaceae rootstocks to the nematode *Meloidogyne incognita*

Treatment	FP	IP	RF	Result
Pumpkin ‘Enrugado Verde’	9820	3000	3.27	Susceptible
Cucumber ‘Rubi’	18770	3000	6.26	Susceptible
Pumpkin ‘Nova Caravela’	4000	3000	1.33	Susceptible
Squash ‘Exposição’	4770	3000	1.59	Susceptible
Squash ‘Coroa’	15360	3000	5.12	Susceptible
Pumpkin ‘Squash’	4760	3000	1.59	Susceptible
Pumpkin ‘Canhão Seca’	4610	3000	1.54	Susceptible
Pumpkin ‘Menina brasileira’	7940	3000	2.65	Susceptible
Luffa cylindrica	2000	3000	0.67	Resistant
Pumpkin ‘Goianinha’	1760	3000	0.59	Resistant
Melon ‘Redondo Gaucho’	5910	3000	1.97	Susceptible
Pumpkin ‘Mini-paulista’	970	3000	0.32	Resistant
Benincasa hispida	3200	3000	1.07	Susceptible
Melon ‘Redondo Amarelo’	1020	3000	0.34	Resistant
Watermelon ‘Charleston Gray’	706	3000	0.24	Resistant
Melon ‘Bonus no. 2’	5470	3000	1.82	Susceptible

FP: Final population; IP: Initial Population; RP: Reproduction factor.

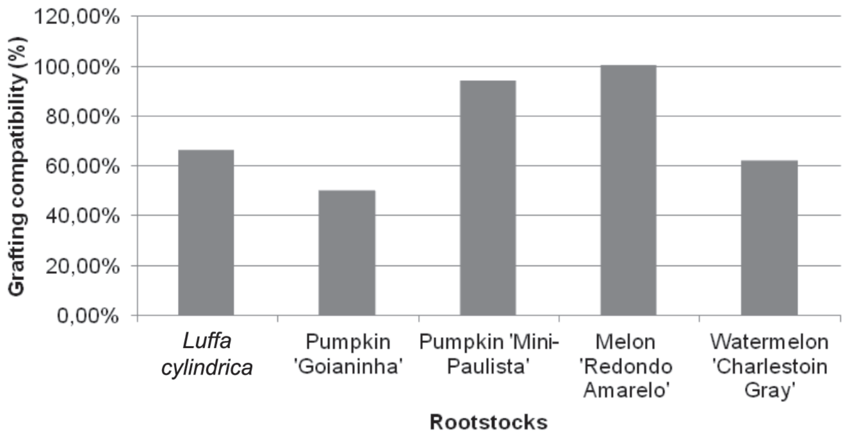

Figure 1. Grafting compatibility between rootstocks considered resistant and the net melon ‘Bonus no. 2’.

The eradication of the gall nematode from infested areas is extremely difficult, and the most efficient control measures are the preventive ones, thus, the utilization of resistant rootstocks would be a short-term solution in the control of phytonematodes in infested soils.

According to Gonzáles (1999), compatibility is defined as the capacity of two different plants, united by grafting, to live together as a single plant. We observed that among the rootstocks studied with regard to compatibility, melon ‘Redondo Amarelo’ showed practically 100% of graft take, showing good botanical affinity between the rootstock and scion.

Similarly to the findings of Ito *et al.* (2009), the pumpkin ‘Mini-paulista’ showed about 90% of graft take, which can be explained by the fact that good botanical affinity displayed by the species belonging to the Cucurbitaceae family is related to the continuity of the cambium, since this continuity is crucial for grafting success.

Watermelon ‘Charleston Gray’ and Sponge gourd showed practically the same performance with about 60 and 65% of graft take, respectively. Rizzo *et al*. (2000), utilizing the open cleft grafting method, also obtained similar results for Sponge gourd, demonstrating that this rootstock is not so interesting compared to the two rootstocks above mentioned.

Unlike that observed by Ito *et al.* (2009) and similar to the results obtained by Rizzo *et al*. (2000), pumpkin ‘Goianinha’ had the smallest percentage of graft take, with approximately 50%, demonstrating little compatibility with Bonus no. 2. This low graft take rate can be explained by the difference on growth between rootstock and scion, which were planted on the same day: the pumpkin had a more vigorous growth compared to ‘Bonus no. 2’.

Therefore, it can be seen that the level of compatibility between scion and rootstock determines the success or failure of the grafting, not considering factors such as temperature and relative humidity during and after grafting, as well as contact surface and salinity, which could have a negative influence on wound healing (callus formation). Poor wound healing can result in reduction of leaves, slow growth and low survival rate of seedlings (Oda *et al.*, 2005; Johkan *et al.*, 2009).

Thus, the movement of water and translocation of nutrients can be determined by the vascular connection or continuity of the cambium between scion and rootstock, thereby affecting other physiological characteristics.

CONCLUSIONS

The genotypes Sponge gourd, pumpkin 'Goianinha', pumpkin 'Mini-Paulista', melon 'Redondo Amarelo' and watermelon 'Charleston Gray' are resistant to the nematode *M. incognita*. The better compatibilities occurred with the rootstocks melon 'Redondo Amarelo', which had a 100% of graft take, followed by the pumpkin 'Mini-Paulista' with 94%. The rootstocks *Luffa cylindrica*, watermelon 'Charleston Gray' and pumpkin 'Goianinha' had low graft take percentages of 66%, 62% and 50%, respectively.

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