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YIELD AND FRUIT QUALITY OF TOMATO GRAFTED ONTO ROOTSTOCKS PARTIALLY RESISTANT TO ROOT-KNOT NEMATODES IN A NATURALLY INFESTED GREENHOUSE

Isabel Mourão* [1], Carlos G. Sá[2], Luísa Moura[3], L Miguel Brito[1], M Clara V. Santos[4], Sofia R. Costa[4]

[1]CIMO - Mountain Research Centre, Escola Superior Agrária, Instituto Politécnico de Viana do Castelo (ESA/IPVC), [2]ESA/IPVC, Ponte de Lima, Portugal, [3]CISAS - Centre for Research and Development in Agrifood Systems and Sustainability, ESA/IPVC, Ponte de Lima, [4]CBMA - Centre of Molecular and Environmental Biology, University of Minho, Braga, Portugal

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Abstract: Root-knot-nematodes (RKN), *Meloidogyne* spp., are major soilborne diseases in protected tomato production and grafting with resistant or partially resistant rootstocks has been showing promising results. The experiment was carried out in a sandy soil greenhouse in the Littoral NW Portugal. Tomato cv. Anairis was grafted onto rootstocks Embajador, Emperador, Multifort and Silex, with non-grafted and self-grafted plants used as controls, in an experimental design of 6 treatments in three randomized blocks, to evaluate the effects on yield and fruit quality. Soil samples were collected at planting and at the end of the trial to estimate soil populations of RKN. At the end of the trial, plants were uprooted to evaluate the numbers of galls, egg masses and female fecundity. The potential benefits of increased yield by plant grafting have not been revealed. However, plants grafted onto any of the tested rootstocks suffered significantly less nematode damage, which are in agreement with previous findings in organic and transitional fields when soil RKN pressure was low. As tomato production in organic greenhouses can be affected by RKN due to relatively short rotations, grafting with appropriate rootstocks may play an effective role in RKN management when high populations of nematodes are present.

Introduction: Root-knot-nematodes (RKN), *Meloidogyne* spp., are major soilborne diseases in protected tomato production and grafting with resistant or partially resistant rootstocks has been showing promising results. In fact, vegetable grafting is an increasingly used crop management strategy aiming to prevent soilborne biotic and abiotic stresses and safely adapted for organic crop protection (Hasna et al., 2009).

Several rootstock cultivars, described by seed companies as having intermediate resistance to RKN, are available for tomato and, in a previous study (unpublished data) we assessed the host reaction of 11 different tomato rootstock cultivars to *M. incognita* in controlled conditions. From these trials, we identified rootstock cultivars that significantly reduced RKN root galling and egg mass production compared to a susceptible control. Although these rootstocks did not

all prevent nematode reproduction, they generally suffered less damage (root galling) from RKN, and so we hypothesize that they could be used to successfully improve tomato yield in RKN-infested greenhouses. In order to assess this, we evaluated the effects of grafting tomato plants onto rootstocks Embajador (EM), Emperador (EP), Multifort (MU) and Silex (SI) on yield and fruit quality, in a greenhouse reportedly infested with RKN.

Material and methods: The experiment was carried out in a sandy soil greenhouse at a major fresh market tomato-producing region in Portugal, the Littoral North. Tomato cv. Anairis was grafted onto rootstocks EM, EP, MU or SI with non-grafted (A) and self-grafted (AA) plants used as controls, in an experimental design of 6 treatments in three randomized blocks. Grafted plants were pruned to two stems, the controls were pruned to one stem and planted in double to maintain a stem density of 3.0 stems m^{-2} throughout. The soil was covered with black polyethylene film in the plant lines.

A total of 20 harvests, twice a week, were performed on three plants for each replicate of all treatments, from 75 to 141 days after planting. The number of fruits and the fresh weight were recorded for each fruit grade. The dry matter, firmness, pH, total soluble solids content and titratable acidity were evaluated through UE Standard Norms for four harvests during the harvesting period.

The mean daily air temperature throughout the growing period was 19.8°C (range 13.9-27.3°C). The mean daily soil temperature under the film cover was 21.0ºC (range 16.4-26.4°C). Composite soil samples were collected from each treatment plot at planting and at the end of the trial, and mobile nematodes were extracted to provide estimates of initial and final soil populations of RKN. At the end of the trial, the three plants were uprooted, roots were washed free of soil, cut into small pieces and a 3 g sample was taken from each root. Numbers of galls and egg masses were recorded in each root sample, and eggs were extracted using sodium hypochlorite and counted to determine female fecundity. Nematodes were identified as *M. incognita* through esterase phenotyping after polyacrylamide gel electrophoresis of female macerates. Data were analysed with SPSS Statistics v22, with a $p = 0.05$ threshold.

Results: Harvest in the non-grafted plants started about one week earlier than in the grafted plants and two days before the self-grafted plants. The total number of fruits and yield were identical for all treatments, on average 14.8 kg m^{-2} and 61.4 fruits m^{-2}.

Compared to non-grafted plants, the different rootstocks showed different responses for fruit grades and quality parameters. Generally, the non-grafted plants had higher fresh weight percentage of smaller fruits (≤ 66 mm) compared to plants grafted onto EP, MU and SI rootstocks, higher percentage of fruits grade 67-102 mm than EM rootstock, but similar with all the other treatments and lower percentage of larger fruits (>102 mm) compared to plants grafted onto EM and SI rootstocks. Fruit dry matter was identical in control treatments A and AA (mean 5.5%) and higher ($p<0.05$) than that of the rootstock treatments (mean 4.7%). Fruit firmness was similar for all treatments, but fruits of non-grafted plants were sweeter (4.8ºBrix) than fruits from plants grafted onto EM and SI (mean 4.2ºBrix) and less acidic than fruits from plants grafted onto EP ($p<0.05$), with no significant differences of the pH between fruits of all treatments.

The initial population of 0.25 RKN juveniles ml $soil^{-1}$ was identical in all plots, and increased to a grand mean of 8.4 juveniles ml $soil^{-1}$ by the end of the trial. With a mean of over 80 galls g $root^{-1}$, plants in the control treatments suffered significantly more root damage than those in any of the rootstock treatments, that had similar numbers of galls among them (mean 40 galls g $root^{-1}$). More egg masses were also produced in roots from the control than in grafted treatments ($p<0.05$), but female fecundity was significantly higher in grafted plants: with an estimate of 282 eggs per egg mass, EM provided the largest female fecundity ($p<0.05$), and all rootstock treatments led to significantly larger fecundity than

control treatments (under 90 eggs per egg mass). Final numbers of juveniles in soil were expectedly largest in the EM treatment (13.3 ml soil^{-1}), but smaller in MU (6.2 ml soil^{-1}) than in all other rootstock treatments ($p<0.05$).

Discussion: Beyond the possibility of better managing soilborne diseases and the improvement of abiotic stress tolerance, vegetable grafting can also be used to improve fruit quality. However, results found in the literature were very variable as quality parameters depend largely on grafting combinations as well as on the interaction of genetic, climatic and cultural factors (Leonardi et al., 2017). Thus, selection of an appropriate rootstock for a given scion is important not only for optimal yield but also for fruit quality.

In the present study, the potential benefits of increased yield by plant grafting have not been revealed. However, plants grafted onto any of the tested rootstocks suffered significantly less nematode damage than the non-grafted or self-grafted plants. These results are in agreement with previous findings that report similar marketable yield and smaller gall numbers in tomato rootstocks MU and Survivor than in non-grafted plants in organic and transitional fields when soil RKN pressure was low (Barrett et al., 2012).

Here, the higher fecundity in rootstocks compensated the larger numbers of egg masses produced in non-grafted and self-grafted plants, resulting in similar or larger RKN populations developing in the greenhouse that could pose a threat to subsequent crops.

Organic practices as crop diversity show good nematode strategy control as during the transition period to organic, non-grafted tomato plants following a cover crop regime had significantly lower levels of root galling from RKN infection compared to plants in a continuous tomato monoculture (Chellemi et al., 2013). Similarly, van Bruggen et al. (2016), referred that tomato production in organic greenhouses can be severely affected by RKN due to relatively short rotations. Thus, grafting with appropriate rootstocks may play an effective role in RKN management when high populations of nematodes are present and organic production also presents an important contribute to manage this soilborne pathogen.

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Disclosure of Interest: None Declared

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