MORPHOPHYSIOLOGICAL STAGE IDEAL FOR GRAFTING IN NET MELON 'BONUS N° 2'

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SUMMARY: The intense cultivation of the melons in greenhouses has caused the rise of serious problems involved with soil pathogens, making it necessary to use grafting as an alternative in crop management in this environment. The objective of the present study was to determine the ideal morphophysiological stage of melon plants 'Bonus No. 2' for grafting by the closed cleft method, utilizing as rootstock the pumpkin hybrid 'Shelper', and to see if it affects take rate and productivity and quality of the fruits. A completely randomized block design was used with five treatments and five repetitions, where each plot comprised eight plants. The treatments consisted of four different stages of development of the seedlings of net melon (scion): developed cotyledonary leaves; first leaf in development; second leaf in development; and two developed leaves. Non-grafted plants served as the control. The non-grafted plants showed better values for rind netting, rind thickness and soluble solids. When compared to the graft treatments, there was no significant difference regarding the characteristics evaluated. If there is a need for grafting because of soil pathogens and salinity, the utilization of scions with the first leaf in development is recommended since they show better values for rind yield and soluble solids at an early morphophysiological stage.

Keywords: *Cucumis melo* var. *Reticulatus* Naud. Closed cleft. rootstock. Greenhouse cultivation. Seedlings.

RESUMO: O cultivo intensivo do meloeiro em ambiente protegido tem causado o surgimento de sérios problemas relacionados à patógenos de solo, tornando necessário o emprego da enxertia como alternativa de manejo nesse ambiente. O objetivo com o presente trabalho foi a determinação do estádio morfofisiológico do meloeiro 'Bônus n° 2' ideal para a realização da enxertia pelo método da fenda cheia utilizando como porta-enxerto o hibrido de abóbora 'Shelper', e sua influência sobre o pegamento, produtividade e qualidade dos frutos. Utilizou-se o delineamento de blocos ao acaso com cinco tratamentos e cinco repetições, cada parcela foi constituída por oito plantas. Os tratamentos constaram de quatro diferentes estádios de desenvolvimento de mudas do meloeiro rendilhado: folhas cotiledonares desenvolvidas; primeira folha em desenvolvimento; segunda folha em desenvolvimento; duas folhas desenvolvidas e da testemunha sem o uso de enxertia. As plantas não enxertadas obtiveram os melhores valores de rendilhamento da casca, espessura da casca e sólidos solúveis. Quando comparado os tratamentos onde houve o emprego da enxertia não ocorreu diferença significativa entre as características avaliadas. Se houver necessidade de enxertia em função de patógenos de solo e salinidade, a utilização de enxertos com a primeira folha em desenvolvimento é recomendada uma vez que não apresenta diferença com as plantas não enxertadas.

Palavras-chave: *Cucumis melo* var. *reticulatus* Naud. Fenda cheia. Porta-enxerto. Cultivo protegido. Mudas.

INTRODUCTION

Melon is very appreciated fruit in the whole world, where it is eaten by people of all age groups. The fruit can be consumed in various ways: as is, as a juice, in salad and in candy. Also, the seeds can be eaten toasted, as they are readily accessible (NATH, 2007).

The continuous use of the soil for the cultivation of melons in greenhouses without rotations has favored the emergence of soil pathogens and the increase in salinity which are obstacles to the production of net melons in this environment (PEIL, 2003).

Research on grafting in vegetables and fruits has been reported since 1920 in Japan, utilizing *Cucurbita moschata* as rootstock aimed at controlling *Fusarium oxysporum* in the watermelon crop

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(SAKATA et al., 2007).

Studies in Brazil and at the international level, especially in countries such as Japan, South Korea and Spain, have demonstrated that the use of grafts can increase production, confer greater adaptability to climatic conditions, such as low temperatures, and increase tolerance to drought and soil salinity, reduce the appearance physiological disorders, improve the visual characteristics of the fruits, increase the vigor of the plants and control diseases (SANTOS et al., 2003).

The emergence of new races of soil pathogens, mainly *Fusarium oxysporum* f. sp. *melonis*, has increased the necessity of the use of rootstocks resistant or tolerant to these new races (CRINO et al., 2007; HERMAN and PERL-TREVES, 2007; SAKATA et al., 2008).

The first experiences in relation to the age of seedlings for grafting were gained with tomato plants. Experiments were carried out to evaluate the age of the rootstock, compatibility and acclimatization of the seedlings (SANTOS, 2003). Santos et al. (2003) noted the existence of an intimate relation between age of the seedling for grafting and productivity.

The literature with respect to the morphophysiological stage of the melon plant that is more adequate for grafting is scarce. Therefore, the objective of this study was to determine the ideal morphophysiological stage of net melon for grafting, by the closed cleft method, and its influence on productivity and quality of the fruits.

MATERIAL AND METHODS

The experiments were conducted in a greenhouse belonging to Sector of Olericulture and Aromatic Medicinal Plants, Department of Crop Production, School of Agricultural and Veterinary Sciences, UNESP, Jaboticabal Campus, SP, whose geographic coordinates are 21° 14' 05'' S, 48° 17' 09'' W with an altitude of 614 m, during the period of July to November of 2013.

A completely randomized block design was utilized, with five treatments and five repetitions. Each experimental plot consisted of eight plants, taking the four central plants as the area to be used.

The treatments consisted of four different ages of the hybrid 'Bonus No. 2' melon (scion) for grafting: two cotyledonary leaves, first true leaf in development, the second true leaf in development, and two true leaves totally expanded. The control consisted of non-grafted plants.

The seeds of the rootstock 'Shelper' and scion 'Bonus No. 2' were planted on July 12 in Styrofoam trays with 128 cells, filled with the commercial substrate Plantmax HT® and kept in a germination room until the time of the graft.

The plants were grafted according to the development of the vegetative stage, utilizing the closed cleft method. In each treatment, 60 plants were grafted, using as rootstock plants of the pumpkin hybrid 'Shelper' with on true leaf completely developed. The grafted plants were placed in a room with a high relative humidity until complete wound healing of the graft area, which occurred approximately 20 days after the graft, and afterwards they were transplanted in the definitive location.

Based on soil analysis and recommendations of Raij et al. (1997), soil preparation of and fertilizing at planting were carried out, using 30 kg ha^{-1} of both nitrogen and potassium (phosphate fertilizer was not necessary). The plants received cover fertilization in doses of 75 kg ha^{-1} of nitrogen and 50 kg ha^{-1} of potassium, divided into three times, at 15, 30 and 45 after transplanting.

Before transplanting in the definitive location, the total number of successful grafts was determined to obtain the take percentage, and the plants were then transplanted with a spacing of 1.0 m between rows and 0.5 m between plants. The plants were staked with a single stem up to a height of 2.0 m using a plastic stick at which time the apical meristem of the plants was removed. Lateral shoots were removed up to the 10th – 12th node, after which the secondary stems were allowed to grow and the fruits formed. Pollination was done manually, and when fruiting, the stem was pruned leaving one leaf after the fruit, maintaining only two fruits per plant.

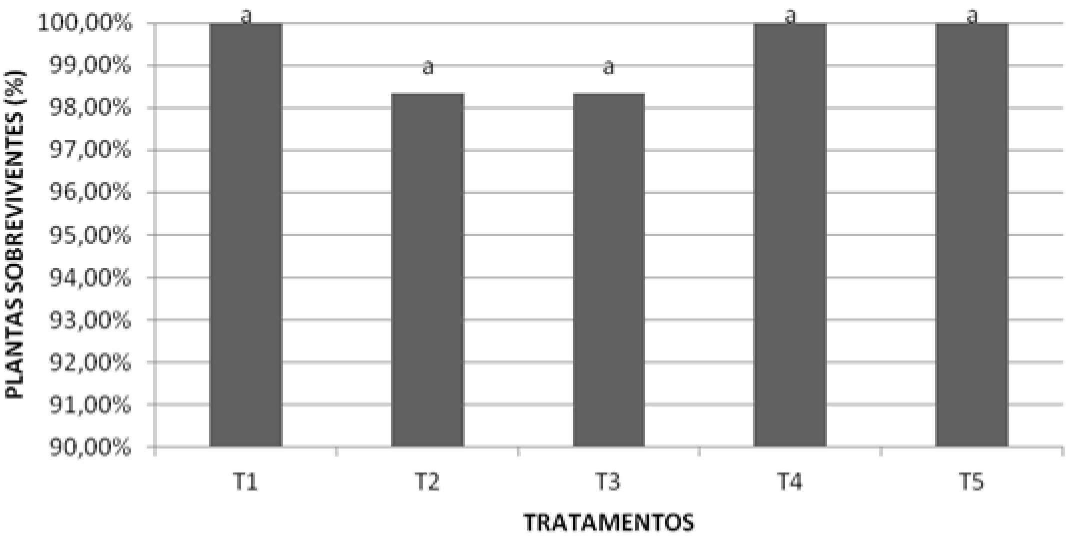
The characteristics evaluated were: a) Percentage of surviving plants, determined by counting the plants that showed complete wound healing of the graft site at the moment of transplanting to the definitive location; b) mean fruit mass, determined by weighing the fruits in a precision balance; c) longitudinal and transverse diameters of the fruit and of the locule, determined by measuring with a ruler; d) thickness of the pulp and of the rind, measured with a ruler; e) level of soluble solids, determined with a refractometer, taking a central portion of the fruit; f) netting index, based on scale of grades: 1-weak, 2-medium and 3-intense netting (RIZZO et al., 2004).

The data obtained were submitted to analysis of variance (F test), and the means compared by Tukey's test (5%).

RESULTS

With respect to the percentage of surviving grafted plants, there was no significant difference between the treatments. The take rate was high in all treatments, with means as high as 99.17%, showing no compromise in the production of seedlings (Figure 1).

Figure 1: Percentage of surviving grafted plants according to developmental stage of the melon 'Bonus No. 2', T1-control (no grafting) T2–two cotyledons, T3-one leaf in development, T4-second leaf in development and T5-two developed leaves. Jaboticabal-SP/Brazil, UNESP-FCAV, 2013.



There was no significant difference when evaluating fruit mass, longitudinal and transverse diameters of the fruit and of the locules and pulp thickness (Table 1).

Table 1: Fruit mass (MF), longitudinal diameter of fruit (DLF), transverse diameter of fruit (DTF), longitudinal diameter of locule (DLL), transverse diameter of locule (DTL) and rind thickness (EP) of net melon. Jaboticabal-SP/Brazil, UNESP-FCAV, 2013.

TREATMENT	MF (kg)	DLF (cm)	DTF (cm)	DLL (cm)	DTL (cm)	EP (cm)
Control	1.07 a	12.76 a	12.40 a	8.51 a	6.13 a	3.10 a
Two cotyledons	1.04 a	12.56 a	12.13 a	8.52 a	6.00 a	3.10 a
First leaf in development	1.04 a	12.66 a	12.36 a	8.26 a	6.10 a	3.06 a
Second leaf in development	1.06 a	12.82 a	12.23 a	8.47 a	5.91 a	3.16 a
Two developed leaves	1.04 a	12.54 a	12.27 a	8.39 a	6.13 a	3.00 a
CV%	9.13	3.91	3.74	5.26	3.82	4.33
DMS (Tukey, 5%)	0.1864	0.9589	0.8892	0.8594	0.4492	0.2590
F TEST	0.09^{NS}	0.30^{NS}	0.28^{NS}	0.33^{NS}	1.09^{NS}	0.95^{NS}

Means followed by the same letter in the columns do not differ, according to Tukey’s test, $p \leq 0.05$.

Fruits produced by non-grafted plants showed a higher netting index (1.93), which was significantly higher compared to fruits originating from grafted plants with two cotyledonary leaves (1.70), but not differing from the other treatments (Table 2). This is an important factor for the sale of the fruits; after all, it is responsible for the appearance of the fruit that attracts the attention of the consumer, that is, the fruit that is most attractive to the eyes of the consumer has greater netting index.

Table 2: Netting index (R), level of soluble solids (SS) and rind thickness (EC) of net melon. Jaboticabal-SP/Brazil, UNESP-FCAV, 2013.

TREATMENT	R^*	SS (%)	EC (cm)
Control	1.93 a	14.55 a	0.10 b
Two cotyledons	1.70 b	12.25 b	0.12 a
First leaf in development	1.78 ab	12.32 ab	0.11 ab
Second leaf in development	1.82 ab	12.41 ab	0.10 b
Two developed leaves	1.84 ab	13.07 ab	0.10 b
CV%	6.24	8.95	10.68
DMS (Tukey, 5%)	0.2196	2.2391	0.0224
TESTE F	2.91^{NS}	3.50^{*}	5.03^{**}

* Means transformed into square root of x + 1;
Means followed by the same letter in the columns do not differ, according to Tukey’s test, $p \leq 0.05$.

With respect to soluble solids, the non-grafted plants had the highest mean level (14.55%), which was significantly higher than that of fruits from the grafted plants with two cotyledonary leaves (12.25%) (Table 2).

There was significant difference between the treatments when evaluating rind thickness, where the grafted plants in the two cotyledon group reached the highest values, differing significantly from the other graft groups and non-grafted control group (Table 2). A greater rind thickness can be of interest for fruits destined for long-distance transport such as those that are exported, making the fruit more resistant to storage and transport.

DISCUSSION

The characteristics evaluated differed little between the treatments with the use of grafting. Fruit shape did not differ between grafted and non-grafted plants, corroborating the findings of Proietti et al. (2008) and Rouphael et al. (2008) who found that normally fruit shape of cucurbits is not affected by grafting.

Levels of both rind netting and soluble solids are important characteristics related to the quality of the fruits. No significant difference was found between the fruits produced by grafted and non-grafted plants with the exception of those grafted when showing only cotyledonary leaves, which produced fruits with a lower level of soluble solids and netting. There are many reasons for the influence of the rootstock on the quality of the fruits, the most notable is the incompatibility between rootstock and scion, which can cause underdevelopment of the plant with lower flow of water and nutrients in the graft area. Often, these characteristics are only clear at the moment of frutification when the demands of the plant become greater (LEE and ODA, 2003).

Even the lower values found are not an obstacle for the sale of the fruits on the national and international markets, Because the minimum required by the European community for receiving the fruits is 9 % soluble solids, this being much lower than that found in the present study (MENEZES et al., 2011).

Incompatibility can be attributed to various characteristics. In the present situation, the factor evaluated was the stage of growth of the plant (scion). A smaller contact area between the scion and rootstock can impede the flow of water and nutrients, even when excellent healing has occurred at the graft site and the plants show good vegetative development (GOTO et al., 2003). The stage of the plant at the time of grafting is important in relation to the efficiency of the interaction between rootstock and plant top (JOHKAN et al., 2009). The hydraulic architecture of the conducting vessels is of fundamental importance, because the flow of water is associated with numerous processes in plants (MARTINEZ-BALLESTA et al., 2010).

Another characteristic with significant results pertained to rind thickness, which was greater in fruits of early grafted plants, but this characteristic can have two different attributions. For the consumer, this is undesirable characteristic, because it results in lower quantity of the edible part. However, this also confers greater resistance to transport, increasing shelf life and minimizing post-harvest damages.

Non-grafted plants showed fruits with important characteristics for commercial purposes, such as higher levels of soluble solids and netting compared to grafted plants, which can be explained by the fact that the graft presents itself as a stress factor for plants. Under the conditions of this study, where there was no evidence of a limiting factor related to the soil, non-grafted plants had growth conditions without limitations, thereby having an advantage of not suffering any initial stress, unlike the grafted plants. Grafting is justified in locations where there are negative factors, mainly related to soil, making the growth of non-grafted plants limited; this would make it necessary to use grafts as a tool for crop management and for recovery of productivity potential.

CONCLUSION

Net melon shows good versatility with respect to the right time to do closed cleft grafting, with excellent survival rates of the grafted plants. Grafting in net melons is only justified in cases where production is limited by biotic and/or abiotic factors possibly solvable by the use of a rootstock that confers resistance or tolerance to this limiting factor. If grafting is necessary, one should use scions that show the first leaf in development because they show better rind netting and soluble solids at an early morphophysiological stage.

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