Chapter 116

Gourd (Lagenaria siceraria (Mol.) Standl) seedling production and transplanting in different containers

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ABSTRACT
The seedling production of gourd in protected environmental may be an alternative to the use of seed directly in crop system. Thus, the study aimed to verify if the production and transplanting of gourd seedlings in different types and sizes of containers may be agronomic alternative to gourd crop. Two experiments were conducted sequentially in time to assess the growth and response of the species to transplanting. In the first experiment with 6 replications, we compared for 38 days the biomasses of the plants grown in tray cells and in black plastic bags. Upon transplanting the seedlings to pots, they were grown for 37 days more in a 2 x 2 bifactorial arrangement with 4 replications. At 24 days after emergence (DAE), the emergence percentage was 50.7% and the seedlings were 8.9 cm high. Seedlings produced in the plastic bag exhibited 30% more biomass than seedlings produced in tray cells. At 61 DAE, the transplanted seedlings produced initially in the larger container exhibited a 100% survival rate and greater height. The viability of transplanting organic seedlings of gourd broadens their use as a multifunctional ornamental plant in sustainable landscaping, in addition to direct planting as a crop.

Keywords: Agroecology, family agriculture, landscaping, organic seedling production.

1 INTRODUCTION

Throughout the world, the gourd (Lagenaria siceraria (Mol.) Standl.) crop has a broad range of uses. For example, this species has food potential (VAN WYK, 2011) and has medicinal properties (CHEN et al., 2008), with an antioxidant effect (MOHAN et al., 2012) and works as an agent to combat stress (VINOD & SHIVAKUMAR, 2012). Santos et al. (2014) found high oil quantity and quality in gourd seeds, comparable in quality to the olive oil concerning omega's type oils. In Brazil, more specifically in the state of Rio Grande do Sul (RS), on small family-type rural properties, gourds are cultivated in order to produce gourds devices for drinking mate - a traditional gaucho drink. Since 2010, the RS Forestry Program has incentivized actions in order to improve the structure of gourd production chain, increasing the use of the species and recognition of the importance of the species for the region and for the country. Despite its nutritional and cultural importance, the gourd is still underutilized within the exploitation of horticultural crops. Thus, we have the challenge of inserting the gourd in new agricultural scenarios.

Gourd seedlings are used as rootstock for watermelon [Citrullus lanatus (Thunb.) Matsum. & Nakai.] growing, with eight varieties registered in China (LEE et al., 2010) resistant to fusarium wilt (Fusarium oxysporum f. sp. Lagenariae FOLag) (LOUWS et al., 2010), with tolerance to waterlogged soils (YETISIR et al., 2006) and to high salinity conditions (HUANG et al., 2013). The species stands out also as an ornamental plant, where it is found in residential gardens in Africa (VAN WYK, 2011) and in the Orient (TRINH et al., 2003), and has landscaping potential for use on walls, roofs and balconies because individual plants grow vertically, without competing for occupation of the soil by building constructions, a characteristic which is currently greatly appreciated in landscaping (GUILLAUIC, 2010). Since it is a rustic, it may be more successfully used in contemporary landscaping projects.

Traditionally, the gourd propagation occurs in a sexual way, where seeds are early extracted from fruit selected from the crop itself and used for the following crop (BISOGNIN & STORCK, 2000). Sowing occurs in the springs and summer seasons (i.e., August to October) and under the conventional system, using high soil disturbance (use of plow and disc harrow, for example). This factor combination the gourd crop encounters several adversities, such as excess rainfall and low temperature (SANTOS et al., 2010). Thus, adopting technologies that minimize these inconveniences and that enhance the gourd productive chain, such as the production of quality seedlings, is a key factor to encourage the use of the species and provide profitability to producers.

As one of the major agronomic challenges is to improve the establishment of crops, the production of seedlings of this Cucurbitaceous in a protected environment is an alternative for crop applications, as well as for horticulture, since it has the advantage of allowing better control of edaphoclimatic conditions at the beginning of the cycle (REGHIN et al., 2007). In horticultural crops, the supply of quality seedlings to producers is important to obtain high production after the establishment of plants in their cultivation environment (CHIOMENTO et al., 2019; COSTA et al., 2020). This quality refers to the plant robustness in the face of abiotic and biotic stresses (ZHAO et al., 2016). However, one difficulty in producing seedlings in containers is to ensure the production of aerial biomass with a limited portion of roots (LEMAIRE, 1995), restricted to a small volume of substrate. Thus, in order to obtain quality seedlings, the size of the container is important since root development is directly affected (REGHIN et al., 2007), and it will affect photosynthesis, chlorophyll content, growth, and nutrient acquisition (NESMITH & DUVAL, 1998), as well as production and aesthetic presentation for commercialization in the case of ornamental use (PINTO et al., 2010).

Therefore, here we investigate the viability of gourd seedling production in different types and sizes of containers, as well as the seedling response to transplantation, with the purpose of contributing to enhance the use of this species in sustainable landscaping, as rootstock and even in direct planting in crops.

2 MATERIAL AND METHODS

2.1 PLANT MATERIAL AND EXPERIMENT LOCATION

In our study, we carried out two experiments: Experiment #1 - production of gourd seedlings; Experiment #2 - transplant of gourd seedlings (remaining from Experiment #1). The experiments were conducted in a sequential manner in the period from June (winter) to October (spring) 2008 in a greenhouse of the Horticulture Sector of the College of Agronomy and Veterinary Medicine of the University of Passo Fundo, municipality of Passo Fundo (28º 15' S, 52º 24' W; 687 m altitude), Rio Grande do Sul (RS), Brazil. The greenhouse is 210 m2 with a height of 2.5 m, a galvanized aluminum structure and an arched roof covered with low-density polyethylene (LDPE), provided with movable side curtains and set up in a northeast-southwest direction. So as to reduce temperature and insolation, a black shade screen was set up internally at 2.5 m height and at the sides with 75% shading ability. The climate in the region is characterized as subtropical Cfa, according to the Köppen classification, with rains well distributed throughout the year and mean annual temperature of around 17ºC.

The genetic material of gourd used came from rural producers from the municipality of Vicente Dutra (27º 09' S, 53º 24' W), RS, and, considering the possible physiological inviability of seeds used in the experiments, a prior germination test was performed in the laboratory (pre-test) as the Seed Analysis Rules (BRAZIL, 1992) indicate for the gourd.

2.2 EXPERIMENTAL DESIGN

Experiment #1 consisted of evaluation of two containers for sowing the gourd: tray cells (TC) with a 143 cm3 volume (polystyrene tray with 72 cells.plugs-1), and black plastic bag (PB), with a volume of 339 cm3, arranged in a completely randomized design with 6 replications, each plot consisting of six plants.

To evaluate the transplanting procedure (Experiment #2), a completely randomized design with 4 replications was used, consisting of a bifactorial (2 x 2) arrangement, evaluating the effect of two containers (from sowing to 24 DAE = TC and PB) and two sowing densities in the final pot (1 and 2 seedlings). The four treatments were thus designated: TC2, pots with 2 seedlings coming from sowing in polystyrene tray cells; TC1, with 1 seedling coming from sowing in a polystyrene tray cell; PB2, pots with 2 seedlings coming from sowing in plastic bags; PB1, with only 1 seedling transplanted. Each pot constituted a plot.

2.3 PROCEDURES

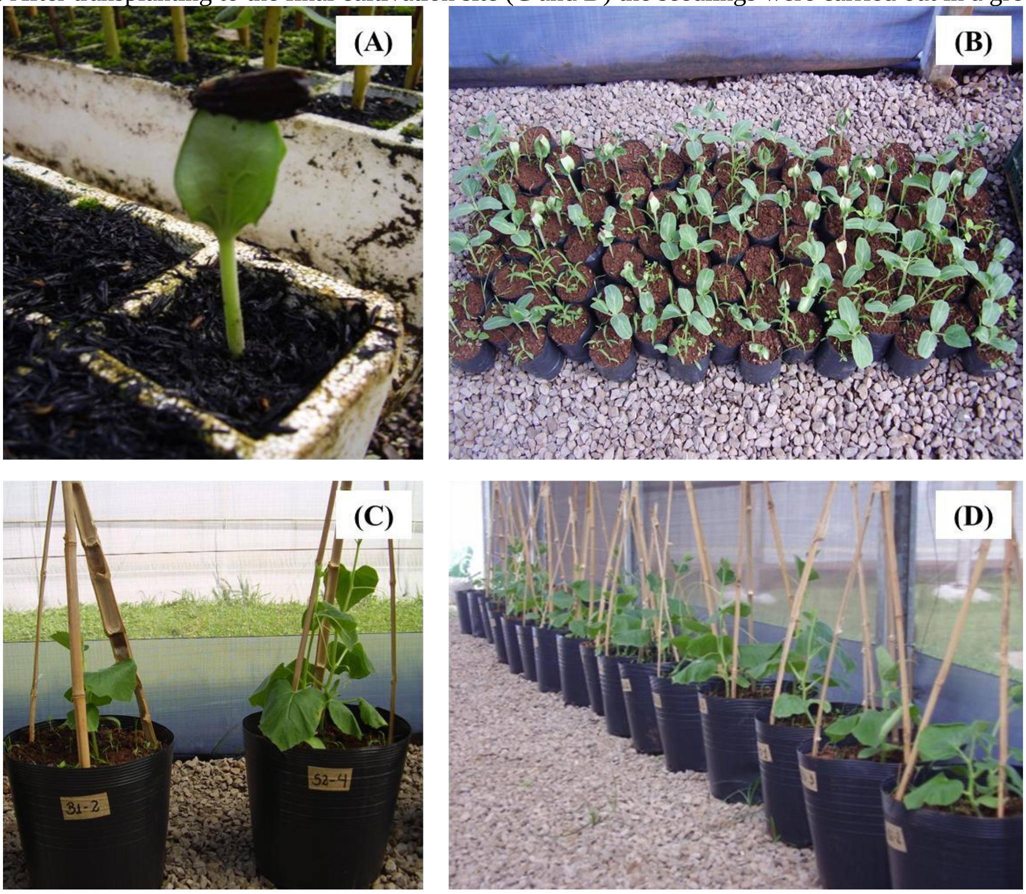
In both experiments, irrigation was performed manually every two days. There was no monitoring of the internal temperatures of the protected environment and, even during the winter, there was no problem of losses to outside frosts which occur in this period. To carry out the experiments, no synthetic chemical product was used, not even soluble chemical fertilizer, and no plant health treatment recommended in organic production was necessary.

In Experiment #1, a mixture at a 1:1 proportion of the soil Typic Hapludox (Soil Taxonomy, 2010) and hand-crafted organic compost (dead leaves, etc.) was used to fill the containers (TC and PB). The mixture had the following characteristics according to CQFS-RS/SC (2004): clay = 26%; organic matter = 3.8%; pH in water = 6.8; P = 53 mg.dm-3; K = 1168 mg.dm-3; Ca = 9.0 cmolc.dm-3; Mg = 6.3 cmolc.dm-3; Al = 0.0 cmolc.dm-3; sulfur = 43.0 mg.dm-3; zinc = 9.6 mg.dm-3; boron = 0.9 mg.dm-3.

Manual sowing was performed on July (winter) 14, and each TC or PB container received 2 seeds, at a depth of 1.5 cm. At 14 days after sowing (DAS), as of the first seedling to emerge (which occurred on July 28), the emergence dates of each seed were registered for validation in emergence percentage. As soon as the second seedling in each container emerged (TC or PB), thinning was carried out so as to leave only the most vigorous seedling. This experiment ended on August (winter) 20, 24 days after emergence (DAE) of the seedlings (or 38 days after sowing) based on a study performed by Seabra Júnior et al. (2004), who observed a trend toward interruption of seedling growth of cucumbers (Cucumis sativus L.) produced in a smaller container (34.6 cm3) as of 29 days of age of the plants. At that time, half the plants from each plot (3 plants) were collected for analysis. The attributes we evaluated regarding the shoot of the seedlings were plant height (H, cm), with caliper rule, fresh mass (FMS, g) and dry mass (DMS, g). Regarding the root system of the seedlings, we also evaluated the fresh mass (FMR, g) and dry mass (DMR, g). Evaluation of fresh mass (shoot and root) consisted of quantification of the weight of recently collected seedlings, washed and dried with paper toweling, through the use of a precision balance. These samples were placed in a laboratory oven at 105°C for 24 h and then quantification of the dry mass (shoot and root) was carried out with a balance (0.01g precision). After that, we determined the total fresh (TFM, g) and dry (TDM, g) masses of seedlings. The remainder of the seedlings of the plot were used in transplanting to pots, thus generating Experiment #2.

Experiment #2 began on August 20, the ending date of Experiment #1, at which time the height of all the plants coming from the two types of containers was measured through the use of a caliper rule, and the seedlings were transplanted to larger black plastic pots with a volume of 15,168.5 cm3 (Figure 1). Removal of the plants from the plastic bags and the trays and transplanting to pots was performed manually, without damage to the earth around the roots. The difficulty experienced in removing the plants produced in the polystyrene tray cells is noteworthy.

Figure 1. Establishment of Experiment #2 with the remaining seedlings of Experiment #1 produced in TC (A) and PB (B). After transplanting to the final cultivation site (C and D) the seedlings were carried out in a greenhouse.



Source: author's photos.

For this post-transplanting growth (Experiment #2), a mixture of mineral soil and organic compost (1:1) was used, prepared as in Experiment #1, but having the following characteristics according to CQFSRS/SC (2004): clay = 36%; organic matter = 4.3%; pH in water = 6.4; P = 52 mg.dm-3; K = 1021 mg.dm-3; Ca = 2.8 cmolc.dm-3; Mg = 4.8 cmolc.dm-3; Al = 0.0 cmolc.dm-3; sulfur = 35 mg.dm-3; zinc = 9.6 mg.dm-3; boron = 0.7 mg.dm-3. To evaluate the survival and growth response of gourd to transplanting, over the 37 days after transplanting (DAT), in the period from August 20 to September (spring) 26, the percentage of viable live plants and plant height (H, cm) was evaluated weekly at 8, 15, 22, 30 and 37 DAT through the use of tape, measuring the length from the root collar to the tip of the main stem.

2.4 STATISTICAL ANALYSIS

The data obtained from the variables analyzed in Experiment #1 were subjected to analysis of variance (Anova) and the T test. In Experiment #2, over the time periods, the data obtained from the variables were subjected to regression analysis, and for each time period, the Tukey test was applied when Anova showed significance at 5% probability of error.

3 RESULTS

3.1 PRE-TEST TO DETERMINE SOWING DENSITY OF GOURD IN POTS

Regarding to pre-test to determine sowing density of gourd in pots, the results of the germination test (±standard deviation) performed in the laboratory showed at first count 59% (±5.81) normal seedlings, and, in the second count, 13% (±3.80) normal seedlings, 2% (±2.37) abnormal seedlings, 19% (±4.14) dead seedlings and 7% (±3.22) hard seeds.

3.2 EXPERIMENT #1: SEXUAL PRODUCTION OF GOURD SEEDLINGS

Up to 24 days after emergence (DAE), although the seedlings coming from tray cells had lower values for percentage of emergence and for height, they were not different from the seedlings produced in plastic bags (Table 1). In relation to production of fresh mass and dry mass of the root at 24 DAE, the container of greater volume (PB) exhibited seedlings with values greater than those produced in tray cells (Table 1). The fresh mass and dry mass of the above ground part and of the whole plant (Table 1) showed the same trend for root biomass; in other words, lower production in smaller containers.

Table 1. Phytometric morphology of gourd (L. siceraria) 24 days after emergence (DAE) of the seeds.

Container [1]	PE[2] (%)	H (cm)	FMR* (g)	FMS*	TFM*	DMR*	DMS*	TDM*
TC	49.27±15.45	8.11±1,19	0.15±0.06	3.48±0.24	3.64±0.25	0.010±0.00	0.17±0.02	0.18±0.02
PB	52.08±13.11	9.60±1.17	0.24±0.06	4.77±0.70	5.01±0.70	0.016±0.00	0.23±0.03	0.25±0.03
Mean	50.68	8.85	0.199	4.131	4.330	0.013	0.206	0.219
CV (%)[3]	28.27	17.0	29.65	12.74	12.11	29.32	12.32	11.72

Source: author's data.

Data presented as mean ± standard deviation.

* Significant at p<0.05 by the F test.

[1] TC: tray cells with a volume of 143 cm3; PB: black plastic bag with a volume of 339 cm3.

[2] PE: percentage of emergence; H: height shoot; FMR fresh mass of root; FMS: fresh mass of shoot; TFM: total fresh mass; DMR: dry mass of root; DMS: dry mass shoot; TDM: total dry mass.

[3] Coefficient of variation.

3.3 EXPERIMENT #2: VIABILITY OF TRANSPLANTED GOURD SEEDLINGS

Due to the occurrence of interaction between containers and time periods, the development of the seedlings coming from tray cells and plastic bags when transplanted to pots are shown in Table 2. Comparing the time periods, we observed that on the transplanting date and at the first evaluation at 8 days after transplanting (DAT) (August 20 and 28, respectively) there was no significant difference among the types of containers in relation to the plant height, since this was an establishment phase for the seedlings after transplantation.

Table 2. Plant height (cm) and percentage of viable plants (%) at 37 days after transplanting (DAT) of gourd (L. siceraria) seedlings when transplanted to pots (15,168.5 cm3).

Treatment[1]	DAT						Viable plants (%)
	0	8	15*	22*	30*	37*	
TC1	9.00±0.81 ns	10.00±1.41 ns	11.75±1.25 b	15.50±1.84 ab	28.75±4.26 b	59.00±9.97 b	100 a
TC2**	8.00±1.03	7.00±0.62	8.00±0.50 ab	10.50±2.75 b	17.25±3.60 c	32.00±9.01 c	75 b
PB1	12.00±1.41	13.50±1.29	16.75±2.04 ab	21.25±4.22 a	37.50±4.65 ab	73.25±9.28 a	100 a
PB2**	10.75±1.44	12.75±2.13	19.00±2.17 a	25.25±3.54 a	42.25±3.58 a	69.75±3.90 a	100 a
Mean	9.93	10.81	13.87	18.12	31.43	58.5	93.75
CV (%)[2]	13.48	12.65	10.77	17.06	12.81	14.19	-

Source: author's data.

Data presented as mean ± standard deviation.
ns Not significant.
* Significant at $p<0.05$ by the Tukey test.
1 TC1: pot containing one seedling coming from expanded polystyrene tray cell (143 cm3); TC2: pot containing two seedlings coming from expanded polystyrene tray cell (143 cm3);
PB1: pot containing one seedling coming from plastic bag (339 cm3); PB2: pot containing two seedlings coming from plastic bags (339 cm3).
2 Coefficient of variation.
** Values relative to the mean values of height of the two plants.

At 15 DAT, plant height in the PB2 treatment was greater only in comparison to treatment TC1. At 22 DAT, the PB2 treatment, without differing from PB1, exhibited greater height only in comparison to TC2, and at 30 DAT, it did not differ from PB1 and was greater than the others. The development of these seedlings over the 37 days of growth, when transplanted to pots, follows the regression equations with quadratic behavior (Table 3).

Table 3. Regression equations and determination coefficients from quantitative data of gourd (L. siceraria) seedlings when transplanted to pots in each treatments.

Treatment[1]	Regression equations	Determination coefficients
TC1	$y = 11.682 - 1.1323x + 0.626x^2$	$R^2 = 0.93$
TC2	$y = 8.9114 - 0.6397x + 0.0331x^2$	$R^2 = 0.97$
PB1	$y = 15.053 - 1.2268x + 0.0727x^2$	$R^2 = 0.96$
PB2	$y = 12.357 - 0.5642x + 0.0556x^2$	$R^2 = 0.98$

Source: author's data.

1 TC1: pot containing one seedling coming from expanded polystyrene tray cell (143 cm3); TC2: pot containing two seedlings coming from expanded polystyrene tray cell (143 cm3); PB1: pot containing one seedling coming from plastic bag (339 cm3); PB2: pot containing two seedlings coming from plastic bags (339 cm3).

4 DISCUSSION

The data presented in our study concern gourd seedling process as alternative to the use of seed directly in the crop system. The study aimed then to verify if the production and transplanting of gourd seedlings in different types and sizes of containers may be agronomic alternative to gourd crop. Our results suggested that we can anticipate seedling process on farm, protecting topsoil rapidly as well as having high plant development.

The results of pre-test to determine sowing density of gourd in pots showed that the seeds did not exhibit good physiological qualities, which increases the risk of losses during the establishment of seedlings (NASCIMENTO, 2005). Bisognin et al. (1999), upon evaluating the physiological quality of gourd seeds obtained when extracted from fruits at different times after harvest, observed that in terms of germinating power (GP), maximum GP was obtained in extraction of seeds at 58 days, with 82.8% normal seedlings, and the lowest percentage of non-germinated seeds at 62 days, with only 1.2% of non-germinated seeds. In gourd, there is the flow of nutrients from the fruit to the seed after harvest, and the fruit must remain in a dry, shaded and well-ventilated place for a period of around 60 days before seed extraction (BISOGNIN et al., 1999). As the germplasm used did not allow greater understanding of the process through which it was extracted, the low physiological quality of the seeds explains the low percentage of emergence (50.68%) obtained afterwards in Experiment #1 conducted in a protected environment, requiring the sowing of two seeds per container to make up for such a low percentage. This is one of the problems in production of native species, mixed varieties or unconventional garden crops that do not use standardized genetic breeding material, therefore constituting a concern of this branch of horticulture which deserves greater appreciation.

Up to 24 days after emergence (DAE) the seedlings coming from TC were not different from the seedlings produced in PB (Table 1). Bisognin et al. (2004) observed that squash (Cucurbita spp.), watermelon and cucumber show greater rates of increase in leaf area as of the appearance of the first true leaves in relation to the gourd, and that the gourd after attaining equivalence between leaf area and cotyledon area shows a slow increase of leaf area. Since slow growth of leaf area is a characteristic fact of the species, this may also be reflected in plant height and, for that reason, there was no difference in height among the containers studied (Table 1).

Seedling responses after transplantation to the final cultivation environment is directly influenced by the root system morphology, as it is a source of hormones responsible for shoot growth (MARCHIORETTO et al., 2020). The restriction of the root system caused by cells of trays with restricted volume, as we verified in our study (Table 1), makes the taproot of dicot seedlings to get a matted and spiraled aspect of the secondary roots making the seedling more susceptible to abiotic stresses (TSAKALDIMI & GANATSAS, 2006). In addition, that restriction of the root system harms development of the above ground part (PEREIRA & MARTINEZ, 1999). Thus, it is important that nurserymen choose larger containers for the seedling production, which will result in plants with better quality during acclimatization and greater viability after transplantation. At 37 DAT, the pot with one plant coming from the plastic bag (PB1) exhibited greater height, without differing from that which contained two plants (PB2), both greater than the other treatments in tray cells (Table 2). The plants that grew least at 30 and 37 DAT were those that contained two seedlings coming from tray cells (TC2), indicating that competition in the pot accentuated the deleterious effect of producing this cucurbitaceous sown and initially grown in tray cells. In relation to the percentage of viable plants after transplanting (Table 2), we observed that only the

TC2 treatment showed a lower percentage, explained by the low root mass of the seedlings coming from tray cells (Table 1) and by the difficulty of removal of these seedlings for transplanting.

The greatest growth of seedlings after transplantation is strongly related to the root system, as non-matted roots have the potential to grow faster and acquire more water and nutrients, reducing the ecophysiological stresses promoted by the transplanting (GROSSNICKLE & MACDONALD, 2018). In our study, we confirmed that gourd seedlings (produced in larger containers) with higher root biomass (Table 1) showed greater viability after transplantation (Table 2). The survival of transplanted seedlings is correlated to internal nutrient status (LIU et al., 2016). This means that seedlings with an enhanced nutrient content are able to remobilize it to biomass growth and then speed up plant growth in the field (MARCHIORETTO et al., 2020).

Therefore, we confirmed that smaller plants were produced in the smaller containers (TC), and the seedlings produced in containers of greater volume exhibited better development after transplanting because the seedlings exhibited greater height and greater root fresh mass (Table 1). Although similar results have been found in cucumbers (SEABRA JÚNIOR et al., 2004), our findings on the viability of transplanting in the gourd crop are unprecedented. The findings of our study can be useful to support the choice of containers by nurserymen so that these professionals can produce better quality seedlings. Thus, it will be possible to minimize the inconveniences caused by the traditional propagation of gourd culture [soil disturbance and bare soil condition, for example (Figure 2)] and enhance the productive chain of this horticultural crop. We emphasize that the production of quality seedlings is a key factor to encourage the use of the species and provide profitability to the gourd producers, who will certainly choose to acquire more robust seedlings, with higher survival rates and better adaptation of the plants after transplantation in the growing environment. Seedlings with a more developed root system, as seen in those produced in PB containers (Table 1), suffer less from abiotic and biotic stresses after transplantation (GROSSNICKLE, 2005). Finally, these investigations are filling the gap between the production of gourd seedlings related to their viability after the plant establishment in the field.

Figure 2. Illustrative images from topsoil (~1 m2) after plowing and get disk arrow system in two systems: sowing and seedling. DAE = days after emergency; DAT = days after transplanting. Photos: D. B. Santos. Unpublished images, but it were used for determining of the soil cover vegetation presented in Santos et al. (2010).

Aspects after two situation: sowing and seedling

0 DAE 30 DAE 60 DAE

Sowing

10 DAT 30 DAT 60 DAT

Seedling

Source: author's photos.

5 CONCLUSIONS

The present study placing together the type of container and the number of seedlings transplanted per container leads to the conclusion that there is viability for production of gourd seedlings transplanted at 24 days after emergency, which makes for alternative management of the species (sowing in the field). The species accepts transplanting, with more vigorous seedlings when produced in large containers from the beginning of production. In addition to ensuring its use as rootstock in horticulture, the viability of transplanted seedlings thus expands use of the species as multifunctional ornamental in sustainable landscaping and for direct planting in crops.

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REFERENCES

BISOGNIN, D. A.; AMARANTE, C. V. T.; DELLAI, J. Contribuição das folhas cotiledonares para o crescimento e estabelecimento de plântulas de cucurbitáceas. Horticultura Brasileira, v. 22, p. 309-313, 2004.

BISOGNIN, D. A.; MENEZES, N. L.; CENTENARO, R.; ALBINI, A. M. Influência da época de extração na qualidade fisiológica de sementes de porongo. Ciência Rural, v. 29, p. 7-12, 1999.

BISOGNIN, D. A.; STORCK, L. Estimativa dos componentes de variância e herdabilidade para formato de fruto em porongo: Lagenaria siceraria (Mol.) Standl. Ciência Rural, v. 30, p. 593-597, 2000.

BRAZIL. Ministério da Agricultura e Reforma Agrária, Departamento Nacional de Produção Vegetal. Divisão de Sementes e Mudas. Regras para Análise de Sementes. Ministério da Agricultura, Brasilia, 1992. 365p.

CHEN, C. R.; CHEN, H. W.; CHAN, C. I. D:C-friedooleanane-type triterpenoids from Lagenaria siceraria and a their cytoxic activity. Chemical and Pharmaceutical Bulletin, v. 56, p. 385-388, 2008.

CHIOMENTO, J. L. T.; FRIZON, P.; COSTA, R. C.; TRENTIN, N. S.; DE NARDI, F. S.; CALVETE, E. O. Water retention of substrates potentiates the quality of lettuce seedlings. Advances in Horticultural Science, v. 33, p. 197-204, 2019.

COSTA, E. G.; BARRETO, C. F.; FARIAS, R. M.; MARTINS, C. R. Propagation of blackberry on different substrates and rooting stimulators. Brazilian Journal of Development, v. 6, n. 6, p. 36654-36662, 2020.

CQFS-RS/SC. Comissão de química e fertilidade do solo. Manual de adubação e de calagem para os Estados do Rio Grande do Sul e Santa Catarina. SBCS-Núcleo Regional Sul, Porto Alegre, 2004. 400p.

GROSSNICKLE, S. C. Importance of root growth in overcoming planting stress. New Forests, v. 30, p. 273-294, 2005.

GROSSNICKLE, S. C.; MACDONALD, J. E. Why seedlings grow: influence of plant attributes. New Forests, v. 49, p. 1-34, 2018.

GUILLAUIC, I. “Outros lugares, começam aqui...” com O “muro vegetal” do Museu do Cais Branly em Paris. Revista Brasileira de Horticultura Ornamental, v. 16, p. 17-21, 2010.

HUANG, Y.; LIL, J.; HUA, B.; LIU, Z.; FAN, M.; BIE, Z. Grafting onto different rootstocks as a means to improve watermelon tolerance to low potassium stress. Scientia Horticulturae, v. 149, p. 80-85, 2013.

LEE, J. M.; KUBOTA, C.; TSAO, S. J.; BIE, Z.; ECHEVARRIA, P. H.; MORRAF, L.; ODAG, M. Current status of vegetable grafting: Diffusion, grafting techniques, automation. Scientia Horticulturae, v. 127, p. 93-105, 2010.

LEMAIRE, F. Physical, chemical and biological properties of growing medium. Acta Horticulturae, v. 396, p. 273-284, 1995.

LIU, J.; BLOOMBERG, M.; LI, G.; LIU, Y. Effects of copper root pruning and radicle pruning on first-season field growth and nutrient status of Chinese cork oak seedlings. New Forests, v. 47, p. 715-729, 2010.

LOUWS, F. J.; RIVARD, C. L.; KUBOTA, C. Grafting fruiting vegetables to manage soilborne pathogens, foliar pathogens, arthropods and weeds. Scientia Horticulturae, v. 127, p. 127-146, 2010.

MARCHIORETTO, L. D.; DE ROSSI, A.; CONTE, E. D. Chemical root pruning improves quality and nutrient uptake of Cape gooseberry (Physalis peruviana) seedlings. Scientia Horticulturae, v. 261, e-108948, 2020.

MOHAN, R.; BIRANI, R.; KARMASE, A.; JAGTAP, S.; BHUTANI, K. K. Antioxidant activity of a new phenolic glycoside from Lagenaria siceraria Stand fruits. Food Chemistry, v. 132, p. 244-251, 2012.

NASCIMENTO, W. M. Condicionamento osmótico de sementes de hortaliças visando a germinação em condições de temperaturas baixas. Horticultura Brasileira, v. 23, p. 211- 214, 2005.

NESMITH, D. S.; DUVAL, J. R. The effect of container size. HortTechnology, v. 8, p. 495-498, 1998.

PEREIRA, P. R. G.; MARTINEZ, H. E. P. Produção de mudas para o cultivo de hortaliças em solo e hidroponia. Informe Agropecuário, v. 20, p. 24-31, 1999.

PINTO, C. M. F.; BARBOSA, J. M.; MESQUITA, D. Z.; OLIVEIRA, F.; MAPELI, A. M.; SEGATTO, F. B.; BARBOSA, J. G. Produção e qualidade de pimentas ornamentais comestíveis cultivadas em recipientes de diferentes volumes. Revista Brasileira de Horticultura Ornamental, v. 16, p. 113-122, 2010.

REGHIN, M. Y.; OTTO, R. F.; OLINIK, J. R.; JACOBY, C. F. S. Produtividade da chicória (Cichorium endivia L.) em função de tipos de bandejas e idade de transplante de mudas. Ciência e Agrotecnologia, v. 31, p. 739-747, 2007.

SANTOS, D. B.; PETRY, C.; BORTOLUZZI, E. B. Cobertura de solo e produção de porongo sob diferentes configurações de cultivo. Ciência Rural, v. 40, p. 527-533, 2010.

SANTOS, D. B.; PETRY, C.; BORTOLUZZI, E. B. Composição centesimal e perfil dos ácidos graxos de sementes de porongo. Ciência Rural, v. 44, p. 31-36, 2014.

SEABRA JÚNIOR, S.; GADUN, J.; CARDOSO, A. I. I. Produção de pepino em função da idade das mudas produzidas em recipientes com diferentes volumes de substrato. Horticultura Brasileira, v. 22, p. 610-613, 2004.

TRINH, L. N.; WATSON, J. W.; HUE, N. N.; DE, N. N.; MINH, N. V.; CHU, P.; STHAPIT, B. R.; EVZAGUIRRE, P. B. Agrobiodiversity conservation and development in Vietnamese home gardens. Agriculture, Ecosystems & Environment, v. 97, p. 317-344, 2003.

TSAKALDIMI, M. N.; GANATSAS, P. P. Effect of chemical root pruning on stem growth, root morphology and field performance of the Mediterranean pine Pinus halepensis Mill. Scientia Horticulturae, v. 109, p. 183-189, 2006.

VAN WYK, B. E. The potential of South African plants in the development of new food and beverage products. South African Journal Botany, v. 77, p. 857-868, 2011.

VINOD, P.; SHIVAKUMAR, H. A current status of adaptogens: Natural remedy to stress. Asian Pacific Journal of Tropical Disease, p. 480-490, 2012.

YETISIR, H.; CALISKAN, M. E.; SOYLU, S.; SAKAR, M. Some physiological and growth responses of watermelon [Citrullus lanatus (Thunb.) Matsum. and Nakai] grafted onto Lagenaria siceraria to flooding. Environmental and Experimental Botany, v. 58, p. 1-8, 2006.

ZHAO, X.; JOO, J. C.; KIM, D.; LEE, J.; KIM, J. Y. Estimation of the seedling vigor index of sunflowers treated with various heavy metals. Journal of Bioremediation and Biodegradation, v. 7, 2016.