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DEVELOPMENT OF PAPAYA SEEDLINGS IN DIFFERENT CONTAINER SIZES AFTER THE IDEAL PLANTING PERIOD

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ABSTRACT
The choice of the production method and size of the bag to be used is decisive for the production of quality seedlings at an affordable cost for the producer, who should look for the ideal bag and the method that best suits the local conditions. The objective of this study was to evaluate the effect of different container sizes on the maintenance of papaya seedlings in the nursery after the normal planting period. Papaya seeds of the Formosa cultivar were used, sowing one seed per 200 mL tube, soil substrate + sand + humus (2:1:1). After 60 days from the beginning of emergence, the seedlings were transplanted into bags of the following sizes: 15x15 cm; 15x20 cm; 15x25 cm; 15x30 cm; 15x35 cm. After 90 days of transplanting, the following variables were evaluated: plant height; number of leaves, stem diameter, root length; green and dry mass of the leaves; green and dry root mass. The 15x30 cm bag presented the best results in the evaluation of the aerial part, however, in the evaluation of the production of green and dry mass of the leaves, the 15 x 25 cm bag treatment obtained the best result. The 15 x 25 cm bag was considered the best container size for the maintenance of papaya seedlings in the nursery.

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INTRODUCTION

Papaya or papaya, the name given to the fruit of the papaya tree, is widely used in diets, as it is an excellent source of calcium, pro-vitamin A and vitamin C (ascorbic acid) (SERRANO & CATTANEO, 2010).

The species has as its center of origin the Northwest of South America, more precisely the upper part of the Amazon Basin, where its genetic diversity is maximum (MARTINS & COSTA, 2003). This plant adapts well to the climatic conditions of several Brazilian regions, and in recent years the crop has been standing out in national fruit growing, with the production of seedlings being the first step towards a healthy crop (PAIXÃO et al., 2020).

Brazil is the world's second largest producer of papaya, surpassed only by India. The states of Espírito Santo and Bahia are responsible for about 65% of the national production. Espírito Santo stands out as the first producer and exporter of export-type papaya in the country, with an average productivity of 58.7 t/ha/year, considered one of the highest in Brazil. In addition to leading production, Espírito Santo has a productivity 40% higher than the national average, harvesting an average of 60.04 tons per hectare (IBGE, 2022).

The papaya tree has great social importance, generating direct and indirect jobs and income. This crop demands labor throughout the year, since the cultural treatments, harvesting and commercialization are carried out continuously in the crops, in addition to the plantations being renewed every 2 or 3 years, contributing to the permanence of man in the field and to the reduction of the rural exodus (DANTAS et al., 2013).

In the State of Espírito Santo, papaya production is a source of income for farmers in several regions. Production is still growing and the search for higher productivity is a preponderant factor for higher production and improvement in producers' income (SANTOS et al., 2018).

Papaya is usually sown in plastic containers, however sowing in windrows or beds and subsequent pricking to specific containers is still a practice carried out by some nurserymen and rural producers. In the production of seedlings, several containers are used, such as plastic bags, Styrofoam trays and tubes, with black polyethylene packaging being the most used (ARAÚJO et al., 2006).

The propagation of papaya can be done via cuttings, grafting and seeds. Among the methods mentioned, sexual or seed propagation has been most used in the economic exploitation of this crop, since this method is the most practical. Sowing directly in a polyethylene bag is the most favorable, giving rise to more vigorous plants and earlier production of the seedling (SIMÃO, 1998).

There are different containers on the market for the formation of fruit seedlings, and the selection criterion is defined according to availability and cost. For papaya cultivation, plastic bags with different dimensions are used. In this way, studies on the best container for the propagation of papaya give rise to important knowledge for nurseries who study the subject, since tubes, trays and plastic bags occupy different volumes of substrate, which can influence the final quality of the seedling.

The size of the container has a direct influence on the final cost, as it results in the amount of substrate to be used, the space it will occupy in the nursery, the labor used in transportation, removal for acclimatization and removal for delivery to the producer, in addition to the influence on the amount of inputs demanded (MENDONÇA et al., 2003).

Considering the growing increase in the fruit seedling production sector, the knowledge of the ideal bag for longer maintenance of the papaya seedling in the nursery will be extremely important to nurserymen, with a view to minimizing costs and improving productivity, with the use of seedlings of high commercial value, considering their own characteristics.

The objective of this study was to evaluate the effect of different container sizes on the maintenance of papaya CV. formosa seedlings in the nursery after the ideal planting period.

METHODOLOGY

The experiment was carried out in the seedling production nursery, polyolefin screen with 50% shading, height of 2.3 meters, nursery sector of the Federal Institute of Espírito Santo (IFES-Campus Santa Teresa), located in the same Central region of Espírito Santo, city of Santa Teresa-ES, district of São João de Petrópolis, geographic coordinates 19º56'12"S and 40º35'28"W, with an altitude of 155 m. The climate of the region is characterized as Cwa, mesothermal, with a dry season in winter and heavy rainfall in summer (Köppen classification) (ALVARES et al., 2013), with an average annual rainfall of 1,404.2 mm and an average annual temperature of 19.9 °C, with a maximum of 32.8 °C and a minimum of 10.6 °C (INCAPER, 2011).

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Papayas of the cultivar Formosa was used for the experiment. A compost of soil + sand + humus (2:1:1) was used as substrate. The seedlings were initially produced in tubes with a capacity of 200 mL, sowing one seed per tube.

After 60 days from the beginning of emergence, seedlings of the same height and development were transplanted to bags of the sizes, constructing the treatments described below: treatment 1- 15x20 cm bags; Treatment 2 - 15 x 25 cm bags; Treatment 3- 15x30 cm bags; Treatment 4- 15 x 35 cm bags; Treatment 5- Bags 15 x 40 cm. The design was completely randomized blocks (DBC) containing 5 treatments and 4 replications in which each experimental unit was composed of 10 papaya seedlings.

After 90 days of transplanting the seedlings, the following variables were evaluated: plant height (PA); number of leaves (NF), stem diameter (DC), root length (CR); green mass of leaves (MVF); dry leaf mass (MSF); root green mass (MVR) and root dry mass (MSR).

Plant height (AP) and root length (CR) were evaluated in the laboratory with the aid of a tape measure, and the number of leaves (NF) were counted leaf by leaf per plant. With the aid of a scalpel and a wooden base, the papaya seedlings had their leaves and roots pulled out and separated, in a similar way in all the seedlings evaluated. The diameter of the stem was measured with an electronic caliper. The green mass of the leaves (MVF) of each seedling was determined with the aid of a precision scale, and the leaves were packed in paper bags and demarcated with the respective treatments and field repetitions, in sequence, using the same procedure, the green root mass (MVR) of each seedling was evaluated. All the demarcated paper bags were placed in an oven at a temperature of 70 °C for 72 hours. With the aid of a precision scale, the dry mass of the leaves (FSM) and the dry mass of the root (SRM) were evaluated.

The experimental data were submitted to analysis of variance, meeting the assumptions of the model by the Shapiro-Wilk test to verify normality and the means of the treatments compared by Tukey's test at a level of 5% of probability.

RESULTS AND DISCUSSION

Table 1 shows that the treatment with 15x25 bags presented the best results in the evaluation of the aerial part (AP) of the papaya seedling. A good development of the aerial part is of great importance so that the seedling is in the right conditions for planting and establishing the seedlings in the field.

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Also in table 1, it is possible to observe that the treatment with 15x25 bags achieved the best result in stem diameter (CO). And in the evaluation of the number of leaves (NF), the treatment with a 15 x 30 bag achieved the best result.

The treatment composed of the largest bag, 15 x 40 cm, presented the best result in root length (CR). The fact that the 15 x 40 cm bag is larger, when compared to the other treatments, allowed the roots of the papaya seedling to develop better in this container.

Table 1 – Development of papaya seedlings in different bags

Treatments	AP	NF	Anno Domini	CR
Bag 15 x 20	33.88 c	7.2 ab	11.59 to	29.74 b
Bag 15 x 25	46.40 to	6.4 b	9.28 b	31.32 b
Bag 15 x 30	42.91 b	8.2 to	4.78 c	38.58 abs
Bag 15 x 35	44.34 to	7.7 abs	7.62 b	39.91 abs
Bag 15 x 40	42.91 b	7.6 AB	5.15 c	43.53 to
CV (%)	10,71	17,75	22,24	24,12

Means followed by the same letter in each column do not differ statistically at the level of 5% probability by Tukey's test. Source: prepared by the author.
Legend: AP = seedling height (cm); NF = number of sheets; DC = diameter of the stem (cm); CR = root length (cm).

The papaya seedling should not be measured, in terms of quality standards, by height, because it grows quickly, and the lower the flowering height in the field, the higher the production should be (ARAÚJO et. al., 2006). In this sense, the vigor of the seedling should be associated with the greater diameter of the neck, greater number of leaves and lower height. On the other hand, Sousa et. al. (2018) point out that the height of plants, as well as the length of the roots are factors that define the quality and resistance of seedlings when they are transplanted in the field, and poorly developed plants can provide low production.

Costa et al. (2010), when evaluating three sizes of bags for the production of papaya seedlings, found that the container with the largest size and volume produced better seedlings. From these data, the authors concluded that the size of the container influences the growth, development and initial quality of the seedlings.

The definition of the size of the container for seedling production is an important aspect, as it influences several characteristics of the seedling and can affect the percentage of survival in the field and crop productivity. The shape and size of the container influence the growth of the roots and the aerial part of the plant. Lima et al., (2006), when analyzing the volume of containers and the composition of substrates for seedling production, concluded that a small container limits plant growth, producing seedlings of low quality, and containers of larger volumes, 2 L or more, were the most suitable for seedling production.

Mendonça et. al. (2003) working with different containers in the formation of papaya seedlings, namely, polyethylene bag with a capacity of 750 ml, styrofoam tray with a capacity of 70 mL per cell and 50 ml tubes, mention that the volume of the container had a great influence on the development of the seedlings. The polyethylene bag, in a larger volume container, was largely responsible for the better development of the seedlings. The little development of seedlings in tubes is mainly related to the substrate, whose nutrients are limiting and exhausted in a short time.

The absorption of water and nutrients is essential for the papaya tree to grow and develop healthily. According to Coelho (2005), the absorption of water by the root system depends on the density and distribution of roots in the soil. For the production of papaya seedlings, containers with satisfactory volume should be chosen that allow a good development of the roots.

The larger volume of the container improves the architecture of the root system. However, large containers entail higher production, transportation, distribution, and planting costs (LIMA FILHO et. al., 2019).

Melo et al. (2018), in order to evaluate the influence of container volume on the growth of forest seedlings, came to the conclusion that the use of larger containers form larger seedlings and considered to be of better morphological quality, and the main argument to justify this is the fact of greater nutrient availability.

The size of the container has a great influence on the final quality of the seedling. Containers with greater heights and larger volumes allow for better root development, providing more space for root growth. In addition, larger volume containers have more space to make substrates available to the plant, thus being able to store a greater volume of water, directly impacting the development of seedlings (GARCIA et. al, 2021).

The volume of the container is directly related to the amount of substrate, the space that the seedling will occupy in the nursery, the labor, the final cost of the seedling, the transportation and yield during planting and, mainly, the amount of inputs used. those produced in larger packages had faster growth, requiring less time for formation. Thus, the authors concluded that the type and characteristics of the container to be used influence the quality of the seedlings (LIMA FILHO et. al., 2019).

In the evaluation of the production of green and dry mass (Table 2), treatment 2 composed of a 15 x 25 cm bag, obtained the best results, both in the evaluation of the green and dry mass of the leaves and of the roots.

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Table 2 – Production of green and dry mass in papaya seedlings in different bags

Treatments	MVF	MSF	MVR	MSR
Bag 15 x 20	5.772 b	0.996 b	8,000 b	0.904 b
Bag 15 x 25	9,601 to	1,602 to	14,517 to	1,839 to
Bag 15 x 30	7,300 b	1.193 b	8,310 b	0.761 b
Bag 15 x 35	9,560 to	1,364 ab	14,865 to	1,579 AB
Bag 15 x 40	7,217 b	1,234 ab	12,126 ab	0.995 b
CV (%)	22,38	24,47	34,12	53,53

Means followed by the same letter in each column do not differ statistically at the level of 5% probability by Tukey's test. Source: prepared by the author.
Legend: MVR = green root mass ($^{g.pl-1}$); MVF = green mass of leaves ($^{g.pl-1}$); MSR = dry root mass ($^{g.pl-1}$); MSF = dry mass of leaves ($^{g.pl-1}$).

The treatment with a 15 x 25 cm bag stood out in the evaluation of the aerial part, being elected as the ideal to be used for papaya seedlings that cannot, for some reason, be taken to the field for definitive planting in the normal period, such as problems related to weather conditions or related to the seedling trade market.

Viana et al. (2008), also studying the behavior of forest seedlings, observed that all the variables studied responded positively to the sizes of the containers, that is, the larger the volume of the container, the better the result. It is important to note that the diameter and height of the containers may vary with the characteristics of each species and the respective time of permanence in the nursery.

Barbosa et al. (2013) suggest that it is necessary to find the balance point between volume and container format, in order to obtain quality seedlings, but which can also optimize production costs. Taking into account that 15x25 bags require less substrates and labor to be filled, they have a lower cost when compared to larger bags.

The use of bags larger than conventional sizes is an option when the seedlings cannot be planted at the ideal time and size, due to problems related to weather conditions or other factors that prevent the seedlings from being taken to the field. The larger size of the bag to keep the seedling longer in the nursery can be an alternative for the nursery to increase the useful life of the seedling before it is planted.

CONCLUSION

The size of the container has an effect on the development of papaya seedlings.

The bag of dimensions 15 cm x 25 cm high, presented the best result, being indicated as an ideal container for the maintenance of papaya seedlings in the nursery after the planting period.

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