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Development of scallion (*Allium fistulosum L.)* in substrate and homeopathic solutions of water hyacinth

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Abstract

Scallion (*Allium fistulosum*) is a widely appreciated condiment in the Brazilian population, with significant economic and nutritional importance. Organic cultivation alternatives for this crop have been sought. From this perspective, this study aimed to evaluate the development of scallion in a substrate produced from the floating aquatic plant known as Water Hyacinth (*Eichhornia crassipes*), combined with soil or without it, with the application of homeopathic solutions. A completely randomized experimental design was used, with five replicates and six treatments, namely: Pure Water Hyacinth Substrate (SAP); Water Hyacinth Substrate with Homeopathic solution (SA+HA); Soil and Water Hyacinth Substrate (S+SA); Soil and Water Hyacinth Substrate with Homeopathic solution (S+SA+HA); Pure Soil (SP), and Soil with Homeopathic solution (S+HA). The following parameters were evaluated 60 days after planting: plant height in centimeters (AP), shoot diameter in millimeters (DP), and the number of shoots (NP). Analysis of variance revealed that plant height (AP) did not exhibit significant differences between substrates with or without the homeopathic solution. In contrast, substrates containing Water Hyacinth exhibited greater shoot diameter and number of shoots. This study showed that the Water Hyacinth substrate and homeopathic solution had promising results in the production of scallion seedlings when combined with soil.

Keywords: dynamized solutions, *Eichhornia crassipes,* vegetables

Introduction

Scallion, known as *Allium fistulosum* L., is a botanical species from the Alliaceae family (Paulus et al., 2022). It is classified as a perennial species characterized by cylindrical and fistulous leaves that cluster in tufts (Araújo et al., 2012).

In Brazil, two species are mainly cultivated: the common scallion, originally from the Orient or Siberia, and the thin-leaved scallion, from Europe (Lana & Tavares, 2010). Both species are typically grown using the traditional beds method using chemical fertilizers and pesticides. The harvesting is carried out through cuts, which begin between 55 and 60 days after planting or between 85 and 100 days after sowing when the leaves reach approximately 0.20 to 0.40 meters in height (Araújo et al., 2012).

In many cases, the conventional practice of scallion cultivation is associated with the excessive use of chemical resources, leading to environmental contamination. Therefore, many producers have been seeking agroecological cultivation alternatives (Carvalho et al., 2019).

Practices based on agroecological principles play a significant role in soil conservation. In this sense, plant development is influenced by the choice of the substrate to be used, which allows for the anchoring of the root system, providing nutrients and meeting the water and oxygen requirements necessary for the initial development of the plant (Boldt et al., 2014).

The *Eichhornia crassipes*, known as water hyacinth, is an aquatic macrophyte widely recognized as one of the primary species of floating plants causing environmental issues in various tropical regions due to its rapid and efficient proliferation (Nesslage et al., 2016). It has significant potential for substrate production and is a plant with origin in South America (Farias et al., 2016;

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Teixeira, 2019). Although it is prevalent in Mato Grosso state, it is rarely used as a substrate for horticultural seedling production.

Water hyacinth has been employed as a substrate in various studies for tree seedling production. However, these studies are pioneering in its use as a substrate for vegetable development, particularly when associated with homeopathy.

Homeopathy is based on the experimentation of highly diluted and succussed preparations to promote plant health. Consequently, the introduction of homeopathy in agriculture has emerged as an alternative to reduce reliance on pesticides and the conventional system, which significantly burdens farmers (Mapeli et al., 2015).

Hence, this study aimed to develop scallion seedlings in water hyacinth substrate in the absence or presence of homeopathic solutions. Homeopathic solutions made from water hyacinth were used to determine if they would aid in the development of scallions.

Materials and methods

The experiment was set in pots in an open field under full sunlight for two months.

A completely randomized design (CRD) was used with five replicates and six treatments, totaling 30 plots. The substrates used were obtained from different compositions of dried and crushed water hyacinth plants, soil (Plintossolo), and homeopathic solution:

T1 - Pure Water Hyacinth Substrate (PWHS),

T2 - Water Hyacinth Substrate with homeopathic solution (WH+HS),

T3 - Soil and Water Hyacinth Substrate (S+WH) (1:1 v/v),

T4 - Soil and Water Hyacinth Substrate with homeopathic solution (S+WHS+HS) (1:1 v/v),

T5 - Pure Soil (PS), and

T6 - Soil with homeopathic solution (S+HS), tested in scallion cultivation.

Freshly collected, clean, and fresh water hyacinth leaves (*Eichhornia crassipes*) were used for the homeopathic solution. The preparation of the solutions was carried out using the Hahnemannian Dynamizer Denise Mechanical Arm equipment.

The process began with the preparation of the Mother Tincture (MT), using 114g of plant leaves in 1L of 70% cereal alcohol. The MT was stored in a glass container wrapped in aluminum foil for 15 days. During this period, the preparation was homogenized daily without opening the container. Subsequently, the dynamizations of homeopathic solution from 1 to 5 CH were prepared using the apparatus. The 5CH (fifth centesimal Hahnemannian dilution) was used for irrigation from the seedling planting in the substrates.

In order to quantify the volume of liquid (water and homeopathic solution) required for irrigation to reach field capacity (FC) for each substrate, the amount of water applied per treatment was assessed to ensure that the substrate had appropriate moisture levels throughout the pot's area. Irrigations were performed as needed to maintain the pots at field capacity, and this determination was made through daily weighing.

The calculation used for dilution was CF * VF = CI * VI, where CF is the final concentration, VF is the final volume, CI is the initial concentration, and VI is the initial volume. This procedure served as the basis for the values established regarding the amount of homeopathic solution diluted in distilled water for irrigation when necessary. For treatment 2, 84 mLs of homeopathic solution were diluted in 750 ml of distilled water; for treatment 4, 28 mLs of homeopathic solution were diluted in 250 mLs of distilled water; and for treatment 6, 14 mLs of homeopathic solution were diluted in 125 mLs of distilled water. The remaining treatments were irrigated with water.

The collected plants were dried in a laboratory in a forced-air oven at 60°C for 48 hours. Subsequently, they were manually crushed and used to prepare the water hyacinth substrate. Samples of this material was also sent for chemical analysis, and the results are presented in **Table 1**.

The scallion seedlings originated from fully established adult plants grown in full sun beds and were produced through asexual propagation, specifically from bulbs of *Allium fistulosum*. To this end, seedlings were rinsed with running water and disinfected, and their bulbs were cut, leaving one bulb with one leaf.

These seedlings were cultivated in 1.04 L pots with 11 cm diameter and 11 cm height. The pots were arranged in five distinct rows, with one plant per pot, and placed in field conditions. There was no need for disease and pest control, as there were no infestations.

Table 1. Chemical Analysis of the Substrate Produced with Aquatic Macrophytes (Eichhornia crassipeso).

components	N	P	K	cot	C/N
	(mg kg $^{-1}$)	(mg kg $^{-1}$)	(mg kg $^{-1}$)	(g kg $^{-1}$)	
water hyacinth	14,89	11,33	70,24	614,18	41,44

Data were collected 60 days after sowing to assess plant height in centimeters (AP), shoot diameter in millimeters (SD), and the number of shoots (NS). The data was submitted for analysis of variance, and when significant differences were observed, the means of the parameters were compared by the Tukey test at a 5% probability.

Results and Discussion

There was no significant difference in plant height (PH) of scallions grown in the different substrates, whether in the absence or presence of water hyacinth homeopathic solution (**Table 2**).

The mean plant height was 15.14 cm (Table 2), considered low according to the literature, where mean values of 25 to 35 cm are found (Silva et al., 2022).

Table 2. Morphological characteristics of Scallions (*Allium fistulosum* L.) at 60 days after planting, produced in different substrates with and without a homeopathic solution.

substrate	PH (cm)	NS (unit)	SD (mm)
PWHS	16.40 a	3.25 bc	2.23 c
WH+HS	14.13 a	2.25 c	2.47 bc
S+WH	17.27 a	4.50 a	3.01 ab
S+WHS+HS	16.89 a	4.75 a	3.03 ab
PS	12.19 a	3.75 ab	3.08 ab
S + HS	13.99 a	3.25 bc	3.24 a
C.V. %	16.92	14.17	9.69

Means followed by the same lowercase letter in the column do not differ statistically by the Tukey test ($p \leq 0.05$). PH: Plant height (cm); NS: number of shoots (unit); SD: shoot diameter (mm). PWHS: Pure Water Hyacinth Substrate; WH+HS: Water Hyacinth Substrate with homeopathic solution; S+WH: 1:1 of soil and Water Hyacinth Substrate; S+WHS+HS: 1:1 of soil and Water Hyacinth Substrate with homeopathic solution; PS: Pure Soil; and S+HS: Soil with homeopathic solution.

In response to the plant height of the scallion plants presented in this study, it can be inferred that shoot growth is the result of the influence of exogenous factors such as light, water, and, most importantly, mineral nutrients, among others, as well as endogenous factors like growth hormones (Taiz et al., 2017).

Plants subjected to the water hyacinth substrates (S+WH) and soil combined with water hyacinth irrigated with water hyacinth homeopathic solution (S+WHS+HS) exhibited a higher number of shoots with mean values of 4.50 and 4.75, respectively (Table 2).

A positive response of scallion plants for the number of shoots was observed when the water hyacinth substrate was amended in the soil, regardless of the application of the homeopathic solution (Table 2). This could indicate an efficient substrate to be used as an organic compound, given that the C/N ratio of water hyacinth is around 41.44 (Table 1), facilitating mineralization and nutrient availability to the seedlings. Intraspecific variations in nutrient content in this macrophyte (Table 1) are linked to different trophic conditions in aquatic environments, which can influence nutrient contents in plant tissues, thus promoting productivity (Henry & Camargo, 2002).

The water hyacinth substrate has a high nutrient content (Table 1), particularly in nitrogen and potassium (14.89 and 70.24 g kg^{-1}, respectively). Nitrogen is a component of chlorophyll and amino acids associated with ribulose 1,5-bisphosphate carboxylase/oxygenase (Rubisco), while potassium is an essential macronutrient for plant development. One of its most well-known functions is its involvement in translocating sugars and organic acids to other plant organs (Taiz et al., 2017). Adding this material to the soil may have contributed to reducing the density of the growing substrate, thereby improving root contact with nutrients and assisting in the nutrition of scallion seedlings.

For the shoot diameter, it was observed that all treatments involving water hyacinth substrate, water hyacinth homeopathic solution, and combined soil provided diameters above 3.0 mm (0.03 cm) and were 31% larger than the control substrates (Table 2). A typical commercial bunch typically comprises 12 shoots with an average diameter of 1 cm. Therefore, shoots with smaller diameters may require a larger quantity to form a commercial bunch, which could be a disadvantage for production intended for commercial purposes.

According to Gestel et al. (2005), the increase in diameter results from the accumulation of reserves in the basal region of the bulb. A larger diameter characterizes a greater capacity for reserve production, indicating that scallions may have accumulated assimilates for diameter growth, leading to an increase in leaf area rather than shoot development, as the values for the number of shoots were low (Table 2).

The shoot diameter contributes to understanding the optimization and use of light, as this characteristic is associated with the ability to intercept incident solar radiation. A higher value suggests greater production and distribution of assimilates, promoting seedling development (Taiz et al., 2017).

According to Tejo et al. (2019), knowing the organic carbon content in materials used, such as substrates and the soil itself, is of significant importance to understanding the content of organic substances involved in each agricultural activity, which might be related to reserve accumulation in plants. The water hyacinth material used in our study as substrate has a higher amount of organic matter (COT= 614.18 g kg-1, Table 1).

The quantity and diameter of scallion leaves are among the traits of higher commercial interest in the crop since they constitute the primary edible and marketable organ. Larger, more cylindrical, linear, and longer leaves are the most appreciated (Silva et al., 2022).

Conclusion

The scallion seedlings grew well in water hyacinth substrates, both in the presence and absence of homeopathic solutions. Plants cultivated in the water hyacinth substrate combined with soil, regardless of the application of homeopathic solutions, had a positive increment in the height, number, and diameter of the shoots.

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