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Evaluation of various Media for the Growth and Development of Tomato Seedlings

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Abstract

This study aims to evaluate different growth media to improve tomato seedling's quality. Tomato is an important crop cultivated by small and medium-scale farmers mainly for the domestic market. The demand for tomato seedlings has surged significantly as a result of the COVID-19 pandemic and recent floods. However, poor-quality growing media are often used which results in poor-quality seedlings, slow growth and low yields. As such a trial was conducted in the seedling nursery at the National Agricultural Research and Extension Institute (NAREI). This experiment was arranged according to the Complete Randomized Design with four treatments (T1: Promix; T2: Vermicompost; T3: SOW-mix and T4: burnt paddy hulls) and six replicates. All treatments were subjected to nutrient analysis. After five days, tomato seeds grown in burnt paddy hull media recorded significantly higher percent emergence than vermicompost potting media. Germination percent was significant in the order, of burnt paddy hulls > SOW mix > Promix > Vermicompost. Vermicompost potting soil achieved substantially more leaves per plant, longer leaves, longest plants, longest roots and highest wet and dry plant biomass when compared to the other treatments. Among all treatments, the burnt paddy shell produced the fewest plant parameters mentioned above. As such, seedling growers may consider incorporating vermicompost in their potting mixture to ensure high-quality tomato seedlings are produced and sold.

Keywords: Potting soil, Vermicompost; Burnt paddy hulls; Plant parameters

Introduction

Tomato *(Solanum lycopersicum)* belongs to the Solanaceae family, which is an economically important crop cultivated worldwide for its edible fruit. Tomato is the most important vegetable crop cultivated globally for the fresh and processed markets. The production of tomatoes has grown at a steady pace from 177. 43 million metric tonnes in 2015 to 186.66 million tonnes in 2020 (TRIDGE, 2020). China is the largest producer of tomatoes, which accounts for 34.7% of total production worldwide in 2020 (TRIDGE, 2020) [1].

In Guyana, tomatoes are an important non-traditional crop grown for domestic and international markets by small and medium-scale farmers and consumed in fresh and processed forms. Tomatoes are exported chilled, mashed, and frozen to Canada, Barbados, and Trinidad and Tobago (Wamucll, 2022). However, exports of this commodity have fallen precipitously from 303 tonnes in 2010 to 18 tonnes in 2019, resulting in a decrease in export earnings from 123,000 USD in 2010 to 9,000 USD in 2019. (Wamucll, 2022). This coincides with a dramatic decline in tomato production from 695,651 tonnes in 2015 to 106,608 tonnes in 2019 (NAREI, 2015; Wamucll, 2022) [2].

The demand for tomatoes has increased considerably during the COVID-19 pandemic and recent floods. This spike has prompted many seedling nurseries to use trays and growth media for tomato seedling production and moved away from traditional open-bed seedling production. However, a major hindrance to tomato cultivation is the utilization of poor-quality growth media which often causes poor crop establishment, slow growth and low yields [3].

Many studies have found that good-quality growing media can improve seed germination, seedling emergence, development, and quality of horticultural crops (Corti et al., 1998; Wilson et al., 2001; Sahin et al., 2005; Agbo and Omaliko, 2006). In some cases, commercial substrates are used to grow vegetable seedlings worldwide (Rodriguez et al., 2006). These substrates have better qualities than soil such as water and fertilizer use efficiency and lower populations of soil-borne pathogens (Louvet, 1982; Gullino and Garibaldi, 1994; Rodriguez et al., 2006); hence reducing the cost of soil sterilization or fumigants (Rodriguez et al., 2006) [4].

The most common media used for seedling production in Guyana are burnt paddy hulls, vermicompost, Lambert's mix, coconut coir, or a combination of these materials. Burnt paddy hulls are commonly used as seedling media by commercial producers because it is cheap and readily available in Guyana. Some authors found that decomposed rice hulls can be used as a seedling media due to improved growth of Corchorus olitorius, a leafy vegetable (Japa et al., 2020). The addition of 10% burnt paddy hulls to the growing media considerably increases the biomass and seedling quality index when compared to other media for the growth of P. sargentii seedlings (Aung et al., 2019) [5].

More recently, commercial growing media such as vermiculite or perlite are sometimes used to produce high-quality vegetable seedlings in small quantities. These media have low inherent nutrients and are also too expensive for commercial seedling production. According to NAREI (2018), pro-mix has high bulk density and high water-holding capacity, which is important for seedling production.

NAREI (2014) suggested that growers utilize Lambert's Mix (pro-mix) for seedling production because it can result in faster seedling growth and higher yields. Vermicompost is seldom used in seedling production due to its unavailability and high cost. Nevertheless, NAREI (2014), reported that vermicompost media increase the shoot length

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and leaf length of boulanger seedlings. The addition of vermicompost at a 1:1 ratio with other media or components has led to an improvement in height, stem girth, number of roots, root length and total biomass for papaya seedlings (Kendra et al, 2014) [6].

Consequently, a study was conducted to find out the nutrient composition of the different media and their effects on tomato seedlings.

Research objectives

- To determine the nutrient composition of the various media
- To ascertain seedling emergence
- To determine seedling growth and development using various media

Methodology

This trial was conducted in the Fruits, Vegetables and Other Crops seedling nursery in NAREI Compound, Mon Repos East Coast Demerara from February 2022 to August 2022 [7].

Experimental Design, Sampling, and data collection

This study was arranged according to the Complete Randomized Design (CRD) with four treatments replicated six times. The treatments were T1: Promix; T2: Vermicompost; T3: coconut coir and T4: burnt paddy hulls. Experimental trays were 52 cm by 28 cm with 128 cells. These trays were filled with different media and tomato seeds (Calypso) were sown. Seedlings were irrigated once daily for the first two weeks and then twice daily thereafter. Foliar fertilizer (bluetrex 20:20:20) was applied at two and 4 weeks at a rate of 10g/4L (NAREI, 2014). Seedling emergence was observed from all the sown seeds. 25 seedlings from each replication were randomly selected for the various parameters. 250 g of each media was collected for the chemical soil analysis according to Demir et al. (2010) and Arancon et al. (2012) [8,9].

The germination percentage was calculated according to Demisie et al. (2019) as follows:

Germination Percentage = (emerged plant / total number planted seeds) *100

Data were collected on emergence, plant height, number of leaves, root length, and fresh and dry biomass (Ogunrotimi and Kayode, 2018). Seedling emergence was done by counting the plants from 128 cell seedling trays until a constant reading was obtained according to Mathowa et al. (2017). Measurement of growth parameters began four weeks after sowing. Twenty-five plants in the centre of each tray were tagged for growth measurements, which began after true leaves developed (Mathowa et al., 2017). The plant's height was measured from the base to the shoot tip, and the number of leaves was determined by counting fully opened leaves. A ruler was used to measure the length of the roots from the base of the stem to the root tip. The twenty-five tagged plants were harvested at the end of the trial and placed in brown paper bags for plant biomass determination. An electronic balance was used to determine plant fresh weight immediately after harvest. The samples were oven-dried in a hot air oven for 24 hours at 80 °C (Mathowa et al., 2017) [10].

Statistically Analysis

The Statistix 10 software was used to perform statistical analysis on data collected from various treatments. Analysis of variance (ANOVA) was used to compare the means of each treatment. The means were separated using the least significant difference. Means were considered significantly different at $p < 0.05$.

Results and Discussion

Nutrient analysis of the various seedling media

The quantities of micronutrients and macronutrients differ among the various treatments (Table 1). The SOW mix seedling media had the highest levels of phosphorous and the lowest electrical conductivity among the treatments. On the other hand, Promix (Lambert) seedling media contains the greatest amount of nitrogen, sulphur, magnesium, manganese, calcium, and electrical conductivity when compared to the other seedling media (lambertpeatmoss.com). The vermicompost seedling media had the highest cation exchange capacity, and greater potassium and iron levels when compared to the other media. The highest pH and the lowest nutrient levels among the treatments were obtained from the burnt paddy hulls media [11].

The influence of the different media on the emergence and germination of tomato seed

The percent seedling emergence after five days can be seen in (Table 2). The burnt paddy hulls treatment recorded considerably greater percent emergence compared to the vermicompost media but did not differ from the other treatments (sow mix and promix). The similar percent emergence achieved from these media might be associated with similar physical attributes (Mathowa et al., 2016; Oagile et al., 2016). Nevertheless, the higher seedling emergence observed from the burnt paddy hulls might be attributed to better physical properties, particularly loose soil particles that encouraged earlier emergence (Mathowa et al., 2017). The slower emergence achieved from vermicompost medium might be associated with the physical characteristic (compact soil particles) which decreases emergence. Germination percentages among the various treatments were significantly different from one another. Germination percent was significant in the order of burnt paddy hulls > SOW mix > Promix > Vermicompost. The burnt paddy hulls obtained the highest percent germination of tomatoes which may be ascribed to the media itself (physical composition) and seeds were also exposed to better environmental factors such as oxygen, water availability, temperature, and light (Baiyeri and Mbah, 2006). The higher germination percentage acquired by the SOW mix when compared to promix and vermicompost might be attributed to better physical and chemical properties (Mathowa et al., 2017). On the other hand, the poor germination percentage of tomatoes in vermicompost medium may be due to the presence of sand which formed a crust on this media [12].

The influence of seedling media on the growth of tomato seedlings

Growth parameters were significantly ($P<0.05$) influenced by the seedling media as seen in (Table 3). Tomato seedlings grown in vermicompost media recorded significant improvements in growth such as the number of leaves, leaf length, plant height, root length, and wet and dry plant weight compared to other treatments. These growth improvements may be a result of better physical properties of vermicompost media such as organic matter content, bulk density and porosity which increased water availability to the plants (Grigatti et al., 2007; Abafita et al., 2014). Some authors suggested that the presence of nutrients in vermicompost that are readily available to plants such as nitrates, exchangeable phosphorus and soluble potassium encouraged the growth of tomato seedlings (Atiyeh et al., 2001; Arancon et al., 2012).

The findings from this experiment agree with Arancon et al. (2012) who found that hormones in vermicompost tea increased seedling height, root length and root density. The vermicompost media may stimulate photosynthesis and increase leaf biomass leading to improved growth and development (Atiyeh et al., 2000). Owing to favorable pH and CEC, the vermicompost media offered sufficient nutrients, which spurred root development and enhanced the metabolic process (Hashemimajd et al., 2004). These improvements in tomato seedling can be attributed to better cation exchange capacity and nutrient availability due to favourable pH (Abafita et al., 2014).

Promix media recorded a significant increase in tomato seedlings' leaf length, plant height and root length compared to burnt paddy hulls and SOW mix. SOW mix media obtained considerable increases in seedling growth such as plant height, root length, and wet and dry plant weight than burnt paddy hulls. The slower growth of tomato seedlings in the SOW mix and Promix media may be attributed to either the nutrient not available or it is being leached out of the media due to lower pH and CEC. Burnt paddy husk media had minimal effects on seedling growth which might be attributed to its low inherent nutrients seen in Table 3 [13,14].

Conclusion

These results suggest that vermicompost can be a viable option for growing tomato seedlings inside trays to ensure high-quality seedlings are available throughout the year. At the same time, seedling growers can improve their income and livelihood through increased sales and reduced seedling production time. The use of vermicompost can greatly reduce the dependence on fertilizer during seedling production. The significant increase in seedling emergence in burnt paddy hulls can be an alternative to improve other media.

Recommendations

- Burnt paddy hulls can be included in other media to improve seedling emergence
- Vermicompost should be added to other media to improve seedling growth and development
- More studies should be carried out at different ratios to reduce the dependency on one media type.

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