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QUALITY OF BRAZILIAN SPINACH SEEDLINGS (*Alternanthera sessilis* (L.) R.Br. ex DC.) IN REGIONAL SUMMAÚMA SUBSTRATE

QUALIDADE DE MUDAS DE ESPINAFRE DA AMAZÔNIA (Alternanthera sessilis (L.) R.Br. ex DC.) EM SUBSTRATO REGIONAL DE SUMAÚMA

CALIDAD DE PLÁNTULAS DE ESPINACA AMAZÓNICA (Alternanthera sessilis (L.) R.Br. ex DC.) EN SUSTRATO REGIONAL DE SUMMAÚMA

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ABSTRACT:

The use of unconventional food plants is an alternative for diversification and promotion of food sovereignty. The objective of this work was to evaluate the quality of spinach seedlings from the Amazon produced in samaúma substrate as conditioner. The experiment was carried out in a greenhouse in the experimental garden of the Federal University of Acre, from November to December 2022. The experimental design was completely randomized, with three treatments and 30 repetitions, totaling 90 experimental units. The treatments were 3 substrates, as follows: T1 - Commercial substrate; T2 - commercial substrate + samaúma substrate (1:1) and T3 – samaúma substrate. At 30 days of cultivation, the following variables were evaluated: leaf length, leaf width, seedling height, stem diameter, total number of shoots, total number of leaves, number of leaves per shoot, root length, fresh mass of the part aerial part, fresh mass of roots, dry mass of aerial part, dry mass of roots, total fresh mass, total dry mass and the Dickson quality index was calculated. The combination of the commercial substrate with the samaúma substrate (1:1) is an alternative for the production of spinach seedlings from the Amazon.

KEYWORDS: Amarantaceae, seedling production, unconventional vegetables.

RESUMO:

O uso de plantas alimentícias não convencionais é uma alternativa para diversificação e promoção da soberania alimentar. O objetivo deste trabalho foi avaliar a qualidade das mudas de espinafre da Amazônia produzidas em substrato de sumaúma como condicionador. O experimento foi realizado em estufa na horta experimental da Universidade Federal do Acre, no período de novembro a dezembro de 2022. O delineamento experimental foi inteiramente casualizado, com três tratamentos e 30 repetições, totalizando 90 unidades experimentais. Os tratamentos foram 3 substratos, sendo: T1 - Substrato comercial; T2 - substrato comercial + substrato de samaúma (1:1) e T3 - substrato de samaúma. Aos 30 dias de cultivo, avaliou-se as variáveis: Comprimento foliar, largura foliar, altura da muda, diâmetro do coleto, número total de brotações, número total de folhas, número de folhas por brotações, comprimento de raízes, massa fresca da parte aérea, massa fresca de raízes, massa secas da parte aérea, massa seca de raízes, massa fresca total, massa secas total e calculou-se o índice de qualidade de Dickson. A combinação do substrato comercial com o substrato de sumaúma (1:1) é uma alternativa a produção de mudas de espinafre da Amazônia.

PALAVRAS-CHAVE: *Amarantaceae, produção de mudas, hortaliças não convencionais.*

RESUMEN

El uso de plantas alimenticias no convencionales es una alternativa de diversificación y promoción de la soberanía alimentaria. El objetivo de este trabajo fue evaluar la calidad de plántulas de espinaca de la Amazonía producidas en sustrato de ceiba como acondicionador. El experimento se realizó en invernadero en el jardín experimental de la Universidad Federal de Acre, de noviembre a diciembre de 2022. El diseño experimental fue completamente al azar, con

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tres tratamientos y 30 repeticiones, totalizando 90 unidades experimentales. Los tratamientos fueron 3 sustratos, así: T1 - Sustrato comercial; T2 - sustrato comercial + sustrato samaúma (1:1) y T3 - sustrato samaúma. A los 30 días de cultivo se evaluaron las siguientes variables: longitud de hoja, ancho de hoja, altura de plántula, diámetro de tallo, número total de brotes, número total de hojas, número de hojas por brote, longitud de raíz, masa fresca de la parte aérea, masa fresca de raíces, masa seca de brotes, masa seca de raíces, masa fresca total, masa seca total y se calculó el índice de calidad de Dickson. La combinación del sustrato comercial con el sustrato samaúma (1:1) es una alternativa para la producción de plántulas de espinacas de la Amazonía

Palabras clave: *Amarantaceae, producción de plántulas, hortalizas no convencionales.*

INTRODUCTION

Despite the world's rising number of plant species, only a select few are grown to produce food (REIFSCHNEIDER et al., 2015). As a result, in order to increase food security, it is vital to vary the plant species consumed. Plant species designated as unconventional food plants - PANCs - may serve as an alternative for diversification in this context (TULER et al., 2019).

One of these species is Brazilian spinach, considered rustic and easy to cultivate but has few well-established production procedures (HOLM et al., 1997). Also known as orelha-de-macaco (*Alternanthera sessilis* (L.) R.Br. ex DC), it is a fast-growing species that is normally found in disturbed and humid areas (HWONG et al., 2022; KABEERDASS et al., 2022).

In order to include these species in cultivation and promotional programs, it is vital to investigate the agronomic properties of unconventional food plants native to Brazil (COELHO et al., 2013). An essential stage in the vegetable production process is the production of seedlings, which can be done separately from the growing stage (JOHKAN et al., 2010). The quality of seedlings is the most important factor to consider, as it affects growth and productivity in the field (SANTOS, 2002).

Commercial substrates are utilized in the production of seedlings, increasing the cost of the process and, as a result, lowering producer competitiveness (PASCUAL et al., 2018; AIRES et al., 2020). Therefore, it is usual to combine substrates and conditioners to find the ideal ratio that offers better results for seedling growth and quality, as well as cheaper costs (NANDEDE et al., 2014). The combination of substrates with easily accessible organic materials as conditioners has been shown to be an excellent strategy to

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minimize or even replace the use of commercial substrates (CUNHA et al., 2014; SILVA et al., 2022).

In the Amazon, decomposed stems are commonly used as substrates or substrate conditioners for vegetable production. *Ceiba pentandra* (L.) Gaertn, is a plant frequently employed for this purpose (SILVA et al., 2018). Lima et al. (2021) found that the use of this alternative substrate, combined with other substrates, results in the production of quality vegetable seedlings.

The abundance of samaúma substrate in the northern region of Brazil drives the use of this raw material in the composition of substrates for the production of seedlings, which reduces reliance on the market and ensures internalization and autonomy throughout the production process (SOUZA et al., 2005; ARAÚJO NETO et al., 2015; SIMÕES et al., 2015; SILVA et al., 2016). The decomposed samaúma stem substrate is rich in essential macronutrients, such as potassium, sulfur, nitrogen and calcium, along with the micronutrient manganese, which are crucial for seedling growth (SILVA et al., 2018). As a result, the goal of this study is to assess the quality of Brazilian spinach seedlings grown in the Amazon using samaúma substrate as a conditioner.

MATERIAL AND METHODS

The research was carried out at the Universidade Federal do Acre's experimental unit, which is located in the municipality of Rio Branco, Acre, at the coordinates (9o 57' 34" S, 67o 52' 13" W, 143 m altitude). The experiment was set up on metal benches in a greenhouse with open sides and a plastic cover (100 microns) + shade factor 50% shadowing, from November to December 2022, totaling 30 days. According to Köppen (1918), the climate in the region is hot and humid, type Am, with an average temperature of 25.4 °C, relative humidity of 88.4%, and precipitation of 752 mm. (INMET, 2023).

The study used a completely randomized design (DIC), with three treatments: T1 - commercial substrate (CS); T2 - commercial substrate + samaúma substrate (CS+SS) and T3 - samaúma substrate (SS) and 30 replications, for a total of 90 experimental units. The commercial substrate used was MecPlant, found in local stores. The samaúma substrate was obtained from

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a local vegetable grower who gathered material from the degraded stem of the woodland plant *C. pentranda*. The mixing of commercial substrate with samaúma substrate was done in a homogenous, 1:1 ratio. Chemical and physical analyses of the substrates and mixture were performed. (Table 1).

Table 1 - Chemical and physical analysis of the substrates used in the production of Brazilian spinach seedlings.

Substrate	**pH**	**N**	**P**	**O. M.**	**W.H.C.**	**E.C**
		------------------ % ------------------				**dS/m**
CS	5,53	0,75	0,50	66,98	212	683
CS+SS	5,18	0,45	0,23	67,16	218	446
SS	4,02	0,76	0,11	78,25	216	144,9

*CS = comercial substrate; CS+SS = comercial substrate + samaúma substrate; SS = samaúma substrate ; O.M = organic matter; W.H.C. = water holding capacity; E.C = electrical conductivity.

Polystyrene containers with a capacity of 200 cm^3 were employed, and 18 of them were filled with substrates according to the established experimental design, followed by the packaging of plant material (cuttings) from Brazilian spinach. The matrices of the vegetative material, were grown in a bed under greenhouse conditions at the Universidade Federal do Acre's experimental unit.

The assessments were carried out in the laboratory after 30 days of acclimatization of the seedlings, with 18 repetitions chosen in each treatment. Plant height (H), stem diameter (SD), leaf length (LL), leaf width (LW), total number of leaves (TNL), total number of shoots (TNS), root length (RL), shoot fresh mass (SFM), shoot dry mass (SDM), root fresh mass (RFM), root dry mass (RDM), total fresh mass (TFM), total dry mass (TDM) were all measured. The collected material was dried in an oven with forced air circulation at 65°C for 72 hours to determine the dry mass. The Dickson seedling quality index (DQI) was calculated to verify the quality of the seedlings using the methods of Dickson et al., (1960), which is stated by the following formula:

$$\mathrm{DQI} = \frac{\mathrm{TDM\ (g)}}{\left(\frac{\mathrm{H\ (cm)}}{\mathrm{SD\ (mm)}}\right) + \left(\frac{\mathrm{SDM\ (g)}}{\mathrm{RDM\ (g)}}\right)}$$

The acquired data were subjected to the Grubbs test (1969), the Shapiro-Wilk test (1965), and the Cochran test (1941) for verification of discrepant data (outliers). Following that, the F test was used to perform an analysis of variance to confirm the significance of the treatments. Tukey's test (1949) at 5% probability was used to compare means for the treatments that indicated a significant difference. Multivariate analysis with principal components and multiple correlation of factors was also performed to identify the influence of substrates. Statistical analyses were carried out using the free and open source software R.

RESULTS AND DISCUSSION

Plant height, leaf length, leaf width, total number of shoots, root length, shoot fresh mass, shoot dry mass, total fresh mass, total dry mass and the Dickson quality index - DQI were all significantly different in seedlings grown in different substrates. Two treatments stood out for DQI. The difference in stem diameter and total number of leaves was not statistically significant. The seedlings grown in CS and CS+SS performed better in all of the variables tested (Tables 2 and 3).

Table 2 - Plant height (H), stem diameter (SD), leaf length (LL), leaf width (LW) total number of shoots (TNS), total number of leaves (TNL) and root length (RL) in seedlings of Brazilian spinach produced in different substrates.

Substrate	H	SD	LL	LW	TNS	TNL	RL
	-- cm --	------------ mm ------------			------ uni ------		-- mm --
CS	6,24 a	3,59 a	41,11 a	38,28 a	48,50 a	2,94 a	19,31 a
CS+SS	4,47 b	4,09 a	22,78 b	20,44 b	20,50 b	3,22 a	18,46 a
SS	3,35 b	3,77 a	12,06 c	10,67 c	8,00 c	2,66 a	10,18 b
CV (%)	23,60	20,88	15,53	16,09	11,68	24,40	18,53

*Means followed by the same letter do not differ (p>0.05) according to the Tukey test. CS = Commercial substrate, CS+SS = Commercial substrate + samaúma substrate, SS = Samaúma substrate

Except for the stem diameter and total number of leaves, the treatments with commercial substrate followed by the combination produced higher values for the majority of the assessed variables (Table 2). Due to the standardization

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of the variables in the experiment at the time of its implementation (SILVA et al., 2022), these two variables did not demonstrate a significant difference. CS and CS+SS had higher values for shoot fresh mass, shot dry mass, total fresh mass, and total dry mass (Table 3).

Table 3 - Shoot fresh mass (SFM), shoot dry mass (SDM), root fresh mass (RFM), root dry mass (RDM), total fresh mass (TFM) and total dry mass (TDM) of Brazilian spinach seedlings, produced in different substrates.

Substrate	**SFM**	**SDM**	**RFM**	**RDM**	**TFM**	**TDM**
	---------------------------------- (g) ---------------------------------					
CS	7,12 a	0,60 a	0,94 a	0,10 a	8,07 a	0,70 a
CS+SS	1,84 b	0,39 b	0,74 a	0,07 a	2,58 b	0,46 b
SS	0,65 b	0,12 c	0,11 b	0,01 b	0,77 c	0,13 b
CV (%)	22,64	30,48	23,36	28,19	18,36	19,07

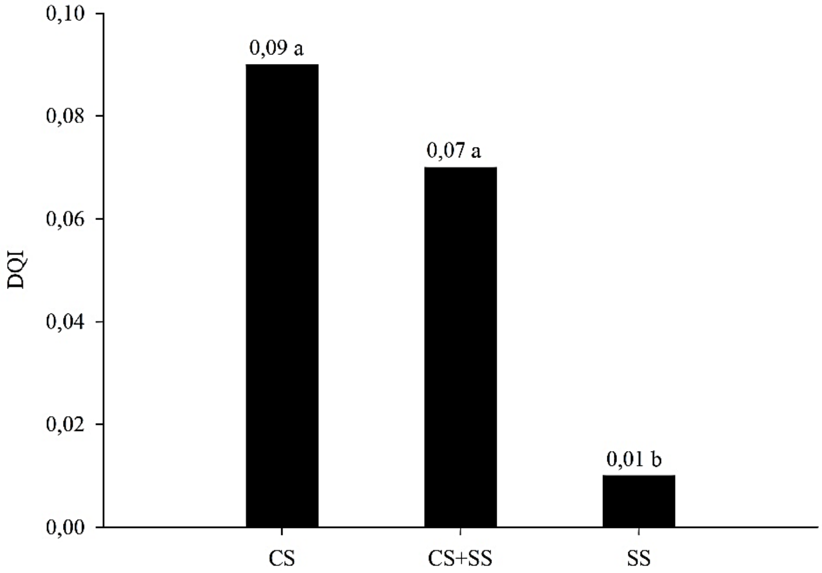
*Means followed by the same letter do not differ according to the Tukey test ($p<0.05$). CS = Commercial substrate, CS+SS = Commercial substrate + samaúma substrate, SS = Samaúma substrate.

The fresh and dry root mass for CS and CS+SS did not differ significantly. The SS treatment had lower fresh dry mass values than the other treatments.

The CS had a higher absolute value for the Dickson quality index variable, but it did not differ from the CS+SS treatment. As a result, the substrate mixture yields high-quality Brazilian spinach seedlings. The SS, on the other hand, had a lower value than the other treatments. In general, the seedlings grown in the SS were inferior for most of the characteristics assessed, with the exception of stem diameter and total number of shoots, which there was no significant difference between the approaches studied (Table 2).

The Dickson Quality Index (DQI) is an indicator of seedling quality because it examines the balance of plant biomass within the most essential evaluated factors for seedling development under field settings. As a result, the higher the DQI value, the higher the seedling quality. Despite being designed to assess the quality of seedlings for forest species, the DQI has also been used to observe the quality of seedlings in vegetable species, observing the idiosyncrasies of the derived indices (SIMÕES et al., 2015).

Figure 1 - Dickson Quality Index in Brazilian spinach seedlings produced in different substrates.



*Means followed by the same letter do not differ according to the Tukey test ($p<0.05$). CS = Commercial substrate, CS+SS = Commercial substrate + samaúma substrate, SS = Samaúma substrate.

During the irrigations, it was noted that the water did not penetrate well into the SS, leaving an impediment layer on the top; the water infiltrated slowly in depth, leaving dry sections; a similar phenomenon occurred in the CS+SS, although to a lesser amount. This is due adopting a substrate made of only one type of material might result in a severely compacted soil that does not enable water and air to penetrate, limiting plant root growth (PREVITALI et al., 2012).

Pure samaúma substrate, which is highly lignified, that is, composed entirely of samaúma materials, is not recommended as an exclusive substrate for plants because it may not provide the nutrients and physical characteristics required for proper plant development, and must be mixed in proper proportions and tested with other materials (SIMÕES et al 2015; UCHÔA et al., 2018).

The insufficient supply of water for the roots in the samaúma substrate hampered seedling development. Water is necessary for nutrient absorption by plants because it transports dissolved nutrients such as nitrogen, phosphorus, and

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potassium from the soil to the roots of plants. Plants cannot absorb nutrients required for growth and development if they do not have access to water (ARAÚJO JÚNIOR et al., 2019).

Besides, water helps to maintain an adequate osmotic pressure for the absorption process, which is critical for the movement of nutrients from the root to the rest of the plant. It is vital to emphasize that the amount and frequency of water provided to the soil must be adequate to ensure optimal nutrient absorption by the plants. Excessive or insufficient water can impair plant nutrient absorption and, as a result, growth (CAMPOS et al., 2021).

The absence of water in the substrate is damaging to root growth and nutrient absorption (THIESEN et al., 2022). According to the literature, samaúma substrate produces quality seedlings when used as a conditioner and in proportion to and in combination with other complementary substrates, such as carbonized rice husks. (SILVA et al., 2018).

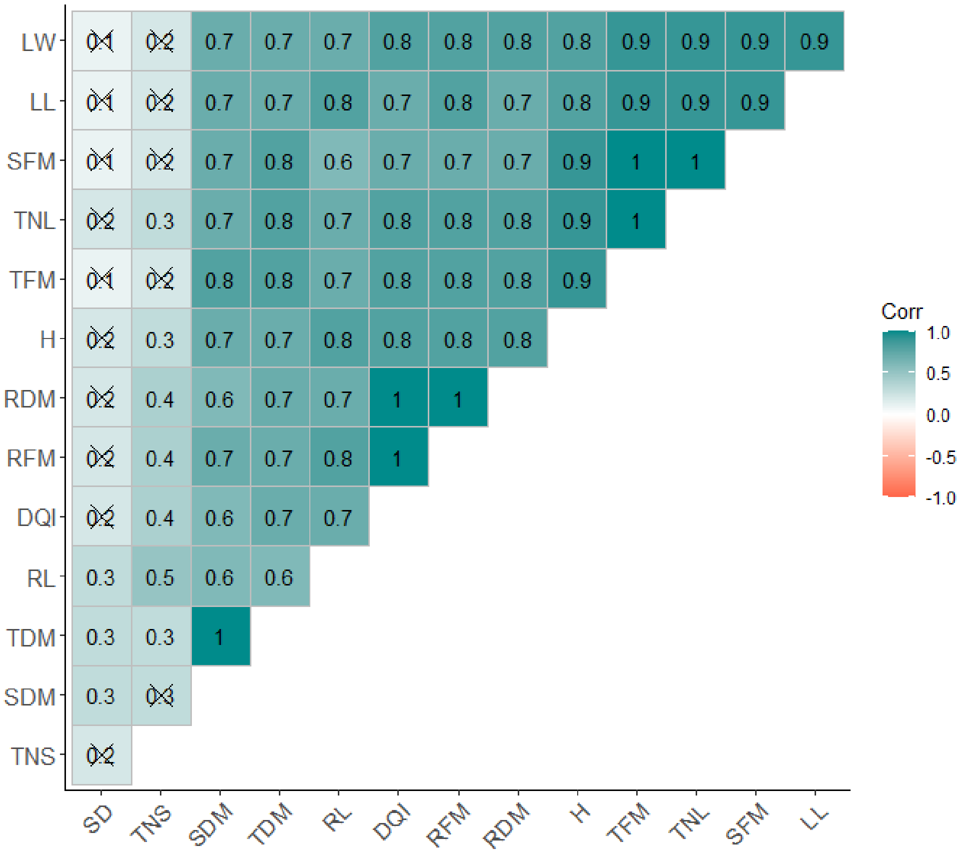
In this respect, Silva et al. (2022) discovered that the differences in substrate properties across treatments influence the morphometric parameters of the seedlings, namely the electrical conductivity (EC) of the soil. Similarly, in the current study, the samaúma substrate had a low electrical conductivity value when compared to the other treatments, highlighting the commercial substrate for having a higher conductivity value (Table 1).

Soil electrical conductivity (EC) is a measure of the soil's ability to conduct electric current and is an important physical attribute that influences fertility and water absorption. The number of ions and salts present in the soil is measured as EC, which can fluctuate depending on soil moisture, temperature, and nutrient levels. Low soil electrical conductivity measurements may suggest that the soil has few dissolved ions and salts. EC may also suggest that the amount of water in the soil is low, which affects plant nutrient uptake and soil biological activity (MOLIN; RABELLO, 2011).

The correlation matrix data were significant in the majority of the assessed variables ($p<0.05$). When the association between variables was verified, it was discovered that the DC and NTB variables did not show a significant correlation with the other evaluated variables and are not related to each other, indicating that they did not show a change in the growth characteristics of Brazilian spinach seedlings.

When comparing the correlations between the growth variables, it was discovered that the variables H, RL, DQI, SFM, RFM, TFM, SDM, RDM, TDM, and TNF had significant ($p<0.05$) and positive correlations with each other. It is quickly apparent that the growth or decrease of these factors is connected, increasing or decreasing together (Fig. 2).

Figure 2 - Correlation analysis between the variables studied in Brazilian spinach seedlings produced in different substrates.



*Positive and negative correlations are shown in blue and red, respectively, with the color intensity proportional to the correlation coefficient. Plant height (H), stem diameter (SD), leaf length (LL), leaf width (LW), total number of leaves (TNL), total number of shoots (TNS), root length (RL), shoot fresh mass (SFM), shoot dry mass (SDM), root fresh mass (RFM), root dry mass (RDM), total fresh mass (TFM), total dry mass (TDM) and Dickson quality index (DQI).

Due to the large accumulation of photoassimilates in the apical and roots, the correlations between the Dickson Quality Index (DQI) and the dry and fresh

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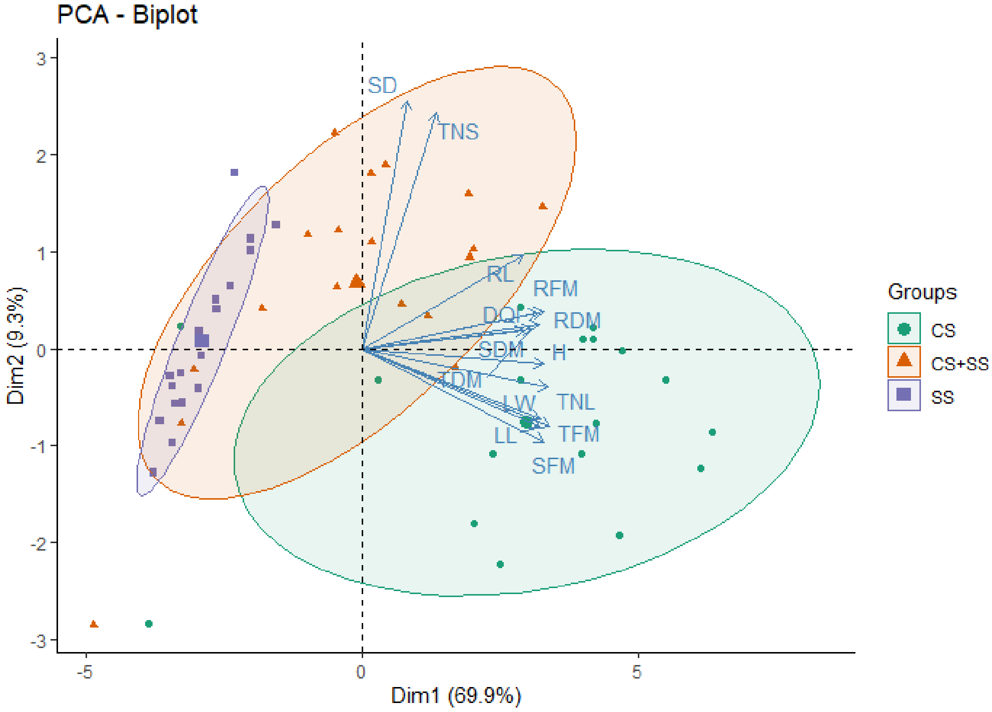
mass characteristics (TDM, SDM, RDM, TFM, RFM, and SFM) were substantial and positive for the index. The TNL variable has a strong relationship with the SFM, LL and LW variables.

The biplot of the principle component analysis (PCA) output modeling is presented in Figure 3. H, LL, RL, DQI, LW, SFM, RFM, TFM, SDM, RDM, TDM, TNS and TNL all contributed similarly to Dim1. These variables were highly associated to the commercial substrate during seedling formation, which contributed in the production of higher values. Furthermore, high positive correlations were found between these growth variables due to their sharp angular linkages.

Figura 3 - Principal component analysis of the variables associated with spinach seedlings from the Amazon produced in different substrates.



*Stem diameter (SD), total number of leaves (TNL), shoot fresh mass (SFM), shoot dry mass (SDM), root fresh mass (RFM), root dry mass (RDM), total fresh mass (TFM), total dry mass (TDM) and Dickson seedling quality index (DQI). Dimension/quadrant (Dim).

Dim2 assessment revealed little addition to the analysis. The stem diameter (SD) and total number of shoots (TNS) contributed more to the CS+SS mixture, but there was no specific association. In the experiment's installation

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methodology, the cuttings had roughly the same diameter as they were taken from the same portion of the matrix plant, indicating dissimilarity with the other evaluated variables, which had a stronger association with the commercial substrate. This is most likely due to the increased availability of nutrients for seedling development.

The results of the principal component analysis allows for the observation of data variability and possible connections between treatments, as well as the distinction of substrates and their mixtures utilized in the development of Brazilian spinach seedlings. The treatments in which the seedlings were formed with commercial substrate and commercial substrate + samaúma substrate did not show a statistical difference; however, when we look at the PCA (Fig. 3), we notice there is only a difference in the data concentration field, with these two treatments being more comprehensive between the quadrants but not differentiating from each other and presenting equality for the analysis.

According to Pereira et al. (2020), there is a growing demand for more cost-effective and viable alternative substrates for the production of vegetable seedlings. To create substrate mixtures, it is critical to understand the right proportion, since it might affect the chemical, physical, and biological components, affecting the quality of the seedlings (SIQUEIRA et al., 2019).

Organic substrates, when applied incorrectly, can reduce seedling quality (SILVA et al., 2018). The disintegrated kapok stem mixture can be used as a conditioner in combinations with various substrates that complement its physical and chemical qualities, resulting in high-quality seedlings. (UCHÔA et al., 2018).

CONCLUSION

The combination of commercial substrate with samaúma substrate (1:1) provides an alternative for the production of Brazilian spinach seedlings.

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Bibliographic References

AIRES, E.S.; ARAGÃO, C.A.; GOMES, I.L.S.; SOUZA, G.N. de; ANDRADE, I.G. de. Alternative substrates for production of yellow passion fruit seedlings. **Revista de Agricultura Neotropical**, v.7, n.1, p.43-48, 2020.

ARAÚJO JÚNIOR, G. do N.; GOMES, F.T.; SILVA, M.J. da; JARDIM, A.M.F. da R. SIMÕES, V.J.L.P.; IZIDRO, J.L.P.S.; LEITE, M.L. de M.V.; TEIXEIRA, V.I. SILVA, T.G.F. da. Estresse hídrico em plantas forrageiras: uma revisão. **PUBVET**, v.13, n.1, p.1-10, 2019.

ARAÚJO NETO, S.E. de; FREDNBERG, N.T.N.; MINOSSO, S.C.C.; NOVELLI, D. da S.; ANDRADE NETO, R. de C. Condicionadores de substrato para produção orgânica de mudas de cupuaçu. **Revista Brasileira de Fruticultura**, v.37, n.4, p.1083-1088, 2015.

CAMPOS, A.J. de M.; SANTOS, S.M.; NACARATH, I.R.F.F. Estresse hídrico em plantas: uma revisão. **Research, Society and Development**, v.10, n.15, p.1-7, 2021.

COCHRAN, W.G. The distribution of the largest of a set of estimated variances as afraction of their total. **Annals of Human Genetics**, v.11, n.1, p.47-52, 1941.

COELHO, M. de F.B.; TEIXEIRA, V.A.; AZEVEDO, R.A.B.; ALBUQUERQUE, M.C. de F. e. Propagação da poaia (Psychotria ipecacuanha) em diferentes substratos e posicionamento das estacas. **Horticultura Brasileira**, v.31, n.3, p.467-471, 2013.

CUNHA, C.; GALLO, A. S.; GUIMARÃES, N. F.; SILVA, R. F. Substratos alternativos para produção de mudas de alface e couve em sistema orgânico. **Scientia Plena**, v.10, n.11, 2014.

DICKSON, A.; LEAF, A.L.; HOSNER, J.F. Quality appraisal of white spruce and white pine seedling stock in nurseries. **Forestry Chronicle**, v.36, n.8, p.10-13, 1960.

GRUBBS, F.E. Procedures for detecting outlying observations in samples. **American Society for Quality**, v.11, n.1, p.1-21, 1969.

HOLM, L.; DOLL, J.; HOLM, E.; PANCHO, J.V.; HERBERGER, J.P. **World weeds:** natural histories and distribution. John Wiley & Sons, 1997.

HWONG, C.S.; LEONG, K.H.; AZIZ, A.A.; JUNIT, S.M.; NOOR, S.M.; KONG, K.W. *Alternanthera sessilis*: Uncovering the nutritional and medicinal values of an edible weed. **Journal of Ethnopharmacology**, p.1-15, 2022.

INMET. Instituto Nacional de Meteorologia. **Banco de dados meteorológicos para ensino e pesquisa**. 2023.

JOHKAN, M.; SHOJI, K.; GOTO, F.; HASHIDA, S.; YOSHIHARA, T. Blue light-emitting diode light irradiation of seedlings improves seedling quality and growth after transplanting in red leaf lettuce. **Hortscience, Abiko**, v.45, n.12, p.1809-1814, 2010.

KABEERDASS, N.; MURUGESAN, K.; ARUMUGAM, N.; ALMANSOUR, A. I.; KUMAR, R. S.; DJEARAMANE, S.; KUMARAVEL, A. K.; VELMURUGAN, P.; MOHANAVEL, V.; KUMAR, S. S.; VIJAYANAND, S.; PADMANABHAN, P.; GULYÁS, B.; MATHANMOHUN, M. Biomedical and textile applications of *Alternanthera sessilis* leaf extract mediated synthesis of colloidal silver nanoparticle. **Nanomaterials**, v. 12, n. 16, p. 1-12, Aug. 2022.

KÖPPEN, W. Klassifikation der klimate nach temperatur, niederschlag und jahreslauf. **Petermanns Geographische Mitteilungen**, Gotha, v.64, n.5, p.193-203, 1918.

LIMA, A. A. de; FERREIRA, R. L. F.; CARVALHO, C. A. C. de; ARAÚJO NETO, S. E. de; SOUZA, L. G. de; SILVA, N. M. Resíduos agroflorestais na composição de substratos e influência na formação de mudas de jambu. **Scientia Naturalis**, v.3, n.5, p.2226-2233, 2021.

MOLIN, J.P.; RABELLO, L.M. Estudos sobre a mensuração da condutividade elétrica do solo. **Engenharia Agrícola**, v.3, n.1, p.90-101, 2011.

NANDEDE, B.M.; RAHEMAN, H.; KUMAR, G.V.P. Standardization of potting mix and pot volume for the production of vegetable seedlings in paper pot. **Journal of Plant Nutrition**, v.37, n.8, p.1214-1226, 2014.

PASCUAL, J.A.; CEGLIE, F.; TUZEL, Y.; KOLLER, M.; KOREN, A.; HITCHINGS, R.; TITTARELLI, F. Organic substrate for transplant production in organic nurseries. A review. **Agronomy for Sustainable Development**, v.38, n. 3, p.1-23, 2018.

PEREIRA, C.M. da S.; ANTUNES, L.F. de S.; AQUINO, A.M. de; LEAL, M.A. de A. Substrato à base de esterco de coelho na produção de mudas de alface. **Nativa**, v.8, n.1, p.58-65, 2020.

PREVITALI, R. von Z.; TUCCI, M.L.S.; ARRUDA, F.B.; PIRES, R.C. de M.; LAGÔA, A.M.M.A. Efeito da compactação do substrato no crescimento de mudas de pupunheira. **Revista Árvore**, v.36, n.2, p.259-268, 2012.

REIFSCHNEIDER, F.J.B.; NASS, L.L.; HENZ, G.P.; HEINRICH, A.G.; RIBEIRO, C.S.C.; FILHO, K.E.; BOITEUX. L.E.; RITSCHEL. P.; FERRAZ, R.M.; QUECINI, V. **Uma pitada de biodiversidade na mesa dos brasileiros.** 17ª ed. 2015. 156 p.

SANTOS, T.M. Produção de mudas de hortaliças. *In*: MACHADO, S.F. (Org.). **Manual de hortaliças.** 2. ed. FUNEP. 2002. p. 163-196.

SHAPIRO, S.S.; WILK, M.B. An analysis of variance test for normality (complete samples). **Biometrika**, v.52, n.3/4, p.591-611, 1965.

REVISTA DESAFIOS ISSN: 2359-3652

SILVA, M.C. da; OLIVEIRA, R.V.; SOUZA, J.K. M. de; SILVA, M.C. da; MOURA, P.A.; LIMA, A.P.A. de; FERREIRA, R.L.F. Qualidade de mudas de espinafre da Amazônia (*Alternanthera sessilis*) produzidas com uso de substratos distintos. **Scientia Naturalis**, v.4, n.2, p.489-498, 2022.

SILVA, N.M. da; SIMÕES, A.C.; ALVES, G.K.E.B.; FERREIRA, R.L.F.; ARAÚJO NETO, S.E. de; Condicionadores alternativos de substrato na qualidade da muda e produtividade de couve manteiga. **Revista Verde**, v.11, n.5, p.149-154, 2016.

SILVA, N.M. da; SOUZA, L.G. de S. e; UCHÔA, T.L.; ALMEIDA, W.A. de; ARAÚJO NETO, S. E. de; FERREIRA, R.L.F. Qualidade de mudas de maracujazeiro amarelo produzidas com substratos alternativos. **Agropecuária Científica no Semiárido**, v.14, n.2, p. 96-102, 2018.

SIMÕES, A.C; ALVES, G.K.E.B; FERREIRA, R.L.F; NETO, S.A. Qualidade da muda e produtividade de alface orgânica com condicionadores de substrato. **Horticultura Brasileira**, Brasília, v.33, n.1, p.521- 526, 2015.

SIQUEIRA, P.D.; BARROSO, D.G.; CARVALHO, G.C.M.W. de; ERTHAL, R.M.; RODRIGUES, M. C.C.; MARCIANO, C.R. Lodo de esgoto tratado na composição de substrato para produção de mudas de *Plathymenia reticulata* Benth. **Ciência Florestal**, v.29, n.2, p.728-739, 2019.

SOUZA, C.R. de; LIMA, R.M.B. de; AZEVEDO, C.P. de; ROSSI, L.M.B. **Sumaúma (*Ceiba pentandra* (L.) Gaerth).** Embrapa Amazônia ocidental, 2005. 22 p. (Documentos, 41).

THIESEN, L.A.; ALTISSIMO, B.S.; HOLZ, E.; PINHEIRO, M.V.M.; SCHMIDT, D. Technical feasibility of minicutting of different portions of the branch to produce clonal seedlings of Aloysia triphylla. **Comunicata Scientiae**, v.13, p.1-6, 2022.

TUKEY, J.W. Comparing individual means in the analysis of variance. **International Biometric Society**, v.5, n.2, p.99-114, 1949.

TULER, A.C.; PEIXOTO, A.L.; SILVA, N.C.B. da. Plantas alimentícias não convencionais (PANC) na comunidade rural de São José da Figueira, Durandé, Minas Gerais, Brasil. **Rodriguésia**, v.70, p.1-12, 2019.

UCHÔA, T.L.; ALMEIDA, W.A. de; ARAÚJO NETO, S.E. de; SOUZA, L.G. de S. e; FERREIRA, R.L.F.; SILVA, N.M. da. Produtividade de almeirão orgânico produzido com substratos alternativos. **Revista Verde de Agroecologia e Desenvolvimento Sustentável**, v.13, n.2, p.132-137, 2018.