AUSTRALIAN JOURNAL OF BASIC AND APPLIED SCIENCES

ISSN:1991-8178
EISSN: 2309-8414

DOI: 10.22587/ajbas.2017.11.16.2
Journal home page: www.ajbasweb.com

Substrates in vegetable growing baby leaf type

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ARTICLE INFO

Article history:
Received 12 October 2017
Accepted 22 December 2017
Available online 15 January 2018

Keywords: *Substrates, Lettuce, baby leaf type*

ABSTRACT

Lettuce is the most consumed leafy vegetable in Brazil,it has minerals such as calcium and iron and satisfactory amounts of B1, B2, B6, C vitamins and pro-vitamin A.However, the substrate is a limiting factor in producing these mini vegetables, the substrate is considered a way to provide structural support for root development, supplying the needs of oxygen, water and serving as a source of nutrients for plants.. Thus, the objective of the study was to evaluate substrates for growing vegetables of Baby Leaf type. There were used mini vegetables as arugula and three types of lettuce: butterhead, purple and american. The experiment was conducted in a greenhouse in the experimental area of UNISEP (União de Ensino do Sudoeste do Paraná), in the municipality of Dois Vizinhos, in the state of Paraná, Brazil, from March 25th to April 16th of 2015.The experimental design was completely randomized with five treatments and four replications. The substrates used were vermiculite, sawdust, coconut fiber, a mix of latosoil + sand + poultry bed (1:1:1 v/v), and commercial substrate. The evaluations were performed 21 days after the installation of the experiment. For the production of butterhead, purple and american lettuces, as well as arugula baby leaf type, the mix of latosoil + sand + poultry bed can be used as an alternative substrate, but it is necessary to develop studies to suit the substrate for cultivation.

INTRODUCTION

Lettuce is the most consumed leafy vegetable in Brazil (SANTOS *et al*., 2001), it has minerals such as calcium and iron and satisfactory amounts of B1, B2, B6, C vitamins and pro-vitamin A, presenting low caloric content with good digestibility (KATAYAMA, 1993; SHIZUTO, 1983). In addition lettuce can be cultivated by different system such as traditionals, hydroponics(Makhadmeh et al,2017), aquaponics (Edaroyati et al,2017) as well as organic.

In general, the species of lettuce have low conservation capacity, being very perishable, in this way they are cultivated or explored near the consumer centers facilitating the logistics of the same.

In the same way, arugula is a plant that contribute significantly to human consumption, besides the production of vegetable oils and fats in regions of mild climate, it can be produced all year round (FILGUEIRA, 2003).

In recent years there has been an increase in consumption of arugula. According to Filgueira (2008), this vegetable tastes bitter and strong, but they are rich in vitamins A and C and minerals such as iron, potassium and sulfur.

However, it is recommended by WHO (World Health Organization) the daily consumption of 400g of fruits

To Cite This Article: Alberto Ricardo Stefeni, DalilaPaula Slomoszinski, Marcelo Dotto, Kelli Pirola Alexandre Hack Porto, Rayanah Stival Svidzinski., Substrates in vegetable growing baby leaf type. ***Aust. J. Basic & Appl. Sci.,*** *11(16):11-16, 2017*

and vegetables, but the consumption of Brazilians does not exceed 100g per day.

Vegetables usually have large amounts of antioxidants, which prevents the formation process of inflammatory substances, thus protecting the cells against oxidative processes (WYNN *et al*., 2010).

The launch of differentiated products in the market, have as main objective to increase the interest of the consumer in acquiring and consuming these products. Since there are already some different vegetables, such as baby carrots and baby leaf lettuces. Baby leaf lettuces are mini vegetables, which through management and cultural treatment anticipate the process of harvesting of the young leaves when soft, without losing their nutritional value, being the same commercialized individually or as a mix of several species in the same package (PURQUERIO & MELO, 2011).

In Japan, United States and Europe the production of mini vegetables has been established since the 1990s (GONNELLA *et al*., 2003). However, in Brazil the exploitation of these vegetables is still in the process of expansion.

For baby leaf production it is necessary to use good quality substrates that meet the nutritional requirements of plants. According to Gomes & Silva (2004), the substrate is considered a way to provide structural support for root development, supplying the needs of oxygen, water and serving as a source of nutrients for plants (Makhadmeh *et al*,2017).

The use of alternative substrates for the production of vegetables is a good option for producers, since they can use materials from the region itself to formulate substrates, reducing production costs.

According to Miranda *et al*. (1998) and Smiderle *et al*. (2001), the alternative substrates for the purpose of growing vegetables have been studied and developed to provide a better development in the exploitation of these. Among some desirable characteristics, there should be paid attention to some characteristics of the substrate as light, good physical and chemical structure, good absorption, water retention and be free of pests, pathogenic organisms or seeds of invasive plants.

However, for the cultivation of baby leaf type vegetables, there is still little information, being necessary to know the best substrate for their production.

Thus, the work aimed at evaluating different substrates for the cultivation of baby leaf type vegetables.

MATERIAL AND METHODS

The experiment was conducted in a greenhouse in the experimental area of UNISEP (União de Ensino do Sudoeste do Paraná), in the municipality of Dois Vizinhos, in the state of Paraná, Brazil, from March 25th to April 16th of 2015.

Five types of substrates were tested: commercial substratum, vermiculite, sawdust, coconut fiber and the mixture of latosoil + sand + poultry bed (1:1:1 v/v).

Commercial seeds of four varieties of vegetables purchased in the local commerce were used, being the butterhead, purple and american lettuces and arugula baby leaf type. The experiment was installed in plastic trays with transparent cover of dimensions (15 x 25cm), which were perforated in the bottom to drain the excess of water. About 300g of substrate was used in each tray according to each treatment. Seeds were plated directly on the substrate, being 100 seeds per replicate, with a depth of 0.5cm. Subsequently, the trays were closed and opened only to perform irrigation, which was performed daily in two shifts, morning and afternoon, according to the need of each substrate, along with irrigation was provided nutrient solution used in hydroponics for the cultivation of arugula and lettuce respectively.

The experimental design was completely randomized, with four replications in a 5 x 4 factorial (substrate x baby leaf varieties), with four replications.

The evaluations were performed 21 days after the installation of the experiment. Ten plants were randomly evaluated from each replicate. The variables analyzed were: leaf width (cm), shoot height (cm), fresh mass of the root system (g), fresh shoot mass (g), and number of leaves. To determine shoot height, leaf width, and fresh mass of the root system, they were carefully removed from the substrates, washed in water and measured with a ruler graduated in centimeters. Subsequently, to obtain the mass of the fresh matter, the plants were weighed with the aid of an analytical balance.

The data were submitted to analysis of variance and to the Tukey test ($p \leq 0,05$), through the ASSISTAT computer program (SILVA & AZEVEDO, 2009). When necessary, the data were transformed according to the sine arc, according to the need presented by the normality test of Lilliefors.

RESULTS AND DISCUSSION

Table 1 shows the aerial shoot height data for american lettuce. It was observed that the substrate based on the mix of latosoil + sand + poultry bed was statistically superior in relation to the other treatments. Height is a very important factor since the baby leaf is commercialized with a size that can vary from 5 to 12cm, so the sooner the leaves reach this size, the sooner the producer can anticipate the commercialization of them.

In relation to the fresh root mass, the substrate based on coconut fiber obtained the best average, but did not differ in relation to substrates based on vermiculite, commercial substratum and the mix based on latosoil + sand + poultry bed, only differing from the sawdust substrate, the root system mass indicates the need of the plant to look for nutrients, since the coconut fiber can be considered a substrate of low fertility, thus, the plants move more energy of the photoassimilates in the roots for nutrients and water and consequently end up harming its vegetative development.

For leaf number, vermiculite and commercial substrate obtained similar results, but did not differ statistically in relation to the substrate based on latosoil + sand + poultry bed, differentiating only from the sawdust substrate. As the number of leaves being a very important factor for producers, the more leaves are, more profitable the production will be.

The origin of the substrate together with the quality of the plant is directly interconnected, influencing the development of the seedlings.

Studies by Medeiros *et al*. (2001), emphasizes that it is possible to obtain better responses with alternative substrates such as humus + charcoal rice husk mixture, due to its retention capacity, due to lower pore sizes.

Table 1: Height of aerial part (HAP) (cm), fresh root mass (FRM) (g), and leaf number (LN) in american lettuce baby leaf type, on different substrates. Dois Vizinhos – PR, 2015.

SUBSTRATES	HAP	FRM	LN
Vermiculite	3.54 b*	0.05 ab	4.75 a
Sawdust	1.84 c	0.02 b	3.97 c
Comercial Substrate	3.79 b	0.09 ab	4.62 a
Coconut Fiber	3.04 b	0.16 a	4.20 bc
Latosoil + Sand + Poultry bed	6.96 a	0.12 ab	4.47 ab
CV (%)	12.28	55.14	3.48

*Averages with different, lowercase letters in the same column differ significantly at the 5% probability level by Tukey test.

Observing table 2, the fresh mass of the aerial part and leaf width, the substrate based on latosoil + sand + poultry bed obtained the best result in relation to the other treatments.

These results may be directly linked to the quality of the substrate since it comprises the poultry bed, containing large amount of important nutrients for the development of vegetables. Besides the chemical characteristics of the substrate, it can still have physical characteristics suitable for water absorption and availability of nutrients for the plants.

Costa *et al*. (2007), analyzing the development of tomato seedlings with alternative substrates and commercial substratum, concluded that the last showed better performance compared to the alternative substrate, where according to the study it presents better aeration, higher concentration of nutrients and greater water retention.

In turn, the alternative substrates, because they have available essential nutrients and greater capacity of retention of humidity, promoted a better development of the plants.

Table 2: Fresh shoot mass (FSM) (g) and leaf width (LW) (cm), in american lettuce baby leaf type, on different substrates. Dois Vizinhos - PR, 2015.

SUBSTRATES	FSM	LW
Vermiculite	0.56 b*	0.95 bc
Sawdust	0.43 c	0.72 c
Comercial Substrate	0.61 b	1.11 b
Coconut Fiber	0.60 b	0.86 c
Latosoil + Sand + Poultry bed	0.84 a	1.60 a
CV (%)	7.11	10.69

*Averages with different, lowercase letters in the same column differ significantly at the 5% probability level by Tukey test.

Analyzing table 3, height of aerial part, fresh root mass and number of leaves of lettuce plants, the results did not present statistical differences in the treatments.

The good quality of a substrate can be evaluated by numerous characteristics such as water retention capacity, aeration and availability of macro and micronutrients for good plant development.

For Guerrini &Trigueiro (2004), commercial substrates have a better percentage of microspores increasing their capacity to retain water, consequently promoting a better development of the plant root system. However, even the commercial substrates having a higher value, in this case it is best to use an alternative substrate of low cost to the producer.

Table 3: Height of aerial part (HAP) (cm), fresh root mass (FRM) (g), and leaf number (LN) in butterhead lettuce baby leaf type, on different substrates. Dois Vizinhos - PR

SUBSTRATES	HAP	FRM	NF
Vermiculite	1.41 ns	0.03 ns	4.25 ns
Sawdust	2.09	0.08	4.25
Comercial Substrate	2.88	0.11	3.95
Coconut Fiber	3.21	0.08	4.20
Latosoil + Sand + Poultry bed	3.38	0.12	2.82
CV (%)	43.28	56.97	18.49

*Averages with *ns* in the column do not differ significantly at the 5% probability level by Tukey test.

In Table 4, the fresh mass of the aerial part the substrate based on coconut fiber obtained the best average, but did not differentiate statistically from the substrates based on latosoil + sand + poultry bed, commercial substrate, sawdust, only differentiating from the vermiculite-based substrate.

For leaf width (Table 4) the substrate based on latosoil + sand + poultry bed had the best average, but was not statistically deferred from the substrates based on coconut fiber and commercial substrate, there being statistic differences between the substrates sawdust and vermiculite.

According to Trani *et al*. (2007), commercial substrates such as the substrate Plantimax® is a good alternative to produce vegetable seedlings if compared to alternative substrates, as it presents higher amounts of essential nutrients and higher content of organic matter.

Table 4: Fresh aerial part mass (FAPM) (g) and leaf width (LW) (cm) in butterhead lettuce baby leaf type, on different substrates. Dois Vizinhos - PR

SUBSTRATOS	FAPM	LW
Vermiculite	0.38 b	0.51b
Sawdust	0.40 ab	0.34 b
Comercial Substrate	0.43 ab	0.69 ab
Coconut Fiber	0.48 a	0.90 ab
Latosoil + Sand + Poultry bed	0.45 ab	1.21 a
CV (%)	8.30	42.50

*Averages with different, lowercase letters in the same column differ significantly at the 5% probability level by Tukey test.

In Table 5, height of aerial part, fresh root mass and number of leaves in purple lettuce showed that the results did not present statistical differences in all the treatments tested.

A quality substrate must contain the appropriate physical, chemical and biological characteristics to meet the requirements of plants.

For Diniz *et al*. (2006), substrates that have high organic matter contents, have high pore space, as a consequence, their density is lower. The porosity is of fundamental importance for the good development of the plants.

Table 5: Height of aerial part (HAP) (cm), fresh root mass (FRM) (g), and leaf number (LN) in purple lettuce baby leaf type, on different substrates. Dois Vizinhos - PR

SUBSTRATES	HAP	FRM	LN
Vermiculite	1.63b	0.01ns	1.77ns
Sawdust	1.38b	0.01	2.05
Comercial Substrate	2.31ab	0.02	2.45
Coconut Fiber	2.55ab	0.02	3.02
Latosoil + Sand + Poultry bed	3.43ª	0.03	2.88
CV (%)	36.36	77.90	27.08

*Averages with *ns* in the column do not differ significantly at the 5% probability level by Tukey test.

The data presented in Table 6 show that there were no significant differences for fresh aerial part mass. Regarding leaf width, the alternative substrate latosoil + sand + poultry bed, obtained the best results, but not differentiating in relation to the commercial substrate and coconut fiber. Leaf width is a very important factor for the commercialization since larger leaves may have a greater weight in addition to a larger leaf area for light absorption much needed for the production of photoassimilates through photosynthesis.

Smiderle *et al*. (2001) evaluated lettuce, cucumber and pepper seedlings with commercial substrate, commercial substrate + soil and sand mixture, obtaining a higher emergence speed. For Trani *et al*. (2004), testing several commercial substrates in the development of lettuce seedlings cv. Vera, obtained satisfactory results in shoot height with the use of commercial substrate.

Table 6: Fresh aerial part mass (FAPM) (g) and Leaf Width (LW) (cm) in purple lettuce baby leaf type, on different substrates. Dois Vizinhos - PR

SUBSTRATES	MEPA	LF
Vermiculite	0.02ns	0.51b
Sawdust	0.01	0.34 b
Comercial Substrate	0.02	0.69 ab
Coconut Fiber	0.02	0.90 ab
Latosoil + Sand + Poultry bed	0.03	1.21 a
CV (%)	79.06	42.50

*Averages with different, lowercase letters in the same column differ significantly at the 5% probability level by Tukey test, *ns* do not differ significantly.

Analyzing the data of table 7 for fresh root mass the latosoil + sand + poultry bed substrate obtained the best result, differentiating only from the substrate of sawdust.

Regarding the number of leaves, the latosoil + sand + poultry bed mix obtained the largest number of leaves in relation to the others, but not statistically differing from the commercial substrate. For the height of the aerial part the substrate based on latosoil + sand + poultry bed obtained statistical differentiation in relation to the other treatments applied.

Table 7: Height of aerial part (HAP) (cm), fresh root mass (FRM) (g) and leaf number (LN) in aruculababy leaf type, on different substrates. Dois Vizinhos - PR.

SUBSTRATES	HAP	FRM	LN
Vermiculite	2.74 b	0.03 ab	3.60 bc
Sawdust	1.41 c	0.01 b	3.50 bc
Comercial Substrate	3.17 b	0.03 ab	3.95 ab
Coconut Fiber	3.18 b	0.01ab	4.17 c
Latosoil + Sand + Poultry Bed	5.83 a	0.05 a	4.55 a
CV (%)	11.70	64.15	8.33

*Averages with different, lowercase letters in the same column differ significantly at the 5% probability level by Tukey test, *ns* do not differ significantly.

Substrates with organic origin may present a higher percentage of organic matter, in addition to providing for plants a good physical and chemical structure, providing a better development.

Nascimento *et al*. (2012), stated that substrates based on earthworm humus, coming from poultry bed (90%) + charcoal rice husk (10%) and from goat manure (90%) + charcoal rice husk 10%), promoted satisfactory results for lettuce seedlings production.

In Table 8 when we observed the fresh mass of the aerial part where the substrate based on soil + sand + poultry bed, allowed a better result in relation to the other substrates used, the same occurred for leaf width. These differences can be linked to the type of substrate (latosoil + sand + poultry bed), these materials can present better physical and chemical conditions in addition to several nutrients necessary for the plants, so we can point out that fresh mass of the upper aerial part and width can be advantageous for the producers where they can harvest the plants in advance. According to Cabral *et al*. (2011), significant results were obtained using an alternative substrate composed of bovine manure and bean straw, in the proportion of 1:1, in the production of lettuce seedlings.

Table 8: Fresh aerial part mass (FAPM) (g) and leaf width (LW) (cm) in arugula baby leaf type, on different substrates. Dois Vizinhos - PR.

SUBSTRATES	MFPA	LF
Vermiculite	0.52 b	0.88b
Sawdust	0.38 b	0.64 c
Comercial Substrate	0.53 b	0.90b
Coconut Fiber	0.53 b	0.85b
Latosoil + Sand + Poultry Bed	0.79 a	1.14 a
CV (%)	13.72	4.95

*Averages with different, lowercase letters in the same column differ significantly at the 5% probability level by Tukey test, *ns* do not differ significantly.

Conclusion:

We conclude that for the production of american lettuce, butterhead lettuce, purple lettuce and arugula baby leaf type, the use of alternative substrate composed of the mix of latosoil + sand + poultry bed, in the proportion of 1:1:1 (v/v/v) may be used, but we emphasize that the need to develop further studies that may determine other alternative substrates.

Future Work:

It is suggested an evaluation of the minimum time of production and analysis of biochemical compositions of the leaf to relate to a final quality of the product, proving a quality.

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