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Production of tomato seedlings Santa Cruz cv. Kada in different substrates

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Abstract

The tomato crop is considered of great socio-economic importance in the world, being responsible for feeding millions of people daily. Still, the crop is considered strategic because its production is diverse in the world, being produced in a familiar way to large agroindustries, moving a rich productive chain. This work aimed to evaluate the production of tomato seedlings as function of different substrates, and to comprehend the character's interrelation through linear associations. The experimental design was randomized blocks, being one tomato cultivar, Santa Cruz Kada, disposed in 32 repetitions for each treatment. The treatments were established through the substrates carbonized rice husk, grape husk (S10), coconut fiber and commercial substrate (Bioplant®), the experiment was carried out in a greenhouse using tubes. The characters measured 25 days after sowing were: Stem diameter, number of leaves, shoot length, root length, green mass of root, green mass of shoot, dry mass of shoot, and dry mass of root. Variance analysis was performed, and the characters that presented significance were compared by the Duncan test at 5% of probability. Subsequently, Pearson's linear correlation was individually performed for each substrate. Commercial and grape skin substrates were the most suitable for production of tomato seedlings cultivar Santa Cruz Kada. The characters stem diameter, number of leaves, shoot length, green mass of root and green mass of shoot revealed significant correlations; however they differently behaved in the substrates.

Keywords: *Solanum lycopersicum* L, grape skin, Bioplant®, linear correlation.
Abbreviations: SD_ stem diameter; NL_ number of leaves; RL_ root length; SL_ shoot length; GMR_ green mass of root; DMR_ dry mass of root; GMS_ green mass of shoot and DMS_dry mass of shoot.

Introduction

Tomato (*Solanum lycopersicum* L.) is considered one of the most widespread vegetables in the agricultural scenario, being cultivated under several field and protected environments (Pereira, 2010). In Brazil, tomatoes are the second economically most important among vegetables. It has consumption preference mainly due to its organoleptic qualities and its value as a functional food because of the antioxidant properties of lycopene (Ronchi et al., 2010).

One crucial step in tomato production is the development of high-quality seedlings, since vigorous seedlings result in good plant performance, which affects early production, satisfactory fruit size and high final yield (Oviedo, 2007). In this context, seedling production is closely related to the substrate used, regarding mineral, organic or synthetic raw material, mixtures, and desirable chemical, physical and biological features of the substrate (Kanashiro, 1999). In addition, related characteristics such as precocity, reduction of contamination, higher seed/seedling ratio, and lower stress caused by transplant reveal that a suitable substrate may increase yield compared to traditional methods of seedlings production (Silveira et al., 2002).

Substrates of organic origin are widely used by nurseries, because they do not only meet plants nutritional needs at the beginning of development, but also because they present low cost and cause lower environmental contamination (Silva Júnior et al. 2014). In addition, they contribute to moisture retention, nutrient supply, increased oxygen diffusion to the roots due to greater porosity, cation exchange capacity, suitable pH regulation, aid in the physical support and plants development (Camargo et al., 2011; Pessoa et al., 2012; Costa et al., 2013).

Several organic materials such as turf, wood residues, carbonized husk of pine and rice, lignite and vermiculite are used as substrate, either alone or in composition, for the commercial production of vegetable seedlings (Carrijo et al., 2002). The rice carbonized husk presents great potential for use due to the raw material availability in rice fields, combined to the need of giving an economically and ecologically correct destination to it, as well as coconut fiber and grape skin are considered materials of low cost and high availability.

After the seedlings establishment, it is important to verify the interrelations between traits that determine the crop potential, because they allow to understand linear associations and to identify which of them are indispensable and must be measured. In this way, the Pearson linear

correlation analysis allows to identify tendencies between traits and to determine which should be considered and measured (Carvalho et al., 2004).
The aim of this work was to evaluate de effect of different substrates in the production of tomato seedlings.

Results and discussion

The variance analysis revealed significant differences at 5% of probability for the traits stem diameter (SD), number of leaves (NL), root length (RL), shoot length (SL), green mass of root (GMR), dry mass of root (DMR), green mass of shoot (GMS), and dry mass of shoot (DMS).
Stem diameter (SD) presented superiority when the plants were grown in commercial substrates. The substrates rice husk and coconut fiber were inferior to the others (Table 1). This behavior is due to rice husk and coconut fiber providing less nutrients. Silva et al. (2012) conducted a study with different combinations of substrates for the production of tomato seedlings, and concluded that regardless of the level of rice husk used, the commercial substrate is superior. According to Campos (2002) and Silva et al. (2012), the stem diameter is an indicator of seedling quality, and may be associated with survival and growth after transplantation to the definitive site. Thus, it is possible to infer that the plants produced in commercial substrates and grape skin may have a higher survival rate after transplantation.
The number of leaves (NL) was higher when using commercial substrate and grape skin, and the substrate rice husk was inferior to the others. This character is strongly influenced by mineral nutrition, that is, substrates that present greater nutrients availability, tend to increase the number of expanded leaves per plant. Silva Júnior et al. (2014), when evaluating the production of tomato seedlings cv. Caline IPA 6 grown in different substrates, verified that the number of leaves vary with the type of substrate used, therefore, the magnitude of leaves per plant is dependent on the techniques and management used for seedling production. Medeiros et al. (2013), evaluated the performance of cherry tomatoes seedlings cv. Fern on organic and commercial substrates (Plantmax®). The authors found that the organic substrate promoted greater emission of leaves in the seedlings than the commercial substrate.
The root length (RL) was higher when the seedlings were cultivated in commercial substrate, grape skin and rice husk, being the smallest magnitude verified in the coconut fiber (Table 1). No difference was evidenced among commercial substrate, grape skin and rice husk for this character. The formation of larger roots results in a better adaptation of the seedlings after transplantation, allowing a more efficient exploitation of the available substrate volume, thereby resulting in a greater aeration, water and nutrient uptake (Souza et al., 2013). In studies conducted by Dos Santos et al. (2015), there was an increase in root length of tomato seedlings, due to the increase of the rice husk proportion in the substrate. Research by Silva Júnior et al. (2014), evaluating the production of tomato seedlings cv. Caline IPA 6 in different substrates, verified significant differences in the root length of seedlings, and proved the influence of the type of substrate in this character.
For the characters shoot length (SL) and green mass of rot (GMR), superiority was revealed for the commercial substrate and grape skin. This result is due to the satisfactory proportions of chemical and physical constituents, which allowed the formation of better quality seedlings. These results corroborate with Silva Júnior et al. (2014), who evaluated different substrates for production of tomato seedlings cv. Caline IPA 6 and obtained significant difference for shoot length as function of the substrates.
The dry mass of roots (DMR) presented the largest magnitude for commercial substrate. Seedlings with higher root volume provide greater resistance to adverse conditions after transplanting, since they evidence a vigorous root system, associated to a greater leaf development, stem diameter and plant height, which are characteristics that can favor the survival on field and avoid dumping off.
The characters green mass of shoot (GMS) and dry mass of shoot (DMS) revealed superiority for the substrate grape skin, being the smallest magnitudes revealed by rice husk and coconut fiber, evidencing that the substrate quality positively or negatively influences the accumulation of phytomass. Silva Júnior et al. (2014), evaluating the production of tomato seedlings cv. Caline IPA 6 on different substrates, revealed that dry mass of shoot was significantly influenced by the substrates used. Silva et al. (2012), evidenced that the addition of rice husk on different substrates for the production of tomato cv. Santa Clara reduced the mass of shoot. These results corroborate with this experiment, and define the cause of the seedlings to have produced lower dry mass was due to the higher addition of rice husk.
In order to ensure substrates with adequate properties for plants development, the physical, chemical and biological characteristics of these materials is essential, however the physical characteristics are the most important because they control air and water relationships (Farias et al., 2012). According to Silva et al. (2006) the Bioplant® commercial substrate, similar to the one used in this study, is the most suitable for production of tomato seedlings when compared to other commercial substrates.
The Pearson's linear correlation was performed for the eight morphological characters (table 2) revealing 112 associations, being 18 significant at 5% of probability by the t test. According to the classification by Carvalho et al. (2004), the correlations equal to 0 correspond to null; correlation from 0 to ≤ 0,30 are considered weak; correlation from 0,30 to ≤ 0,60 are intermediate; correlation from 0,60 to ≤ 0,90 are strong; correlation 0,90< 1 are very strong, and correlation equal to one are considered perfect correlation.
The character stem diameter (SD) was positively correlated with number of leaves (NL) in the substrates coconut fiber (r = 0.60*) and commercial (r = 0.38*), indicating that, as larger the stem diameter is, greater the number of leaves will be.
The number of leaves (NL) showed significant negative correlation coefficient with dry mass of the root (DMR r = -0.38*), indicating that the larger the number of leaves, the lower the dry mass of root. Root length (RL) did not reveal significant correlation for any character in this study.
Regarding shoot length (SL), significant negative correlation was verified with dry mass of root (DMR r = -0.51 *) in the substrate rice husk. Significant positive correlation was observed for the substrate grape skin in the characters green mass of root (GMR r = 0.46 *), green and dry mass of shoot (GMS r = 0.80*; DMS r = 0.73*), and in the compost

Table 1. Average results for the characters: (SD) stem diameter (mm), (NL) number of leaves (unidades), (RL) root lenght (cm), (SL) shoot lenght (cm), (GMR) green mass of root (g), (DMR) dry mass of root (g), (GMS) green mass of shoot (g) and (DMS) dry mass of shoot (g), Pelotas – RS, 2017.

Substrates	SD	NL	RL	SL	GMR	DMR	GMS	DMS
Rice husk	1.30 c	2.13 c	2.79 a	4.86 b	0.003 b	0.0007 c	0.035 c	0.002 c
Coconut fiber	1.26 c	2.60 b	1.55 b	5.44b	0.003 b	0.0007 c	0.029 c	0.001 c
Grape skin	2.36 b	5.15 a	3.16 a	15.23 a	0.046 a	0.0025 b	0.679 a	0.034 a
Commercial	2.54 a	5.20 a	3.16 a	15.23 a	0.048 a	0.0053 a	0.470 b	0.029 b
CV (%)	9.88	17.35	41.17	10.65	37.62	57.9	30.5	33.3

*Means followed by the same letter in the column do not statistically differ from each other by the Duncan test, at 5% of probability.

Table 2. Estimates of Pearson's linear correlation for the characters: (SD) stem diameter (mm), (NL) number of leaves (unidades), (RL) root lenght (cm), (SL) shoot lenght (cm), (GMR) green mass of root (g), (DMR) dry mass of root (g), (GMS) green mass of shoot (g) and (DMS) dry mass of shoot (g), Pelotas – RS, 2017.

		NL	RL	SL	GMR	DMR	GMS	DMS
	Rice husk	-0.14	0.01	-0.31	-0.09	-0.21	-0.25	-0.04
SD	Coconut fiber	0.60*	0.07	0.06	0.48	-0.22	-0.22	-0.11
	Grape skin	-0.15	0.11	0.27	0.02	-0.12	0.30	0.24
	Commercial	0.38*	0.17	0.04	-0.09	-0.27	-0.23	-0.15
	Rice husk		0.06	-0.26	0.49	0.35	0.06	0.17
NL	Coconut fiber		0.02	0.14	-0.06	0.10	-0.38	-0.11
	Grape skin		-0.28	-0.08	-0.09	0.14	-0.13	-0.06
	Commercial		-0.02	-0.04	-0.01	-0.38*	0.00	0.05
	Rice husk			0.22	0.07	-0.18	0.38	0.30
	Coconut fiber			0.01	-0.22	-0.17	-0.19	0.08
RL	Grape skin			0.28	0.08	-0.10	0.28	0.24
	Commercial			0.28	0.25	0.04	0.24	0.25
	Rice husk				0.19	-0.51*	0.29	0.11
	Coconut fiber				-0.21	-0.02	0.47	0.08
SL	Grape skin				0.46*	0.19	0.80*	0.73*
	Commercial				0.36*	0.13	0.28	0.24
	Rice husk					0.13	0.39	0.51*
GMR	Coconut fiber					0.06	-0.15	-0.15
	Grape skin					0.39*	0.61*	0.52*
	Commercial					0.55*	0.50*	0.51*
	Rice husk						-0.12	0.13
DMR	Coconut fiber						0.00	0.36
	Grape skin						0.14	0.17
	Commercial						0.30	0.27
	Rice husk							0.75*
GMS	Coconut fiber							0.45
	Grape skin							0.80*
	Commercial							0.92*

*Pearson linear correlation coefficients (n = 32) significant at 5% of probability of error.

substrate for the character green mass of root (GMR r = 0.36*). The character green mass of root (GMR) presented significant positive correlation with green mass of shoot (GMS r = 0.51*) on rice husk substrate, indicating that the larger the magnitude of green mass of root, there will be an increment in shoot green mass. There was also correlation of this character on grape skin with dry mass of root (DMR r = 0.39*), green and dry mass of shoot (GMS r = 0.61*DMS r = 0.52*). On the commercial substrate, there was positive significance with dry mass of root (DMR 0.55*), and with green and dry mass of shoot (GMS r=0.50* DMS r=0.51*), indicating that an increment in the magnitude of root green mass is followed by an increment of root dry mass, green and dry mass of shoot. For the character dry mass of root (DMR), there was no significant correlation.

Regarding the character green mass of shoot (GMS), positive significant correlations were found with dry mass of shoot (DMS) in the substrates rice husk (r=0.75*), grape skin (r=0.80*) and commercial (r=0.92*), indicating that the greater the green mass, larger the dry mass of shoots.

Materials and methods

The experiment was conducted in a greenhouse in the 2016 year, in the Department of Plant Science of the Eliseu Maciel Agronomy College - Federal University of Pelotas - RS. The experimental design used was randomized blocks, being one tomato cultivar, Santa Cruz Kada, disposed in 32 repetitions for each treatment. The treatments were established through the substrates (carbonized rice husk, grape husk (S10), coconut fiber and commercial substrate (Bioplant®). Seeding was carried out with seeds provided by *Isla sementes,* in tubes of 200 cm^{-3}, with sowing depth standardized at 1.5 centimeters for planting. After the emergence, thinning was performed, remaining only one seedling per tube, which was considered as an experimental unit. The seedlings were kept in a greenhouse under constant light and temperature at 25°C, with daily irrigations.

Measured characters

The response variables were measured 25 days after sowing (DAS), being they: Stem diameter (SD), measured through a caliper ruler 1 cm above the substrate level, with results in millimeters. Number of leaves (NL): verified by counting the number of expanded leaves per plant, with results in units; Shoot length (SL) and root length (RL), obtained with the aid of a ruler, where the distance between the neck and the aerial and radicular apex of the plant was measured, results in millimeters. Green mass of root (GMR) and green mass of shoot (GMS) were obtained through a digital scale at the exact moment of evaluation, with results in grams. For determining the dry mass of shoot (DMS) and dry mass of root (DMR), the tissues were placed in kraft bags and later into an oven with forced ventilation at 65°C until the samples to reach constant weight, with results expressed in grams.

Statistical analysis

The data were submitted to the normality test of residues by Shapiro Wilk (1965), and the homogeneity of variances by Bartlett (Steel et al., 1997), and there was no need to perform transformation in the collected data. The analysis of variance was performed, and the characters that presented significance were compared by Duncan at 5% of probability. Afterwards, Pearson's linear correlation was individually carried out for each substrate, the correlation coefficients were classified by Carvalho et al., (2004). The statistical analyzes were performed using the Genes software (Cruz, 2013).

Conclusion

Commercial and grape skin substrate are the most suitable for production of Tomato seedlings cultivar Santa Cruz Kada. The characters stem diameter, number of leaves, shoot length, green mass of root and green mass of shoot reveal significant correlations, however they differently behave in the substrates.

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