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REGULAR ARTICLE

Cucumber seedlings production: tray size impact on development

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Autor contribution
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Abstract

The size of the tray in seedling production has a direct influence on the area of root development and availability of resources, such as water as well as nutrients, with a potential impact on the seedling final quality. The objective of this work was to analyse the impact of the tray size on the development of cucumber seedlings. As such, this study was developed in two experiments: in the first, seedlings produced in trays with 50 and 128 cells were compared, while in the second, trays with 50, 98, and 128 cells were considered. For that, polyethylene trays and commercial substrate were used. The trays were kept in a greenhouse, and evaluations were carried out at 21 days after sowing. Morphological development and SPAD index were analysed. The data were submitted to ANOVA and the means compared by the Tukey test (0.05). Linear correlation was performed between the analysed variables. The best development of cucumber seedlings was obtained by adopting trays with 50 cells. Cucumber seedlings produced in trays with a higher number of cells show reduced development, mass accumulation and lower photosynthetic activity.

Keywords

Cucumis sativus; Morphological Development; Seedling Quality.

Introduction

Cucumber (*Cucumis sativus*) belongs to the Cucurbitaceae family, and it is a vegetable of high economic importance worldwide, whose marketable part is the immature fruit (Feng et al., 2020). Field crop development is influenced by environmental characteristics, such as photoperiod and temperature, as well as by crop management, such as nutrition, irrigation, and seedling quality (Aslam et al., 2020; Kumi et al., 2020; Hassan et al., 2021).

The quality of seedlings is fundamental in the implantation and development of plants, which reflects on the productive potential, being influenced by environmental, genetic, and growing medium factors (Bayoumi et al., 2019; Watthier et al., 2019; Ma et al., 2020). Commercial quality seedlings characteristics are standardization, phytopathogenic health, adequate root and shoot development (Kumi et al. 2020; Wenneck et al., 2021).

Cucumber seedlings can present development influenced by the size of the cells, with reflection on growth, mass accumulation, and physiological characteristics such as chlorophyll content (Cavalcanti et al., 2019; Kumi et al., 2020). In this sense, the present study aimed to analyse the development of cucumber seedlings in trays with different sizes.

Materials and methods

The study was carried out at the Technical Centre for Irrigation (CTI) of the State University of Maringá (UEM), Brazil. The experiment was conducted in a protected environment with a completely randomized design, being carried out in two periods (September and October 2021), using different tray sizes for seedling production. During the development of the seedlings, the relative humidity of the environment varied from 48 to 96%, and the temperature from 17 to 38°C.

In the first period (September 2021), the development of cucumber seedlings in polyethylene trays with 50 and 128 cells was analysed. In the second period (October 2021), the development of cucumber seedlings in polyethylene trays with 50, 98 and 128 cells was analysed. For each treatment, 10 repetitions were performed. In both periods, the trays were filled with commercial substrate (MecPlant®), with seeds placed at a depth of 0.5 cm. Irrigation was performed four times a day with a manual watering can. The seedlings were evaluated 21 days after sowing (DAS), and the analysed components were: seedling height, stem diameter, number of

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leaves, fresh mass (stem and leaf), dry mass (root, stem, and leaves), length and width of the seedlings leaves, root length, and Soil Plant Analytical Division (SPAD) index.

All cells in the trays were sown, using 10 seedlings per tray located in the central area. A digital calliper was used to determine the height, diameter, length, and width. An analytical balance was used to determine the mass (fresh and dry) of the components. To determine the dry mass, they were kept in an oven with forced air circulation (65°C) until reaching constant mass. The SPAD index was determined with SPAD-502 (Minota®).

The data were submitted to analysis of variance (ANOVA) and the means were compared by the Tukey test with 5% of significance. Linear correlation analysis was performed between the analysed variables. For data analysis, SISVAR software (Ferreira, 2019) and Microsoft Excel® were used.

Results and discussion

Comparing the seedlings produced in trays with 50 and 128 cells, the development was higher in the tray of 128 cells only for the height variable (Table 1), which is characteristic of etiolation considering the lower values of fresh and dry mass.

Table 1. Morphological components of cucumber seedlings, experiment 1.

Tray	Height	Stem diameter	Fresh leaf mass	Fresh stem mass	Dry leaf mass	Dry stem mass
	(cm)	(mm)	(g)			
50	6.35 b	4.25 a	1.69 a	1.29 b	0.185 a	0.034 a
128	12.46 a	3.44 b	0.97 b	1.38 a	0.107 b	0.039 a
CV (%)	38.45	18.97	36.08	24, 8	38.24	37.91

*Distinct letters in the columns differ from each other by the Tukey test with 5% significance.

Regarding the number of leaves, there was no significant difference between the conditions, however, the seedlings produced in trays of 128 cells presented leaves with smaller length and width (Table 2). Besides that, a significant difference was obtained for the length and dry mass of the roots, possibly associated with a limitation in the volume of the substrate in a tray with a greater number of cells.

Table 2. Morphological and physiological components of cucumber seedlings, experiment 1.

Tray	Number of leaves	Root length (mm)	Dry root mass (mg)	Leaf length (cm)	Leaf width (cm)	SPAD
50	4.0 a	15a	26.06 a	8.44 a	6.44 a	56.61 a
128	3.0 a	9.00 b	10.82 b	7.30 b	6.00 b	42.47 b
CV (%)	14, 75	23.23	50.71	9.00	10.63	13.70

*Distinct letters in the columns differ from each other by the Tukey test, with 5% significance.

Regarding the SPAD index, which indirectly measures the chlorophyll content, superior results were also obtained for the seedlings produced in a tray of 50 cells (Table 2). The adoption of a tray with the highest number of cells (128) showed a positive correlation only with the height of the seedlings (0.87), and a negative correlation for most of the morphological characteristics analysed (Table 3).

For the 98-cell tray, no significant differences were observed for stem diameter and number of leaves. For other variables, leaf development and SPAD index were lower for the 50-cell tray (Table 4). Similar to what was obtained in experiment 1 (Table 3), the size of the tray (number of cells) had a negative influence on the development of leaves (Table 5), and seedlings from trays with a greater number of cells showed less development.

The best development of seedlings in the tray with 50 cells is similar to the results obtained by Kumi et al. (2020), which are associated with the availability of water and nutrients by the substrate, greater area of root development, and less competition for light.

Characteristics associated with the substrate, related to chemical, physical and biological factors, directly influence the morphological development, physiological activity, and commercial quality of cucumber seedlings (Gao et al., 2017; Bayoumi et al., 2019; Watthier et al., 2019; Ma et al., 2020). However, in the present experiments, the same substrate was adopted, showing the effect of the cell size of the tray on the seedlings.

Table 3. Linear correlation for analysed variables, experiment 1.

	TS	h	SD	NL	FLM	FSM	DLM	DSM	RL	DRM	LL	LW	SPAD
TS	1.00	-	-	-	-	-	-	-	-	-	-	-	-
h	0.87	1.00	-	-	-	-	-	-	-	-	-	-	-
SD	-0.57	-0.58	1.00	-	-	-	-	-	-	-	-	-	-
NL	-1.00	-0.87	0.57	1.00	-	-	-	-	-	-	-	-	-
FLM	-0.77	-0.70	0.65	0.77	1.00	-	-	-	-	-	-	-	-
FSM	0.13	0.33	0.14	-0.13	0.31	1.00	-	-	-	-	-	-	-
DLM	-0.72	0.56	-0.34	-0.72	-0.64	-0.03	1.00	-	-	-	-	-	-
DSM	0.20	0.06	-0.11	-0.20	-0.37	-0.49	0.67	1.00	-	-	-	-	-
RL	-0.86	-0.66	0.50	0.86	0.66	0.03	-0.73	-0.45	1.00	-	-	-	-
DRM	-0.82	-0.88	0.42	0.82	0.73	-0.36	-0.66	-0.17	0.70	1.00	-	-	-
LL	-0.85	-0.82	0.23	0.85	0.61	-0.22	-0.72	-0.24	0.73	0.71	1.00	-	-
LW	-0.35	-0.22	0.12	0.35	0.43	0.21	-0.50	-0.75	0.28	0.12	0.53	1.00	-
SPAD	-0.62	-0.48	0.29	0.62	0.45	-0.02	-0.44	-0.07	0.66	0.36	0.73	0.43	1.00

*TS - tray size; h - height; SD - stem diameter; NL - number of leaves; FLM - fresh leaf mass; FSM - fresh stem mass; DLM - dry leaf mass; DSM - dry stem mass; RL - root length; DRM - dry root mass; LL - leaf length; LW- leaf width.

In experiment 2, with the inclusion of a tray with an intermediate number of cells (98 cells), results similar to those from experiment 1 were obtained (Tables 1 and 2). A higher height was noticed on the 128-cell tray, while, for the 50-cell tray, the SPAD index and leaf development were significantly higher (Table 4).

Table 4. Development of cucumber seedlings, experiment 2.

Tray	**Height (cm)**	**Stem diameter (mm)**	**Number of leaves**	**Fresh leaf mass**	**length (cm)**	**Leaf width (cm)**	**SPAD**
50	4.83 b	2, 52 a	4.0 a	0.35 a	3.78 a	4.57 a	38.19 a
98	7.87 a	2.35 ab	3.25 ab	0.171b	2.48b	2.78b	35.52b
128	7.58 a	2.02 b	3.0 b	0.13 c	2.23 b	2.32 b	35.21 b
CV (%)	17.49	16.33	14.69	50.48	26.27	34.25	6.54

*Distinct letters in the columns differ from each other by the Tukey test, with 5% significance

Although frequent irrigation (four times a day) was adopted, in smaller cells (tray with a greater number of cells) there is a greater limitation in terms of water availability, which may reflect on plants with changes in metabolic activities (Fan et al., 2017) and, consequently, in the seedling development.

Tray with a greater number of cells has less spacing between seedlings, causing competition for light in quantity and quality, which has a direct effect on the hormonal balance, with changes in primary and secondary development (Song et al., 2019; Garcia & Lopez, 2020). In addition, seedlings produced in trays with a higher number of cells (98 and 128) showed lower values of SPAD index (Table 2 and 4), indicating changes in photosynthetic activity.

Variations in the development of seedlings in the same tray may be associated with temperature variations between cells, as presented by Cavalcanti et al. (2019), when analysing the spatial variability of seedling trays with geo-statistics techniques. However, when performing statistical analysis of the data, a significant effect was obtained from the number of cells factor in the tray on the different variables analysed.

According to the results obtained in this study, cucumber seedlings grown in trays with fewer cells present better plant development. New studies are needed to analyse the economic impact of the adoption of trays of different dimensions (number of cells) and the development of seedlings of other species.

Table 5. Linear correlation for analysed variables, experiment 2.

	TS	h	SD	NL	FLM	LL	LW	SPAD
TS	1.00	-	-	-	-	-	-	-
h	-0.60	1.00	-	-	-	-	-	-
SD	-0.57	-0.09	1.00	-	-	-	-	-
NL	-0.87	-0.08	0.46	1.00	-	-	-	-
FLM	-0.88	-0.03	0.55	0.80	1.00	-	-	-
LL	-0.92	0.02	0.57	0.86	0.83	1.00	-	-
LW	-0.90	0.02	0.49	0.85	0.79	0.92	1.00	-
SPAD	0.51	-0.23	-0.15	-0.33	-0.39	-0.34	-0.30	1.00

* TS - tray size; h - height; SD - stem diameter; NL - number of leaves; FLM - fresh leaf mass; LL - leaf length; LW- leaf width.

Conclusions

The best development of cucumber seedlings was obtained by adopting trays with 50 cells. Cucumber seedlings produced in trays with a higher number of cells show reduced development, mass accumulation, and photosynthetic activity.

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