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Effect of trays and substrates on the initial growth of mini watermelon

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Abstract

The objective of this study was to evaluate the influence of tray type and substrate on the initial development of the mini watermelon hybrid 'Ki Kodama'. The following treatments were compared: three types of tray, 128, 200 and 288 cells, and three types of substrate, Bioplant HT, Biofibra, Bioflora. Treatments were factorially combined. Evaluations were performed 30 days after sowing, and the following parameters were determined: fresh and dry weights of shoot, fresh and dry weights of root, seedling height, number of leaves, root length, stem and root diameters, and leaf and root areas. There was a significant interaction between tray and substrate treatments for fresh and dry weights of shoot and root, stem diameter, and leaf and root areas. For the factor tray, only the root diameter differed, and 128-cell trays showed better performance, while for substrate, height, root length and number of leaves showed significant differences, with Bioflora providing better development of seedlings. For the other parameters, the best performance was observed in 288-cell trays filled with Bioplant HT. The results obtained can be explained because the volume occupied by substrate in each cell varies, which causes root and leaf development also to differ. Thus, for the conditions under which the experiment was conducted, seedlings of mini watermelon 'Ki Kodama' should be grown in 128 or 288 cell trays, filled with the commercial substrate Bioplant Prata HT or Bioflora.

Keywords: *Citrulus lanatus*, germination, seedlings

INTRODUCTION

Watermelon (*Citrullus lanatus* Thunb.) (Matsum & Nakai) belongs to the family *Cucurbitaceae* and is a plant originally from tropical Africa and introduced in Brazil by African immigrants. It is currently found in many regions with tropical and subtropical climates (Gama et al., 2013). It is in a fruit and vegetable group of great economic and social value, where it has numerous nutritional and therapeutic properties, which increases the interest of the consumer for the fruit. Brazil is the fourth largest producer of watermelons (Agrianual, 2014).

According to Marques et al. (2003) the production of crop seedlings is one of the most important steps in production, influencing the final performance of the plants, both from a nutritional point of view and the time necessary till harvest and, consequently, the number of possible growing cycles per year. Therefore, the importance of quality seedlings is evident in commercial planting, and for the production of seedlings of good quality, the size of the receptacle and the type of substrate are the first aspects to be investigated (Barbosa et al., 2010).

The size of the receptacle directly affects the volume available for the development of the roots, while the type of substrate has a marked influence on the architecture of the root system and nutritional state of the plants, affecting the quality of the seedlings (Marques et al., 2003). According to Santos et al. (2013), trays with large-sized cells provide stronger development, precocity and better yield of the plants at harvest.

The objective of this work was to evaluate the influence of types of trays and substrates on the initial development of the mini watermelon hybrid 'Ki Kodama'.

MATERIAL AND METHODS

The experiment was conducted in a greenhouse, in UNESP-FCAV, Jaboticabal Campus, SP, Brazil. The local altitude is 614 m; with coordinates of 21°14'05"S and 48°17'09"W. The climate, according to the Köppen classification, is of the Aw type with transition to Cwa.

The factors considered were type of tray, 128, 200 and 288 cells, and type of substrate, Bioplant HT, Biofibra and Bioflora. A randomized complete block design was used with a 3×3 factorial scheme and three repetitions.

The substrates utilized have the following characteristics: Bioplant HT, ideal for agricultural uses, with high potential for rooting, containing pine husk as the principal raw material, along with the binders coconut fiber, vermiculite and rice husk, as well as nutrients; Biofibra, a ready-to-use substrate, washed product, stabilized and with low tannin level, where its main ingredient is coconut fiber and powder, along with added nutrients; and Bioflora, substrate composed of pine husk, eucalyptus, vermiculite, charcoal, manure, bran and plant cake, along with added nutrients. The substrates were subjected to chemical analysis before setting up the experiment. A sample of each substrate was dried at ambient temperature and sent to the Soil Analysis Laboratory, Agronomic Institute of Campinas, which determined the levels of dissolved NH_4^+-N, NO_3^--N, P, K, Ca, Mg, S, Cl, HCO_3^-, B, Fe, Mn, Cu and Zn, according to the Dutch method proposed by Sonneveld et al. (1974). The results are presented in Table 1.

The mini watermelon hybrid utilized was 'Ki Kodama', which produces fruits with a light green husk with dark green stripes and yellow pulp with a fine, crispy texture and high level of soluble solids (°Brix) (Sakama, 2013).

Seeds were planted on September 10, 2013, in polystyrene trays, filled with the different substrates, using one seed per cell, and then covered with a fine layer of substrate. After seeding, the trays were labeled with their respective treatments, and placed in a greenhouse, where they were irrigated two to three times a day.

The plants were evaluated 30 days after seeding. Accordingly, 10 seedlings of each treatment selected and the following parameters were determined: fresh and dry weights of the shoot; fresh and dry weights of the root, seedling height, number of leaves, root length, stem and root diameters, and leaf and root areas.

Analysis of variance was carried out after obtaining the data, and the means were compared by the Tukey test at 5% probability, utilizing the program AGROESTAT version 1.1 (Barbosa and Maldonado, 2011).

RESULTS AND DISCUSSION

There was a significant interaction for the factors evaluated (tray and substrate) for the parameters of fresh and dry weights of the shoot and of the root, stem diameter, and leaf and root areas (Table 2). The other characteristics are discussed separately.

With regard to trays, fresh and dry weights of the shoot, those with 288 cells showed the best performance, with all substrates evaluated (Figure 1A and B). For substrates, Bioplant in trays of 288 cells showed the best performance (Figure 1A and B). According to Barbosa et al. (2010), it is interesting that the volume of a small cell does not limit root development of the seedlings, maximizing the utilization of space and saving on substrate. Besides, according to the description by the manufacturer, Bioplant consists of materials that favor aeration and respiration of the roots, which allows greater uptake of water and nutrients by the seedlings and, consequently, increased vigor and growth.

For fresh weight of root (Figure 1C), comparison between trays for each substrate showed that 128 and 288 cell trays exhibited better performance, while comparison between substrates, indicated that Bioplant® showed the best development of seedlings in trays of 288 and 128 cells, but that Biofibra® showed the best performance in 288-cell trays.

This result indicates that both the larger the volume of the lower substrate, the seedlings showed good rooting, very likely due also to physical and chemical characteristics of the substrates evaluated.

Table 1. Mean values of pH, electrical conductivity, nitrate, ammonia, chloride, phosphorus, organic carbon, nitrogen, C/N ratio, sulfur, potassium, calcium, magnesium, boron, copper, iron, manganese and zinc in the commercial substrates utilized.

	pH	EC (dS m^{-1})	Nitrate-N	Ammonia-N	Cl$^-$	P	Organic C	N	C/N
				(mg L^{-1})			(g kg^{-1})		
Bioplant	4.9	1.4	9.2	4.6	47.6	3.2	363.02	4.1	89.0
Biofibra	6.6	0.9	6.9	1.6	58.9	60.6	423.17	6.1	69.3
Bioflora	4.9	2.6	47.8	3.9	57.5	31.4	363.89	4.2	87.3
	S	K	Ca	Mg	B	Cu	Fe	Mn	Zn
				(mg L^{-1})					
Bioplant	175.4	149.3	78.5	58.6	0.3	0.01	0.4	1.1	0.1
Biofibra	50.7	254.0	6.2	3.1	0.3	0.03	0.3	0.04	0.2
Bioflora	359.3	123.1	200.15	97.2	0.0	0.01	0.3	1.3	0.1

Table 2. Summary of the analysis of variance for fresh weight of the shoot (FWS), dry weight of the shoot (DWS), fresh weight of root (FWR), height, stem diameter (SD), root diameter (RD), root length (RL), root area (RA), number of leaves (NL) and leaf area (LA) of seedlings of mini watermelon 'Ki Kodama' according to types of tray and substrate.

	FWS	DWS	FWR	Height	SD	RD	RL	RA	NL	LA
		(g)		(cm)		(mm)		(mm^2)		(cm^2)
Trays (B)										
128 cells	0.64 a	0.09 a	0.16 a	6.43 a	1.96 a	0.06 a	940.73 a	607.84 a	2.00 a	6.63 a
200 cells	0.48 b	0.07 b	0.12 b	5.92 a	1.87 a	0.05 b	718.34 b	393.35 b	2.00 a	3.36 b
288 cells	0.42 b	0.06 b	0.11 b	6.29 a	1.89 a	0.05 b	618.09 b	315.76 b	1.00 a	2.55 b
Substrate (S)										
Bioplant HT	0.48 b	0.07 b	0.15 a	5.97 b	1.86 b	0.05 a	892.60 a	502.85 a	1.67 b	3.32 b
Biofibra	0.36 c	0.05 c	0.08 b	5.44 b	1.87 b	0.05 a	508.17 b	276.76 b	1.00 c	0.48 c
Bioflora	0.71 a	0.10 a	0.16 a	7.22 a	1.98 a	0.06 a	876.40 a	537.33 a	2.00 a	8.74 a
Mean	0.52	0.07	0.13	6.21	1.91	0.05	759.05	438.98	1.56	4.18
Interaction B×S	7.11**	7.88**	3.55*	1.37 ns	3.11*	2.73 ns	1.81 ns	3.80*	1.60 ns	11.89**
CV%	13.38	13.31	20.86	10.43	3.85	9.36	20.42	22.38	16.94	32.31

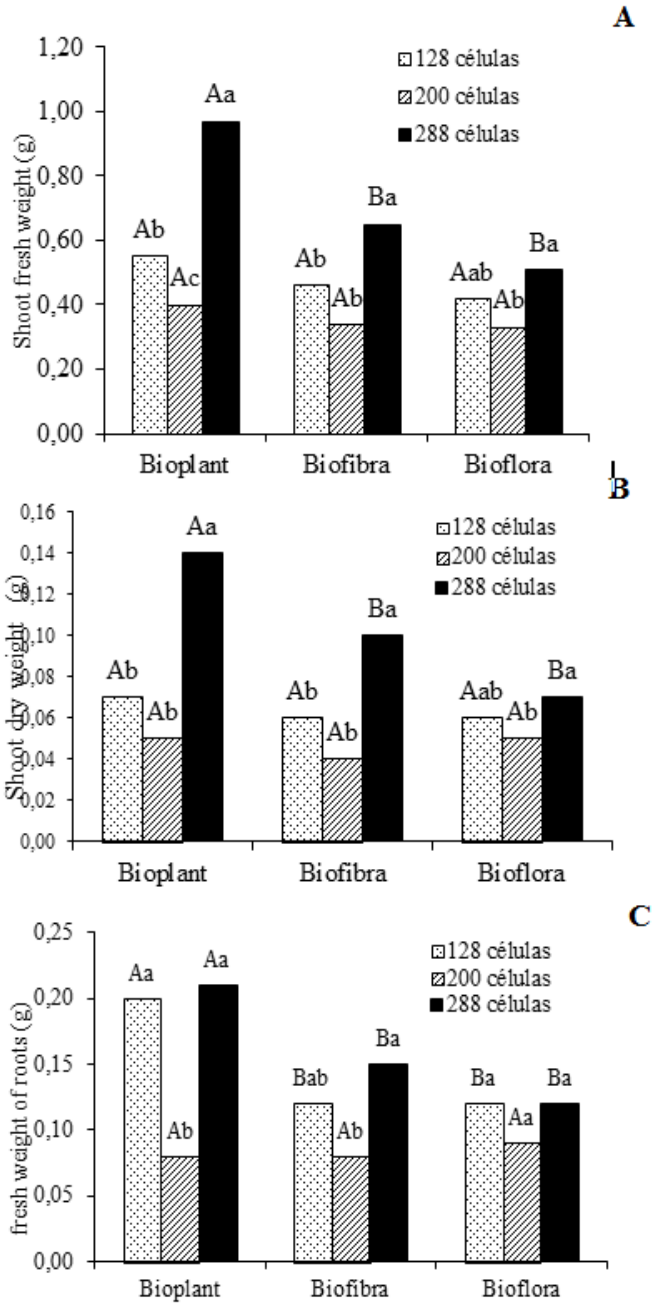

Figure 1. Fresh (A) and dry (B) weights of shoots and fresh weight of roots (C) of seedlings of the mini watermelon 'Ki Kodama' according to types of tray and substrate. Means followed by the same upper case letter compare types of trays, and with lower case letter comparing types of substrates, not differing by the Tukey test (P>0.05).

In analyzing seedling and stem diameter for the factor tray, there were no significant differences, while for substrates, Bioflora® showed the greatest height (7.22 cm) (Figure 2A). This can be explained in view of the substrate in question, showing higher levels of some nutrients, such as nitrate, sulfur, calcium, magnesium and manganese (Table 1). However, greater height of the seedlings is not always a preference of growers, since many prefer shorter seedlings, which show lower probability of falling at the time of transplanting.

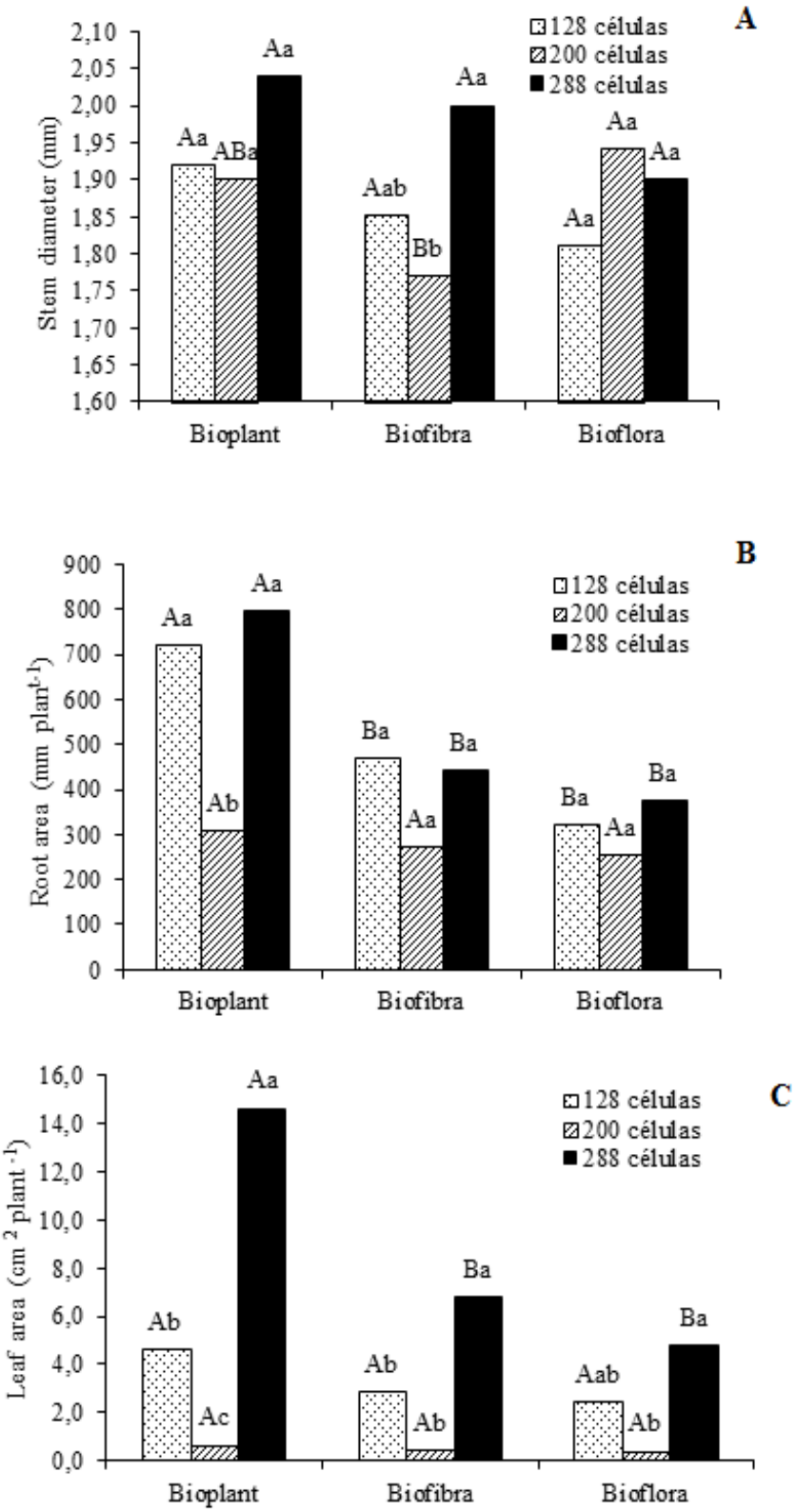

Figure 2. Stem diameter (A), and root area (B), leaf area (C) of seedlings of mini watermelon 'Ki Kodama' according to types of tray and substrate. *Means followed by the same upper case letter compare types of trays and with lower case letter comparing types of substrates, not differing by the Tukey test (P>0.05).

For root diameter (Table 2), there were differences only for type of tray, where those with 128 cells showed the best performance. These results can be explained by the greater volume of substrate that surrounds the root system in trays with fewer cells, making the supply of production factors more optimized for the growth and development of the seedlings in detriment of the other trays (Silva et al., 2000; Menezes Júnior et al., 2000).

In relation to root length, there was a significant difference with 128-cell trays compared to the others, while for substrates, Bioplant HT and Bioflora differed from Biofibra (Table 2). For root area (Figure 2A), comparison between tray types, those with 128 and 288 cells showed better performance, and Bioplant displayed the best performance among the substrates. A likely explanation for this is the greater volume of substrate available to seedlings in trays of 128 cells allowed better development of the root system, which could lead to increased area for absorption of nutrients, favoring more satisfactory performance of the plants originating from these seedlings.

For leaf area, better performance was observed in 288-cell trays in the substrate Bioplant® (Figure 2C). The increase in the number of tray cells favored more rapid development of the seedlings, due to their more rapid filling of the available volume of substrate, without losses in qualitative terms, due to the competition for light and physical space to which the plants were subjected (Purquerio et al., 2004).

CONCLUSIONS

According to the conditions in which the work was carried out, it can be concluded that in the production of mini watermelon seedlings, better results can be obtained in 128-cells trays, utilizing the substrate Bioplant HT.

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