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Research on microgreens farming in vertical hydroponic system

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Abstract: Microgreens are species of vegetables and aromatic herbs in an early stage of growing, which are consumed after a vegetative cycle of 10-14 days. The great majority of microgreens can be grown with no chemical fertilisers and pesticides, because they are consumed in their cotyledon-leaf stage, their development being provided by the spare substances of the seed. This paper presents the comparative study of two growing systems, i.e. ebb&flow benches compared to a vertical hydroponic system, as well as of two substrates frequently used in this culture, i.e. peat and perlite mix (70/30) compared to cellulose. For the four versions resulted, the documented parameters were the germination rate, the height of the microgreens and their weight at harvest. The general conclusion following the analysis of the results is that a vertical hydroponic system alongside a peat and perlite substrate yields better results in microgreens farming in terms of germination rate and harvest, when compared to ebb&flow benches using a cellulose substrate. Furthermore, the vertical hydroponic system yields a slightly increased production on cultivated unit area, as compared to the ebb&flow bench system.

• Introduction

Microgreens, also known as shoots, are vegetables and aromatic plants consumed in their cotyledon-leaf stage or when they have developed their first pair of real leaves. Vertical farming or vertical agriculture is most of the time a hydroponic culture, whose practice requires arranging the growing benches stacked upon each other in columns (multilevel racks), while using artificial lighting and climate control.
This research is a comparative analysis of two systems appropriate for microgreens farming: ebb&flow benches and vertical hydroponic system. The paper also includes a comparative study of two of the most popular substrates used in microgreens farming: peat and perlite mix (70/30) and cellulose.

• Material and method

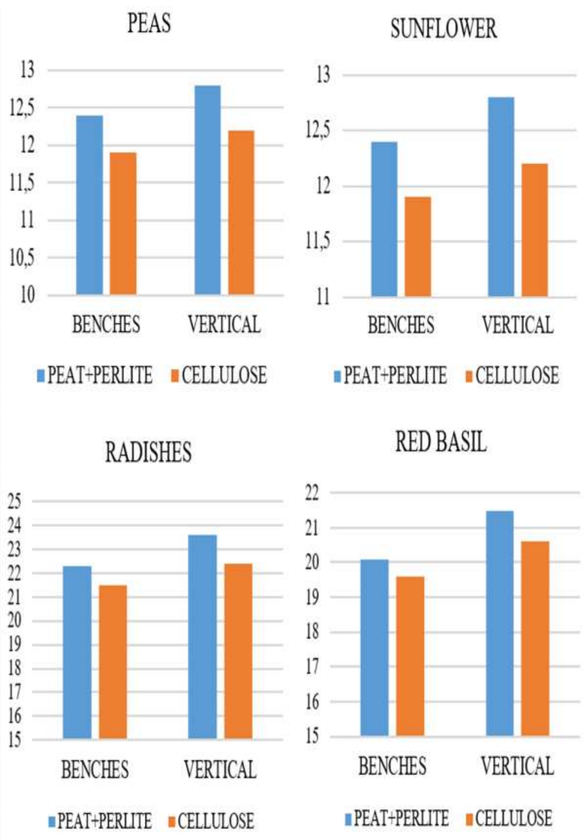
The farm grows microgreens in a hydroponic flood benches system, as well as in an experimental system of multilevel bench rack. Flood tables or benches (ebb and flow system) equipped with automatic irrigation systems are used in the hydroponic farming system. The vertical farming rack has 4 levels of UV-resistant plastic benches , controlled temperature, artificial lighting and permanent ventilation. Moreover, the module is also equipped with its own irrigation and fertilisation (fertirrigation) system, as well as with a pH and EC automatic adjustment system. For both models of farming, the microgreens are sowed in small 9x7 cm plant pots, with a height of 5 cm, made of plastic. They are placed in support-trays containing 16 pots each.

Microgreens growing technique: the plant pot is filled with a peat and perlite mix up to 75-80% of its volume, then the substrate is slightly pressed. After filling, the pot is placed in the support-tray and is sprayed with a small quantity of water on its surface. In the cellulose model, the cellulose was placed in each pot, then 16 pots were placed in each of the trays. After the preparation of the trays, the sowing is done by means of a special sowing machine using a drum. After sowing, the trays are labelled with the name of the species, the lot number and the date of sowing, then they are put in the germination room. Depending on the species, the trays will stay there for a period of 2 to 7-8 days, at a temperature of 18-20 degrees Celsius and an atmospheric humidity of 95-98% (dense mist). After coming out of the germination room, the trays are left for 2-3 hours in a room with a temperature of 20-22 degrees Celsius and diffuse light; during this period the acclimation (adaptation) of the plantules takes place. After this period, the trays are placed on the growing benches – either unfolded in the greenhouse or on vertical racks – where the entire process of growing takes place. Immediately after placing the trays on the benches, the first irrigation is carried out, which moisturises the whole substrate.

The administered water has a pH of 5.8-6 and an EC of 0.8. Then follows a period of two days with no water at all, in order to stimulate the development of the roots, as a consequence of the hydric stress. From the third day onward the cultures are watered daily with a medium volume of water of approximately 270-280 l/bench, with a pH between 5.8 and 6.2 and an EC of 1.0-1.2. The exception to this rule is the basil culture, the EC of which is increased by 0.2 units every 7 days.

• Results and discussions

Crt. no.	Species	Growing substrate	Growing model	Average height of the plants (cm)	Average weight of the plants when sold (g/pot)
1	Red radish	peat 70% + perlite 30%	Growing benches	11.2	22.3
		Cellulose		10	21.5
		peat 70% + perlite 30%	Vertical system	12.9	23.6
		Cellulose		12.1	22.4
2	Red basil	peat 70% + perlite 30%	Growing benches	10.5	20.1
		Cellulose		9.6	19.6
		peat 70% + perlite 30%	Vertical system	12	21.5
		Cellulose		10.9	20.6
3	Peas	peat 70% + perlite 30%	Growing benches	11.7	12.4
		Cellulose		10.4	11.9
		peat 70% + perlite 30%	Vertical system	12.7	12.8
		Cellulose		11.8	12.2
4	Sunflower	peat 70% + perlite 30%	Growing benches	11	28, 2
		Cellulose		10.4	27.4
		peat 70% + perlite 30%	Vertical system	13.3	28.9
		Cellulose		12.6	27.5



When analysing the information in the table, we notice a similar growth rate in terms of height, as all the 4 microgreens species fell within the margin of 9.3-13.3 cm at the moment of harvest. In terms of vegetative mass harvested at the end of the experiment, the 4 species recorded different growth rates, and the maximum was reached by the sunflower microgreens in peat grown in vertical system, with 28.9 g/harvested pot. At the oposite extreme there are the peas microgreens grown on benches, whose average weight was 11.9 g/harvested pot (cellulose substrate).
The graphs above show the average weight in grams of the harvest corresponding to a pot, but, when calculating the productive potential of a full bench the differences become much more obvious. Thus, we can notice that the most important differences between the two growing systems are found in red basil microgreens, where the vertical system with peat and perlite substrate recorded an additional growth of 2.52 kg, as compared to the same species grown in the normal, ebb&flow system (result calculated for the area of a bench – 12.8 sq. m). A notable difference is also recorded for the radish microgreens, in both substrates: 2.34 kg for peat and 1.62 kg for cellulose. When calculating these differences for a whole year, we reach values of 30.24 kg for basil, 121.68 kg for radish microgreens in peat + perlite and 84.24 kg for red radish microgreens in cellulose substrate. These values correspond to the capacity of a single growing bench.

• Conclusions

1. Microgreens are a produce that can be obtained in an ecological system, in a very short time. They are easily adaptable to the conditions of a greenhouse or growing room with artificial lighting. They can also be purchased or grown in a household system and they offer a wide range of health-beneficial substances in any season; this is why they are a good source of nutrients, worthy of being included in our daily diet.

2. Microgreens are appropriate for intensive vertical agriculture, particularly due to the reduced height they reach at harvest and their short life cycle. Vertical agriculture is a new model of performant, technologised agriculture, able to produce significant quantities of fresh food in controlled climate spaces, even within or in the proximity of cities, all year round.

3. In the case of all the four species, the analysis of the results shows that the peat and perlite substrate generated an additional growth in weight and height, as compared to the cellulose substrate, both for the vertical and the horizontal (ebb&flow) system.

4. In the case of all the four species, the analysis of the results shows that the vertical growing system had a slightly improved production on the same farming area as compared to the horizontal (ebb&flow) system. This production improvement completes the production improvement via raising the number of levels of the rack.