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COMPARATIVE DESCRIPTION OF PRODUCTIVITY AND CONTENT OF BIOLOGICALLY ACTIVE SUBSTANCES OF SOME ESSENTIAL OIL-BEARING PLANTS IN CONDITIONS OF NEW WATER STREAM HYDROPONICS

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The results of comparative growing of plants in the newest experimental modules of water stream (cylindrical, gully, continuous), classical hydroponics and soil culture have shown that cylindrical and classical hydroponics system provided the high productivity (1.8-2.7 times) of raw medicinal material of *Mentha piperita* L., at the same time increasing output of essential oil, extractive substances, flavanoids and tannins by 1.2-3.1 times. The cylindrical hydroponics promoted the high productivity (1.1-2.7 times) of raw medicinal material of *Ocimum basilicum* L., at the same time increasing the output of essential oil, extractive substances and flavanoids by 1.2-3.5 times.

Water stream hydroponics – peppermint – sweet basil – essential oil – productivity

Նորագույն ջրաշիթային հիդրոպոնիկայի փորձնական մոդուլներում /գլանային, ակոսային, համատարած/, դասական հիդրոպոնիկայի, ինչպես նաև հողային մշակույթի պայմաններում եթերայուղատու և դեղատու մշակաբույս պղպեղային դաղձի աճեցման համեմատական արդյունքները ցույց են տվել, որ գլանային հիդրոպոնիկական համակարգը և դասական հիդրոպոնիկան նպաստել են դեղահումքի արդյունավետության բարձրացմանը (1.8-2.7 անգամ), միաժամանակ, եթերայուղի, էքստրակտիվ նյութերի, ֆլավոնոիդների, դաբաղանյութերի ելքի մեծացմանը (1.2-3.1 անգամ): Բուրավետ ռեհանի դեպքում դեղահումքի արդյունավետության բարձրացմանը (1.1-2.7 անգամ) և եթերայուղի, էքստրակտիվ նյութերի, ֆլավոնոիդների ելքի (1.2-3.5 անգամ) մեծացմանը նպաստել է գլանային հիդրոպոնիկական համակարգը:

Ջրաշիթային հիդրոպոնիկա – պղպեղային դաղձ – բուրավետ ռեհան – եթերայուղ – արդյունավետություն

Сравнительные результаты культивирования эфиромасличного и лекарственного растения мяты перечной в условиях экспериментальных модулей новейшей струйной (цилиндрическая, бороздовая, сплошная) и классической гидропоники, а также почвы показали, что цилиндрическая и классическая гидропонические системы способствовали максимальному повышению продуктивности лекарственного сырья (1.8-2.7 раза), в то же время увеличению выхода эфирного масла, экстрактивных веществ, суммарных флавоноидов и дубильных веществ (1.2-3.1 раза). Цилиндрическая гидропоническая система способствовала обеспечению высокой продуктивности лекарственного сырья базилика душистого (1.1-2.7 раза), увеличению выхода эфирного масла, экстрактивных веществ и флавоноидов (1.2-3.5 раза).

Струйная гидропоника – мята перечная – базилик душистый – эфирное масло – продуктивность

In terms of rapid expansion of plants hydroponics production and considerable increasing demand for medicinal and essential oil-bearing plants which are considered very valuable in the world market, the development of their hydroponics biotechnologies has become an important and urgent issue. For that purpose in the result of many years' researches in the Institute of Hydroponics Problems NAS RA a new, modern system – "water-stream hydroponics" with polymeric film usage has been worked out and patented in 2006-2007 which is cheaper 5-6 times as compared to the existing classical hydroponicums with reinforced concrete plots [7-10]. This new systems allows to cultivate valuable plants by hydroponics method, providing an optimal air-water-heat-nutrient regime for normal growth and development of plants, increasing plant yield of a nourished unit square and minimizing the consumption of energy, water and nutrient elements. Application of irretrievable push of nutrient solution and closed ecological system allow excluding pollution of the environement, at the same time decreasing of the possibility of disease and insects outbreaks.

The aim of the investigation is comparative description of productivity, content and output of secondary bioactive substances of peppermint (*Mentha piperita* L.) and sweet basil (*Ocimum basilicum* L.) in water-stream hydroponics (cylindrical, gully, continuous), classical hydroponics and soil conditions.

Materials and methods. The essential oil obtained from leaves and inflorescences of peppermint is rich in menthol alcohol (35-46%) and menthon ketone (9-26%). It is used for treating cardiovascular, respiratory, kidney, migraine and other diseases and in case of gastrointestinal diseases its leaves have a sedative, anti-inflammatory property at the same time lower blood pressure. The main compounds of essential oil obtained from sweet basil are methylchavicol (40-52%), linalool (20%) and geraniol (28%). The infusion from leaves and seeds is used for treating atherosclerosis, different ethological tumors, avitaminosis, spasm, gastrointestinal tract, cough, bronchial asthma, epilepsy, skin diseases and recovery of blood pressure. The essential oil is used in perfume, food and sweets production [5, 6, 11], (fig. 1).

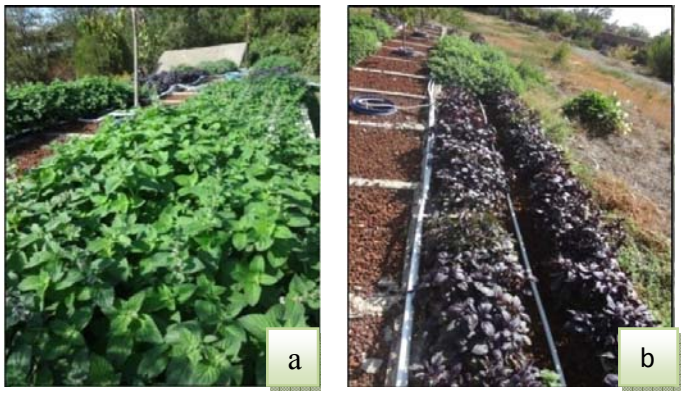


Figure 1. Peppermint (a) and Sweet basil (b) in water-stream hydroponics conditions

Davtyan nutrient solution (0.5-1.0N) was used in the experiments [2], which were pushed directly to the root-bearing stratum of the plant, in spring and autumn 6-8 and in summer 10-20 times a day, by duration 15-20 seconds. The dosage of the solution given once was 20-50 ml/plant. In classical hydroponics (CH) the plants were nourished 1-2 times a day and in soil (control) culture once in 3-4 days, 3-15mm diameter particle volcanic slag was used as substrate in hydroponics modules. The seedlings were planted 8 plant/m^2 planting density.

The content of essential oil was determined by Ginzberg's [4] method, flavonoids according to Borisov [1] and the content of extractive substances, tannins and moisture according to SPh XI [12]. The obtained results were submitted to mathematical working out [3].

Results and Discussion. Growth peculiarities and productivity indices of the studied plants in hydroponics and soil culture conditions is essentially different. This is due to certain regulation factors which provide the growth, development and productivity of plants in hydroponics.

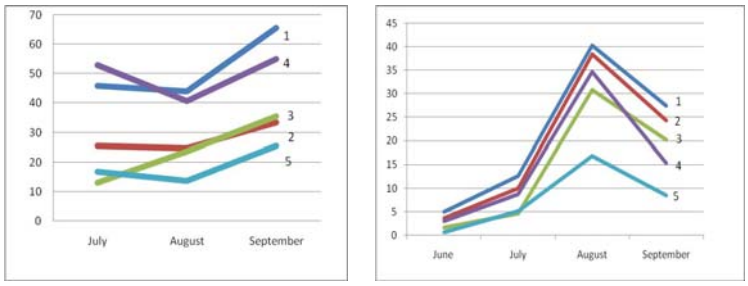
Table 1. Productivity of peppermint and sweet basil

Indices	Cylindrical	Gully	Continuous	CH	Soil (control)
	Peppermint				
Height of the plant, cm	52.4	47.8	46.5	65.1	41.8
Dry medicinal material's weight, g/plant, LED_{05}=15.3	155.0	83.7	69.7	149.0	57.0
Dry Stem's weight, g/plant	81.5	39.0	23.5	96.0	14.5
	Sweet basil				
Height of the plant, cm	56	41	46	52	45
Diameter of the stem base, mm	20	17	16	19	13
Dry medicinal material's weight, g/plant, LED_{05}=12.8	85.3	75.2	57.4	61.3	31.3
Dry stem's weight, g/plant	28.7	21.5	20.1	19.6	9.7
Dry root's weight, g/plant	16.1	16.3	10.6	10.4	4.1

It's obvious from analysis of tabl. 1 that the raw material of both peppermint and sweet basil obtained by using different hydroponics methods exceeds soil culture by 1.2-2.7 and 1.8-2.8 times. At the same time the obtained results have shown that cylindrical and classical hydroponics systems compared to gully, continuous and soil variants provided increase of raw material dry weight by 1.9-2.7 and 1.8-2.6 times. And in case of sweet basil cylindrical hydroponics system provided maximum productivity, which exceeded other variants 1.1-2.7 times.

The influence of cultivation conditions on the development of root system of sweet basil is also quite considerable. Cylindrical and gully hydroponics provided maximum growth of roots dry weight from the tested variants. We can conclude that in variants with maximum raw material there was also root mass weight increase by about 1.5-4.0 times (tab. 1).

At the same time, we can see from fig. 2 that during vegetation, regardless of cultivation conditions, peppermint provides maximum growth in September, while sweet basil reaches its maximum height in August and at the end of vegetation-in September it decreases.

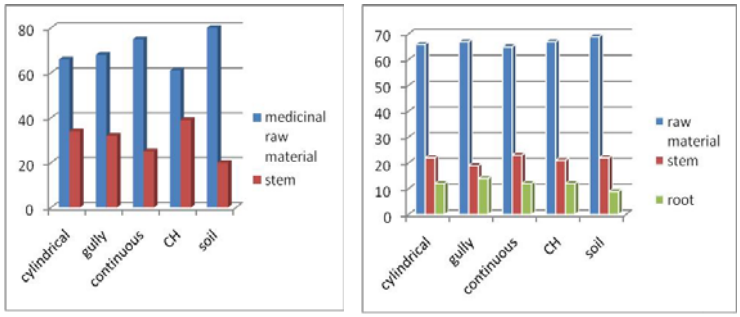


a) b)

1-Cylindrical, 2- Gully, 3- Continuous, 4- CH, 5-Soil

Figure 2. Peppermint (a) and Sweet basil (b) dry medicinal raw material weight by cuts, g/plant

In leaf-stem weight ratio the regularity confirmed in classical hydroponics and soil culture is mainly maintained in water-stream hydroponics modules. So by average value of 61-80 and 75-78% leaf mass accumulation has been observed in dry raw material of peppermint and sweet basil (fig. 3).



a) b)

Figure 3. Peppermint (a) and Sweet basil b) medicinal raw material-stem ratio in dry mass, %

It turned out from Pharmachemical analysis of raw material that growing conditions did not have any considerable influence on essential oil accumulation in the leaves of peppermint. By average data the indices fluctuated between 3.8-4.2% (tab. 2). However, during vegetation concerning the content of extractive substances, sum flavonoids and tannins there haven't been any certain regularities. Peppermint raw medicinal material (essential oil, humidity) meets the requirements of USSR SPh XI [7].

Table 2. The content and output of substances determining the pharmacological-chemical value of peppermint*

Variant	Essential oil		Extractive substances		Sum flavonoids		Tannins		Humidity
	%	g/plant	%	g/plant	%	g/plant	%	g/plant	%
Cylindrical	4.0	6.2	20.6	32.0	2.8	4.3	14.8	22.9	9.6
Gully	4.2	3.5	18.2	15.2	3.0	2.5	14.0	11.7	10.0
Continuous	3.9	2.7	20.2	14.1	3.2	2.2	14.3	10.0	9.7
CH	3.8	5.7	17.2	25.7	2.7	4.0	12.6	18.7	9.3
Soil (control)	4.1	2.3	18.1	10.3	3.3	1.9	14.6	8.3	10.6

**Average value of 3 cuts*

The study results of growth conditions influence on changes of pharmacological-chemical indices of sweet basil are summarized in tab. 3. From essential oil percentage content viewpoint the differences of cylindrical, gully hydroponics modules and soil culture are very little: according to average data it fluctuates between 0.74-0.78%.

In the experiments a greater amount of essential oils was provided by continuous hydroponics system (5-37%), while in classical hydroponics conditions that index considerably reduces, about 19-27%. Analyzing the data of the table we can see that the content of extractive substances and sum flavonoids is to some extent low only in case of gully hydroponics (by 27-31 and 13-28%). However, gully and continuous hydroponics systems provided a greater amount of tannins.

Table 3. The content and output of substances determining the pharmacological-chemical value of Sweet basil*

Variant	Essential oil		Extractive substances		Sum flavonoids		Tannins		Humidity
	%	g/plant	%	g/plant	%	g/plant	%	g/plant	%
Cylindrical	0.77	0.7	26.8	22.8	2.7	2.3	8.7	7.4	9.6
Gully	0.74	0.6	18.5	13.9	2.1	1.6	10.4	7.8	10.3
Continuous	0.82	0.5	26.2	15.1	2.4	1.4	10.8	6.2	10.2
CH	0.60	0.4	25.3	15.5	2.9	1.8	8.2	5.0	10.5
Soil (control)	0.78	0.2	26.3	8.2	2.4	0.8	8.6	2.7	11.0

**Average value of 3 cuts*

In the case of both tested plants the percentage content of bioactive substances: essential oils, extractive substances, flavonoids and tannins in soil variant is close to average indices of hydroponics plants, while the output of the above mentioned compounds reduces 1.2-3.1 (peppermint) and 1.7-3.5 (sweet basil) times. This is due to low harvest of soil plants.

The obtained data let us conclude that cylindrical hydroponics system and classical hydroponics promoted productivity increase of peppermint medicinal raw material (by 1.8-2.7 times), at the same time output increase of essential oils, extractive substances, flavonoids and tannins (by 1.2-3.1 times). Cylindrical hydroponics system promoted productivity increase of sweet basil medicinal raw material (by 1.1-2.7 times), at the same time output increase of essential oils, extractive substances and flavonoids (by 1.2-3.5 times).

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