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The Productivity of *Ocimum Basilicum* L. in the Newest Experimental Modules of Water Stream Hydroponics

Mahsa.Kh. Daryadar

G.S. Davtyan Institute of Hydroponics Problems, National Academy of Sciences, Yerevan 0082, 108 Noragyugh, Republic of Armenia.

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ABSTRACT

.Comparative studies of Sweet Basil (*Ocimum Basilicum* L.) in water stream /cylindrical, gully, continuous/ and classical hydroponics, as well as in soil culture have shown, that cylindrical hydroponics system provided productivity increase of raw medicinal material 1.1-2.7 fold, at the same time output increase of essential oil, extractive substances andflavanoids1.2-3.0 fold.

KEY WORDS: Water stream hydroponics, Sweet Basil, essential oil, productivity.

INTRODUCTION

Hydroponics as a modern biotechnological method for plant material production is more expedient and efficient particularly in countries with limited resources of soil and water. But the creation of hydroponicums requires initial substantial investments, thus, the development of novel and cheap systems is considered to be one, of the main tasks for increasing economic efficiency of plants soilless culture. For this reason at the Institute of Hydroponics Problems of NAS RA a new, modern system-«water stream hydroponics» with polymeric film usage for plants soilless production was worked out which is cheaper for 5-6 times as compared with the existing classical hydroponicum with reinforced concrete plots (Mairapetyanet al 2006; Mairapetyanet al 2007a, 2007b, 2007c; Mairapetyanet al 2009,Mairapetyanet al 2011). The bases of water stream hydroponics are the periodical and irretrievable push /in the from of a jet / of the nutrient solution directly to the root-bearing stratum of the plant which is automatically regulated from the viewpoint of time and quantity.

The aim of the research is to reveal pharmachemical peculiarities as well as growth and development regularities of Sweet Basil in experimental modules of newest water stream /cylindrical, gully, continuous/, classical hydroponics and soil culture conditions.

MATERIALS AND METHODS

Sweet basil (Figure 1) is an annual plant, which belongs to the Lamiaceae family. The overground part of the plant (herb) contains essential oil (1-1.5%), tannins (6%), flavanoids (rutin 0.15%), extractive substances, microelements etc. Methyl chavicole and linalool are the main components of essential oil. According to literature the tincture obtained from leaves and seeds are used for curing atherosclerosis, different ethological tumours, avitaminosis,spasms, epilepsy, gastrointestinal tract, cough, bronchial asthma, meteorism, skin diseases andfor restoring blood circulation. The essential oil obtained from the leaves also used in parfume production, food and sweets industry (Mayrapetyan 1989, Lebedevaet al 2006,Özcanet al2002,Sajjadi 2006).

a) Cylindrical b) Gully c) Continuous

*** Corresponding Author:** Mahsa. Kh. Daryadar, G.S. Davtyan Institute of Hydroponics Problems, National Academy of Sciences, Yerevan 0082, 108 Noragyugh, Republic of Armenia. Daryadar,m.daryadar@ymail.com

d) CH e) Soil

Ficture1. Sweet Basil in different cultivation conditions

During the vegetation plants were subirrigated by 0.5-1N Davtyan's nutrient solution (Davtyan1980), which was pushed directly to the root-bearing stratum of the plant, in sprng and autumn 6-8 and in summer 10-20 times a day, by duration 15-20 second. The dosage of the solution given, for once time, was 20-30 ml/plant in spring and 30-50 ml/plant in summer and autumn. In classical hydroponics (CH) the plants in spring and autumn were nourished 1-2 times a day and 2-3 times in summer and soil culture – once in three days. In the experiments as a substrate by 3-15 mm fractions diameter of the volcanic slag was tested. In experiments as planting material hydroponics saplings were used 8plant/m^2 planting density.During the vegetation biometric measurements, physiological and pharmacochemical analyses were made: the parameters of water regime in the leaves and osmotic pressure of call sap by Gusev(Gusev1989), the content of photosynthetic pigments by Wettstein(Wettstein1957), in a dry medicinal raw material the content of essential oil, flavonoids, extractive substances and tannins by SPh XI (State Pharmacopoeia of the USSR 1990) and byGrinkevich (Chemical analysis… 1983). The results were submitted to mathematical working out (Dospechov 1985).

RESULTS AND DISCUSSION

The result have shown that cylindeical hydroponics in comparison with other system promoted the high productivity (1.1-2.7fold) of medicinal raw material(MRM) of Sweet Basil "see Table1". In this variant the plants had rich branching (15 branches) and thick stem were formed (20mm). The influence of cultivation conditions on the development of root system of Sweet Basil is essential. Among the tested variants, cylindrical and gully hydroponics provided maximum output of dry weight of roots. We can conclude that there was an increase of root mass weight, about 1.5-4 times in variants, which provided maximum planting biomass.

Table 1
Biometric measurements and productivity of Sweet basil

Variant	Height of the plant, cm	Diameter of the stem base, mm	Dry weight of raw material, g/plant	Dry weight of stem, g/plant	Dry weight of root, g/plant
Cylindrical	56	20	85.3	28.7	16.1
Gully	41	17	75.2	21.5	16.3
Continuous	46	16	57.4	20.1	10.6
CH	52	19	61.3	19.6	10.4
Soil (control)	45	13	31.2	9.7	4.1
LED_{05}			12.8		

In the leaf-stem-rootratiothe regularity,which was confirmed in CHand soil culture,on the whole maintainsin water stream hydroponics modules. So according to average data,in all versionsabout 65-68% accumulation of leaf mass was observed in the total dry weight material of Sweet Basil (Figure1).

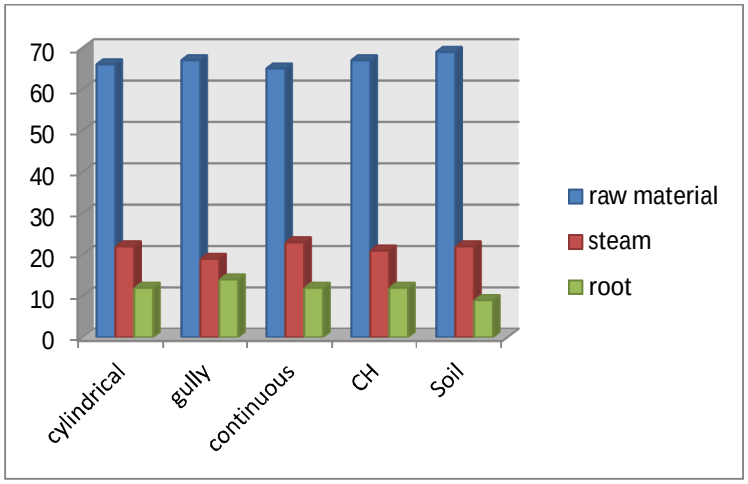

Figure 1. Theleaf-stem-root ratio(%) of Sweet Basil in a dry raw material

During the investigations for harvests have been obtained:1^{st}in June, 2nd in July, 3rd in August,4th in September.The results have shown, that regardless of cultivation conditions, for all variants more intensive accumulation of MRM ofSweet Basil was observed in August (during the third harvist, Figure 2).

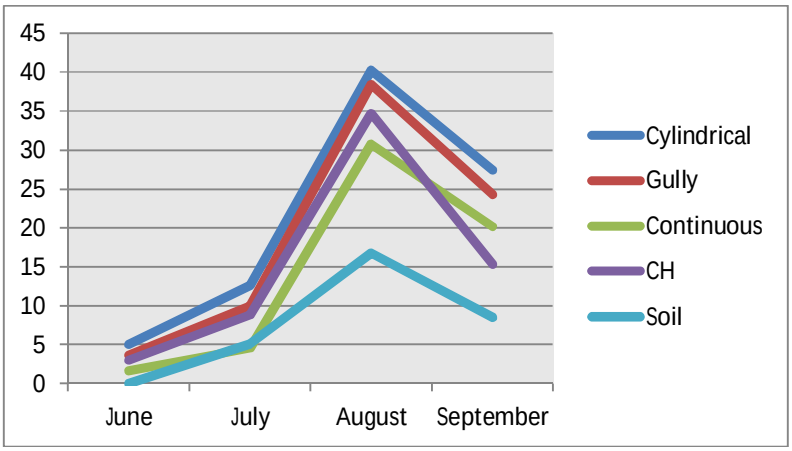

Figure 2.The weight of MRM in a dry over ground of Basil dry harvest, g/plant

On the changes of pharmachemical indices of Sweet Basil the studies of the result of growth conditions influence are assembled in Table 2. The data showed that in case of essential oil content the difference in cylindrical, gully hydroponics modules and soil culture is not significant. According to average data it fluctuates between 0.74- 0.78%.During the investigation continuous hydroponics system provided the highest content of essential oil, while in case of classical hydroponics it considerably reduces (about 23-36%). At the same time, in almost all variants of the studied plant, the content of essential oil is the highest in August.

Table 2
Pharmachemical indices (%) of Sweet Basil by cuts

Indices	Cylindrical			Gully			Continuous			CH			Soil (control)		
	I+ II	III	IV	I+ II	III	IV	I+ II	III	IV	I+ II	III	IV	I+ II	III	IV
Essential oil	0.75	0.92	0.64	0.63	0.81	0.79	0.94	0.83	0.70	0.58	0.67	0.54	0.56	0.95	0.83
Extractive substances	27.6	25.8	26.9	27.3	12.1	16.0	24.8	24.2	29.7	30.6	24.2	21.1	24.4	24.6	30.0
Sum flavanoids	2.3	2.4	3.4	2.6	1.4	2.3	2.1	2.2	3.0	3.3	2.3	3.1	2.6	2.3	2.3
Tannins	9.1	8.5	8.6	9.2	11.0	10.8	10.3	10.6	11.5	7.5	7.5	9.6	7.9	8.2	9.6
oisture	9.0	10.1	9.6	9.0	10.5	10.9	9.6	10.1	10.8	9.8	9.9	11.7	10.1	10.7	12.1

Analyzing the data of the table we see that the content of extractive substances and sum flavanoids is to certain extent low only in case of gully hydroponics variant (by 27-31 and 13-28%).Whereas, the highest content of tannins (19-32%) was

provided by gully and continuous hydroponics systems. According to data analysis on Table3, cylindrical version(system),thanks to height productivity of Sweet Basil, is more notable with maximum output of essential oils, extractive substances and flavonoids. The output of above mentioned combinations, for 1plant in comparison with the gully, continuous, classical and soil versions, increased 1.2-2.7,1.5-2.8and1.3-3.0fold, respectively.

Table 3
The output and content of substances that determine pharmachemical value of Sweet basil

Variant	Essential oil		Extractive substances		Sum flavonoids		Tannins	
	%	g/plant	%	g/plant	%	g/plant	%	g/plant
Cylindrical	0.77	0.66	26.8	22.8	2.72	2.32	8.7	7.4
Gully	0.74	0.56	18.5	13.9	2.10	1.58	10.4	7.8
Continious	0.82	0.47	26.3	15.1	2.44	1.40	10.8	6.2
CH	0.60	0.37	25.3	15.5	2.91	1.78	8.2	5.1
Soil (control)	0.78	0.24	26.3	8.2	2.42	0.76	8.6	2.7

The growing conditions have definitely influenced on the change in several physiologo-biochemical indices of Sweet Basil (table 3).In the result it was found, that water stream hydroponics promoted the increase of water in leaves (2-7%),its more mobile fraction (4-18%) the content “a+b”chlorophyll (14-21%) and carodinoids (5-8%).At the sametime low values (2-10%)of bound water in leaves have been observed.An increase in vitamin C conten about 1.5-2.1fold was registered only in the cyindrical hydroponics.

Table 4
Physiological indices of Sweet Basil in hydroponics and soil conditions

Indices	Cylindrical	Gully	Continuous	CH	Soil (control)
Total content of water, %	88.4	87.9	86.6	84.6	81.1
Content of free water, %	62.9	59.0	57.3	53.6	45.4
Content of bound water, %	25.5	28.9	29.3	31.0	35.7
Ratio of free and bound water	2.5	2.0	1.9	1.7	1.3
Osmotic pressure of the cell sap, atm	3.8	4.31	4.47	4.78	5.42
Chlorophyll “a+b”, mg%	193.6	200.3	197.8	179.3	179.4
Carotinoids, mg%	32.7	33.8	33.8	27.7	26.3
Vitamin C, mg%	124.8	84.9	59.9	68.0	73.2

Conclusion

The cylindrical hydroponics system promoted the productivity increase of Sweet Basil raw medicinal material 1.1-2.7 fold.In case of this variant,the output of most important secondary metabolites-essential oil, extractive substances and sum flavonoids,for one plant, in comparison with the gully,continuous,classical and soil variants increased 1.2-2.7; 1.5-2.8 and 1.3-3.0 fold, respectively. Activation of several physiologo-biochemical processes of plant has been clearly noticed in cylindrical system, too.

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