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Effect of Different Concentration of Nutrients on Growth, Yield and Quality of Sweet Basil (*Ocimum basilicum*) in Hydroponics System

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ABSTRACT: The present research experiment was carried out during February 2020 to May, 2020 under Shade net at Research Field, Department of Horticulture, SHUATS, Prayagraj. The experiment was conducted in Randomized Block Design (RBD), with eight treatments, replicated thrice in hydroponics system with variety Genovese of sweet basil, From the present experimental findings it was found that structure treatment T_3 Epsom salts and micros (7.5ml/10L) ($MnSO_4$, $ZnSO_4$, $CuSO_4$, B, Common Salt) +Iron Chelate (7.5m1/10L) + Mono Ammonium phosphate (7.5ml/10L) +(N:P:K 11:48:00) + Calcium Nitrate (17.5ml/10L)+(N:P:K 15:00:00) + Potassium Nitrate (17.5ml/10L) +(N:P:K 13:00:44) was found to be best in terms of growth parameters, herbage yield and dry herbage yield, TSS and chlorophyll parameters of sweet basis in hydroponics system. Maximum gross return (Rs. 2269.82) and net return (Rs. 1266.85) with maximum benefit cost ratio (2.26) was also observed in treatment T_3.

Keywords: Nutrient film technique, vertical hydroponic system, Sweet basil.

INTRODUCTION

Sweet basil (*Ocimum basilicum* L.) in the Lamiaceae is largely employed as a flavouring agent for food and is cultivated worldwide (Makri and Kintzios, 2007). Sweet basil is also used for cosmetical and pharmaceutical preparations, as it contains large amounts of essential oils (Makri and Kintzios, 2007) and rosmarinic acid, which is a caffeic acid ester (Petersen and Simmonds 2003). Medicinal plants, including sweet basil, are generally cultivated in open field and this results in year-to-year variability in both biomass production and the content of active principles (Bourgaud *et al.,* 2001). Hence, there is an increasing interest for greenhouse hydroponic (or soilless) culture, where growing conditions can be strictly controlled and the production of the metabolites of interest can be maximized. Hydroponic culture offers several advantages over traditional soil culture such as higher yield per unit ground area, all-year round production, higher quality and ease of processing of harvested material on account of minimal contamination from pollutants, pests and pathogens (Pardossi *et al.,* 2006).

The major constituents in Ocimum oil includes linalool, gereniol, citral, eugenol, methyl chavicoal, thymol, methyl cinnamate etc that can be harnessed to yield many commercial products. Cultivation of medicinal and aromatic plants for profit has attracted the attention of many growers. The production of aromatic plants for profit on commercial basis involves a number of factors. The value of such crops depends on their active principle content which makes it different from the principle of production of agricultural crops. Various species of this crop are commercially cultivated in U.P., Jammu and Kashmir, Himachal Pradesh, Punjab and in small scale in Madhya Pradesh. In Madhya Pradesh Ocimum is cultivated commercially in Malwa region particularly in Neemuch, Mandsaur and Ratlam district which is increasing year after year. The export of this crop has increased in last decade. The seeds of this species of Ocimum are exported mainly to Arab countries from India.

It is however necessary to evaluate the real potential of soil less cultivation techniques for the Sweet Basil, in relation to yield and to crop management, adapting techniques of hydroponic cultivation to tropical and subtropical conditions. Hydroponics plays an important role in Sweet Basil production, as recorded the production was high in hydroponically planted Sweet Basil as compared to those planted in field in open atmospheric conditions. Hydroponics also allows the farmers to grow it all round the year.

MATERIALS AND METHODS

The Experimental work was conducted at Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the year 2020-2021.

The Sweet Basil was grown under hydroponics (NFT-Nutrient Film Technique) 8 treatments with 3 replications each was carried out for a duration of 75 days after planting.

RESULTS AND DISCUSSION

The efforts have been made to compare and interpret the result of various experiment carried out during the course of investigation with the findings of the other

research works. The DAP recorded on various characters during February to May 2020. The course of investigation have been presented alongwith appropriate tables, figures and illustrations.

Plant height: The plant height (cm) of (*Ocimum basilicum*) in Hydroponics System in each treatment is presented. The soil less application of different concentration of nutrients viz., $MnSO_4$, $ZnSO_4$, $CuSO_4$, B, Common Salt, Iron Chelate, Mono Ammonium phosphate, Calcium Nitrate and Potassium Nitrate have significant effect on plant height (cm) at 15, 30, 45, 60 and 75 days after planting as compared to control (T_8). Treatment T_3: gave the maximum plant height (cm) at 15, 30, 45, 60 and 75 days after planting (15.35, 25.12, 33.04, 39.33 and 47.21cm) which was followed by T_6 whereas the minimum plant height (10.53, 13.70, 19.07, 22.73 and 25.43 cm) was found in Control. All the treatments were significantly superior in their plant height over control (T_8) except T_7 and T_2.

The increasing concentration of various hydroponics nutrients significantly influence the plant height upto T_3. It clear from the obtained data that plant height in T_3 was significantly superior over all other treatment except T_6 however increasing the concentration at T_4, T_5 and T_7 at no significant effect on plant height of sweet basil. Hence it was noted that the treatment combination in T_3 was optimum for plant height. This might be also due to optimum levels of N, P and K and micro-nutrients which were found suitable for Sweet basil in hydroponic system. There elements are helpful in cell elongation, development of cell and rapid cell division and cell elongation in meristematic region of plant due to production of plant growth substance. This may also be due to optimum supply of plant nutrients and water which led in the better growth of sweet basil. Similar finding where found in Khalil, (2002) on rosemary, Raimondi *et al.,* (2006).

Number of leaves plant^{-1}: Treatment T_3 gave the maximum number of leaves plant^{-1} at 15, 30, 45, 60 and 75 days after planting (20.41, 26.00, 35.26, 40.97 and 45.57) which was followed by T_6, which is at par with each other whereas the minimum number of leaves plant^{-1} (10.27, 15.17, 22.69 27.86 and 34.79) was found in Control. All the treatments were significantly superior in their number of leaves plant^{-1} over control (T_8) except T_1 and T_2.

Significantly maximum Number of leaves per plant was recorded in T_3 at 15, 30, 45, 60 and 75 DAP, which might be due to optimum levels of N, P & K, and micro-nutrients which were found suitable for sweet basil in hydroponic system resulted enhanced photosynthetic and other metabolic activities which lead to increase in various plant metabolites responsible for cell division and elongation. Similar finding where found in Khalil, (2002) on rosemary and Zamani *et al.,* (2013) in sweet basil.

Number of branches plant^{-1}: In term of number of branchesplant^{-1} at 15, 30, 45, 60 and 75 days after planting (35.52, 4.27, 5.77, 6.51 and 7.29) which was followed by T_6 whereas the minimum number of branches plant^{-1} (2.11, 3.33, 3.58, 3.83 and 4.00) was found in Control. All the treatments were significantly superior in their number of branches plant^{-1} over control (T_8) except T_1 and T_7.

Significantly number of branches plant^{-1}was recorded in T_3 at 15, 30, 45, 60 and 75 DAP, might be due to optimum levels of N, P and K and micro-nutrients which were found suitable for sweet basil in hydroponic system resulted enhanced photosynthetic and other metabolic activities which lead to increase in various plant metabolites responsible for cell division and elongation. Similar finding where found in Raimondi *et al.,* (2006).

Leaf area: In term of Leaf area maximum (4.61cm^2) which was followed by T_6, T_5,, T_4 and T_2 which is at par with each other whereas the minimum Leaf area (2.34cm^2) was found in Control. All the treatments were significantly superior in their Leaf area (cm^2) over control (T_8) except T_1.

Significantly maximum Leaf area was recorded in T_3 at 15, 30, 45, 60 and 75 DAP, which were might be due to optimum levels of N, P & K and micro-nutrients, which found suitable for sweet basil in hydroponic system and enhanced photosynthetic and other metabolic activities which lead to increase in various plant metabolites responsible for cell division and elongation. Similar finding where found in Khalil (2002) on rosemary plants.

Root length: In term of root length (cm) maximum at 15, 30, 45, 60 and 75 days after planting (11.34, 13.39, 14.68, 15.54 and 17.28 cm) which was followed by T_6 which is at par with each other whereas the minimum root length (cm) (9.59, 10.38, 11.29, 12.45 and 12.92) was found in Control. All the treatments were significantly superior in their root length (cm) over control (T_8) except T_4 and T_5.

Significantly maximum Root length was recorded in T_3 at 15, 30, 45, 60 and 75 DAP, this may be due to abundant amount of nutrients directly available to the plants roots, which led in the higher water uptake of plants and ultimately growth of roots of sweet basil. Similar finding where found in Khalil, (2002) on rosemary, Raimondi *et al.,* (2006).

Chlorophyll content. In term of Chlorophyll content maximum (39.07SPAD) which was followed by T_6 which were on par with each other whereas the minimum Chlorophyll content (21.69 SPAD) was found in Control. All the treatments were significantly superior in their Chlorophyll content (SPAD) over control (T_8) except T_7 and T_4

The maximum value associated with T_3 might be due to their moisture level in leaves, genetic nature, environmental factor, hormonal factor. Similar finding where found in Munns, (2002); Abo Aly (2019).

Yield Parameters

Total Herbage yield plant^{-1} and structure^{-1}: In term of Total Herbage yield plant^{-1} maximum (27.3g) and structure^{-1} (324.26g) at 1st and 2nd harvest which was followed by T_6 .Where as the minimum Herbage yield plant^{-1}(10.32g) and structure^{-1} (123.84g) at total herbage yield was found in Control. All the treatments

were significantly superior in their total Herbage yield plant^{-1} and structure^{-1} (g) at 1st and 2nd harvest over control (T_8) except T_4 & T_5.

The increasing concentration of various hydroponics nutrients significantly influence the Herbage yield upto T_3. It clear from the obtained data that total Herbage yield in T_3 was significantly superior over all other treatment except T_6 however increasing the concentration at T_4, T_5 and T_7 at no significant effect on total herbage yield of sweet basil. Hence it was noted that the treatment combination in T_3 was optimum in total herbage yield. This might be also due to the plant growth and final yield depends on the continued supply of food material and water. Since N, P and K and micro-nutrients help in the absorption of water and carbohydrates metabolism, its deficiency may cause poor growth and yield of plants. Similar finding where found Raimondi *et al.,* (2006); Oztekin *et al.,* (2018) in Spinach.

Total Dry Herbage yield plant^{-1} and structure^{-1}: In term of Total Dry Herbage yield plant^{-1} maximum (1.81g) and structure^{-1} (21.76g) at 1st and 2nd harvest which was followed by T_6 which is at par with each other whereas the minimum Total Dry Herbage yield plant^{-1} (0.61g) and structure^{-1} (7.27g) at 1st and 2nd harvest was found in Control. All the treatments were significantly superior in their Total dry Herbage yield plant^{-1} and structure^{-1} (g) at 1st and 2nd harvest over control (T_8) except T_4 and T_1.

This might be due to the plant growth and final yield depends on the continued supply of food material and water. Since N, P and K and micro-nutrients help in the absorption of water and carbohydrates metabolism, its deficiency may cause poor growth and yield of plants.Similar finding where found in Oztekin *et al.,* (2018) in Spinach.

Total soluble solid: In term of Total soluble solid maximum (10.88°Brix) which was followed by T,,T_4,T_5,T_7 and T_1 which is at par with each other whereas the minimum Total soluble solid (9.21°Brix) was found in Control. All the treatments were significantly superior in their total soluble solid (°Brix) over control (T_8) except T_2.

The maximum TSS (°Brix) was noted in T_3 might be due to respiration rate, moister percentage in leaves, skin colour with better adaptability for the environmental conditions and internal fiber smoothness. Similar findings were reported by Raimondi *et al.,* (2006).

Economic: The maximum cost of production (Rs. 1247.57) was observed in T_7 followed by T_6 (Rs. 1186.8), minimum cost of production (Rs. 724.1) was observed in Control. The maximum Gross return (Rs. 2269.82) is recorded in T_3 followed by T_6 (Rs. 1954.96), minimum Gross return (Rs. 866.88) was recorded in T_8 (only water). The maximum Net return (Rs. 1266.85) is found in T_3 followed by T_6 (Rs. 768.16), minimum Net return (Rs. 80.7) was found in T_4. The maximum Cost benefitratio (2.26) is observed in T_3 followed by T_1 (1.70), minimum Cost benefit ratio (1.07) was observed in T_4.

Table 1: Performance of Sweet Basil for growth parameters in Vertical hydroponic system under shade net.

Treatment details (No.)	Plant height (cm)					Number of leaves plant^{-1}				
	15DAP	30DAP	45DAP	60DAP	75DAP	15DAP	30DAP	45DAP	60DAP	75DAP
T_1	13.43	19.83	25.96	27.47	32.03	11.81	17.83	22.64	29.16	36.16
T_2	9.97	15.44	23.11	26.06	31.33	14.94	20.00	25.68	27.83	35.09
T_3	15.35	25.12	33.04	39.33	47.21	20.41	26.00	35.26	40.97	45.57
T_4	10.72	16.53	20.12	24.81	35.08	18.06	23.81	29.80	36.07	41.56
T_5	10.94	15.38	20.47	26.16	32.97	17.37	22.58	30.28	36.38	42.48
T_6	14.52	22.64	27.37	31.50	37.50	19.34	24.53	32.80	38.49	44.10
T_7	13.89	16.50	20.46	24.40	27.44	15.63	18.41	27.33	33.69	40.48
T_8: Control (tap water)	10.53	13.70	19.07	22.73	25.43	10.27	15.17	22.69	27.86	34.79
F-Test	S	S	S	S	S	S	S	S	S	S
S.Ed (+)	0.817	1.857	1.559	1.317	1.056	1.56	2.45	1.83	1.10	1.169
C.D. at 5%	1.751	3.98	3.34	2.824	2.65	3.36	5.26	3.92	2.36	2.50

Table 2: Performance of Sweet Basil for growth parameters in Vertical hydroponic system under shade net.

Treatment details (No.)	Number of branches plant^{-1}					Root length (cm)				
	15DAP	15DAP	15DAP	15DAP	15DAP	15DAP	30DAP	45DAP	60DAP	75DAP
T_1	2.75	2.75	2.75	2.75	2.75	9.45	10.68	12.38	12.83	13.06
T_2	3.08	3.08	3.08	3.08	3.08	9.54	11.40	11.86	12.25	13.17
T_3	3.52	3.52	3.52	3.52	3.52	11.34	13.39	14.68	15.54	17.28
T_4	3.17	3.17	3.17	3.17	3.17	9.45	10.56	11.13	11.46	12.47
T_5	2.67	2.67	2.67	2.67	2.67	9.49	10.65	11.08	11.46	12.07
T_6	3.21	3.21	3.21	3.21	3.21	10.18	12.63	13.44	14.41	16.25
T_7	3.00	3.00	3.00	3.00	3.00	10.00	12.11	12.55	12.92	13.52
T_8: Control (tap water)	2.11	2.11	2.11	2.11	2.11	9.59	10.38	11.29	12.45	12.92
F-Test	S	S	S	S	S	S	S	S	S	S
S.Ed (+)	0.229	0.229	0.229	0.229	0.229	0.471	0.465	0.590	0.594	0.503
C.D. at 5%	0.49	0.49	0.49	0.49	0.49	1.010	0.998	1.265	1.273	1.097

Table 3: Performance of Sweet Basil for growth parameters in Leaf area, Chlorophyll content and TSS (°Brix).

Treatment details (No.)	Leaf area (cm^2)	Chlorophyll content (SPAD)	TSS (°Brix)
T_1	3.66	33.29	10.04
T_2	4.32	35.68	9.83
T_3	4.61	39.07	10.88
T_4	4.30	28.89	10.63
T_5	4.34	29.88	10.42
T_6	4.44	37.53	10.76
T_7	4.06	28.29	10.14
T_8: Control (tap water)	2.34	21.69	9.21
F-Test	S	S	S
S.Ed (+)	0.239	0.943	0.429
C.D. at 5%	0.512	2.023	0.919

Table 4: Performance of Sweet Basil for growth parameters in Herbage yield of Sweet Basil in Hydroponics System under Shadenet.

Treatment details (No.)	Herbage yield plant^{-1} (g/plant)			Herbage yield per vertical structure^{-1} (g) (12 plants)		
	I Harvest	II Harvest	Total	I Harvest	II Harvest	Total
T_1	8.34	9.53	17.87	100.08	114.36	214.44
T_2	8.15	8.47	16.62	97.80	101.60	199.4
T_3	13.07	13.96	27.03	156.78	167.48	324.26
T_4	6.65	6.98	13.63	79.80	83.80	163.6
T_5	7.40	7.65	15.05	88.84	91.76	180.6
T_6	11.65	11.63	23.28	139.76	139.52	279.28
T_7	7.98	8.17	16.15	95.76	98.04	193.8
T_8: Control (tap water)	4.78	5.54	10.32	57.36	66.48	123.84
F-Test	S	S	S	S	S	S
S.Ed (+)	0.442	0.493	0.58	5.303	5.913	19.86
C.D. at 5%	0.948	1.057	1.24	11.375	12.683	42.59

Table 5: Performance of Sweet Basil for growth parameters in Dry Herbage yield of Sweet Basil in Hydroponics System under Shadenet.

Treatment details (No.)	Dry herbage yield plant^{-1} (g/plant)			Dry herbage yield per vertical structure^{-1} (g) (12 Plants)		
	I Harvest	II Harvest	Total	I Harvest	II Harvest	Total
T_1	0.33	0.39	0.72	3.91	4.62	8.53
T_2	0.36	0.45	0.81	4.32	5.40	9.72
T_3	0.89	0.92	1.81	10.68	11.08	21.76
T_4	0.33	0.37	0.70	3.92	4.48	8.4
T_5	0.71	0.75	1.46	8.57	8.97	17.54
T_6	0.84	0.88	1.72	10.08	10.56	20.64
T_7	0.76	0.77	1.53	9.13	9.25	18.38
T_8: Control (tap water)	0.29	0.32	0.61	3.43	3.84	7.27
F-Test	S	S	S	S	S	S
S.Ed (+)	0.034	0.021	0.03	0.404	0.255	0.55
C.D.at 5%	0.072	0.046	0.10	0.867	0.546	1.18

Table 6: Cost benefit ratio of nutrient in vertical hydroponics system under Shadenet.

Treatment No.	Total Herbage yield structure^{-1}	Selling price (Rs. g^{-1})	Gross return	Total cost treatments (Rs.)	Net return	Cost benefit ratio
T_1	214.44	Rs. 7	1501.08	880.67	620.41	1.70
T_2	199.4	Rs. 7	1395.8	941.4	454.4	1.48
T_3	324.26	Rs. 7	2269.82	1002.97	1266.85	2.26
T_4	163.6	Rs. 7	1145.2	1064.5	80.7	1.07
T_5	180.6	Rs. 7	1264.2	1118.87	145.33	1.12
T_6	279.28	Rs. 7	1954.96	1186.8	768.16	1.64
T_7	193.8	Rs. 7	1356.6	1247.57	109.03	1.08
T_8	123.84	Rs. 7	866.88	724.1	142.78	1.19

CONCLUSION

On the basis of results obtained, it is concluded that the treatment T_3 Epsom salts and micros (7.5ml/10L) +Iron Chelate (7.5m1/10L) + Mono Ammonium phosphate (7.5ml/10L) + (N:P:K 11:48:00) + Calcium Nitrate (17.5ml/10L) + (N:P:K 15:00:00) + Potassium Nitrate (17.5ml/10L) + (N:P:K 13:00:44) was found best in terms of growth parameters, herbage yield, dry herbage yield, TSS and Chlorophyll of sweet basil in hydroponics system under shadenet. Maximum gross return (Rs. 2269.82.) and net return (Rs. 1266.85.) with maximum cost benefit ratio (2.26) was also observed in treatment T_3.

FUTURE SCOPE

Hydroponics scope is very good especially in India as most of the vegetable supplies available are with

residual chemicals and harmful to our health. No matter how rich or poor we are, these vegetable supplies are same for all of us and affect to us and our children.

In such times, Hydroponic presents an alternate way of growing very healthy vegetables and making them available for common people at comparable cost and big margins. Considering, that consumption of vegetables are very high in India on account of both high population and high percentage of vegetarians, demand to supply ratio is always going to be high and scope of Hydroponic farming which ensures chemical free vegetables, grown in pure water to be always high.

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Conflict of Interest. As a Corresponding Author, I Ajay Kundu, confirm that none of the others have any conflicts of interest associated with this publication.

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