RESEARCH ARTICLE

Comparative Performance of Mint in Different Hydroponics Systems

Shanmugabhavatharani R[1]*, Swarna Priya R[1], Sankari A[1] and Kaleeswari R K[2]

[1]Department of vegetable science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore - 641 003

[2]Department of Soil Science and Analytical Chemistry, Tamil Nadu Agricultural University, Coimbatore - 641 003

Abstract

This study aimed to compare the performance of mint in two modified Nutrient film technique (NFT) hydroponic systems viz., Horizontal (S_1) and Vertical A types (S_2) along with three nutrient combinations viz.,T_1-NPK@ 40:65:40/hectare,T_2-NPK @ 50:75:50/hectare,T_3-NPK @ 60:85:60/hectare. The trail was laid out in Factorial Randomized Block Design (FRBD) with three replication at the Department of Vegetable Science in Tamil Nadu Agricultural University. The nutrient quantities were computed for 100 litre of water and were given through fertigation. The pH of 6.5-6.8 and EC around 2Ds/m was continuously maintained throughout the experimental period. The observations viz., plant height(cm), the number of leaves, the number of branches, shoot length (cm), root length (cm), fresh weight of leaves (g), fresh and dry weight of shoot and root (g) , total plant dry weight(g) were determined. It was inferred that (S_1T_1) vertical A type with nutrient combination of NPK @ 40:65:40/ hectare have given maximum yield when compared to other treatments.

Keywords: *NFT; Vertical A type-NFT; Horizontal type-NFT; Morphological parameter*

Introduction

As the population is increasing day by day and there is a decline in the cultivated area by 38.10 percent. According to the National Horticulture database (2019-2020) the production of vegetables is 191.77 million metric tonnes per year. Still, there is a gap between the demand and productivity of vegetables. Hence, a shift toward new technologies like the modified nutrient film technique (NFT) is required. The nutrient film technique is a hydroponics system, where the plant roots are directly exposed to the thin film of nutrient solution flowing through the channels or plastic pipes. The nutrients will be absorbed through the permeable root system of the plant. These systems are especially useful in areas prone to biotic stresses viz., cold, desert, heat etc. Commercially these hydroponic systems are automatically operated and thus reduce labour and several traditional cultural practices such as weeding, spraying, and watering are eliminated (Jovicich *et al.,* 2003).

Materials and Methods

The experiment was carried out during 2020-2021 at the Department of Vegetable Science; Horticultural College &Research Institute, TNAU which is located at a latitude of N 11°0'34.9596" and longitude of E 76°55'50.22122" .The objective of the study is to examine the effect of different hydroponic systems and nutrient combinations on the growth and yield of mint. Terminal cuttings of 15 cm length were prepared and planted in portrays filled with coir pith. After the fourth true leaf stage, the cuttings were transplanted along with the ball of earth into modified NFT structures viz., vertical A-type, and horizontal modified NFT's. The experimental design was laid out in FRBD with three replication.The treatments are as follows

Factor A- Growing systems:

S1- Horizontal type

S2- Vertical A type

Factor B- Nutrient combinations

T1--NPK@ 40:65:40 per hectare

T2-NPK @ 50:75:50per hectare

T3-NPK @ 60:85:60 per hectare

System designs and nutrient treatment

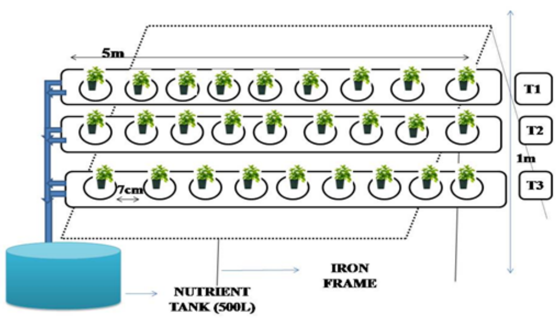
Vertical A-type NFT system

In this system, plants were grown in three layers of racks along with clay pebbles for mechanical support as suggested by Jensen, 1997. PVC plastic pipes of 7cm diameter and length of 5m were taken and mounted on iron frames of dimension

*Corresponding author: tharanisekar1214@gmail.com

(80x40cm) forming 60° triangles. The iron frame hold three rows of plastic pipes and a fixed distance of 35cm between the row. Plants were placed at a spacing of 25 cm in the same plastic pipes. The holes are placed at a diameter of 7cm.Forty plants were planted in each row and nutrient solution was supplied by one main tank of 100L capacity. The nutrient solution was pumped into the tank by 0.5hp through the drip irrigation system. The end of each PVC pipe is closed with 3cm end cap and two holes were made one for the inlet and another for outlet pipes and were connected to the same tank for recirculation of solutions.(Fig.1)

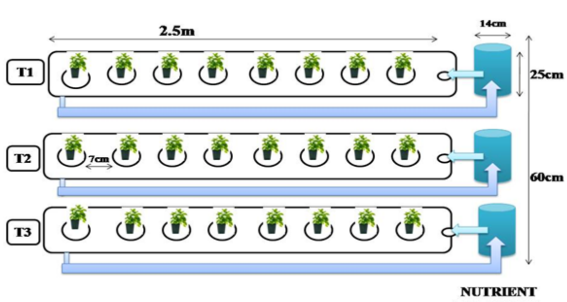
Figure1. Layout of vertical A type NFT system



Horizontal NFT system

The horizontal NFT system was mounted on three flat iron rods with dimensions 35x17cm. Four PVC plastic pipes of 4 inches with 2.5 m in length were fixed at a distance of 12 cm on the flat iron frame with help of a holder and claps. Plants were planted on hydroponic pots filled with clay pebbles, placed at a spacing of 25cm between plants and placed at each row. Different treatments viz., T_1, T_2, T_3 were given to each row. The end of each pipe were sealed with an end cap at the lower part .Each pipe has a hole for drainage. These outlet pipes were again connected to a nutrient solution barrel of 100 L capacity for recirculation (Fig.2)

Figure2. Layout of horizontal type NFT system



pH and EC maintenance

Nutrient solutions used for hydroponics systems contain all the essential elements required for plant growth. The acidity or alkalinity of nutrient solutions also determines the availability of essential elements. Change in pH range cause deficiency of nutrients so that plants will show deficiency symptoms. Wang *et al*. 2017 stated that uptake of nutrients may cause a shift in pH to acidity or alkalinity. The pH calibration was done once a week to maintain pH. If there is a reduction in pH, sodium hydroxide or potassium hydroxide was added at a rate of 12.5 g in one litre of water to increase the pH. Phosphoric or sulphuric acid was added at a rate of 6.25 g in one litre of water for reducing the pH range in the fertilizer tank. Utmost care was taken for proper maintenance of optimum pH and EC.

Result and discussion

Plant height

The statistical analysis of data on plant height showed a significant difference among the different systems for plant height. The interaction effect was also significant. The highest value (77.67 cm),was recorded at (S_2 T_1)Vertical A type-NFT with the nutrient combinations of NPK@ 40:65:40 / hectare followed by Vertical A type-NFT with the nutrient combinations of NPK@ 50:75:50/ hectare with a plant height of 52.67cm (S3T3).The lowest plant height(36cm) was recorded(S1T3) at Horizontal type-NFT with nutrient combination NPK @ 60:85:60/hectare. In this experimental trial recycling of nutrient solutions helps in better growth and development of the plant. These were also reported by Zekki *et al*., (1996) that in tomatoes that an NFT system with regular recycling of nutrient solutions resulted in increased plant height productivity was improved compared to NFT with prolonged recycling of the same nutrient solution yield and growth was reduced. (Table 1 & fig.3).

Number of leaves

There existed significant variations among different treatments and systems for a number of leaves The maximum number of leaves (184.67) was recorded at (S_2T_1) Vertical A type-NFT with nutrient combination of NPK@ 40:65:40 / hectare followed by 182.67 number of leaves at (S_2T_2) Vertical A type-NFT with nutrient combination NPK @ 50:75:50/ hectare, the minimum number of leaves(74) was recorded at (S_1T_3) Horizontal type-NFT with nutrient combination NPK @ 60:85:60/hectare (Table 1 & fig.4).

Number of branches

Data on a number of branches showed a significant variation among different treatments for a number of branches. The maximum number of branches (20.67) was recorded at (S_2T_1) Vertical A type-NFT with nutrient combination of NPK@ 40:65:40 / hectare followed by 17 branches at (S2T2) Vertical A type-NFT with a nutrient combination of NPK @ 50:75:50/hectare, a minimum number of branches (6.33) was recorded at (S_1T_3) Horizontal type-NFT with nutrient treatment NPK @ 60:85:60/ hectare(T_3) (Table1 & fig. 5). Among the nutrient combinations (S_2T_1) vertical A type with nutrient NPK@ 40:65:40 per hectare is the best compared to other nutrient combinations.

Root length (cm)

The ANOVA table on root length showed that there existed a significant difference between different treatments and systems for the length of roots. The highest root length (24.67 cm) was recorded at (S_2T_1)Vertical A type-NFT with a nutrient combination of NPK@ 40:65:40 / hectare, followed by root length of 20.33cm at (S2T3) Vertical A type-NFT with nutrient combination of NPK @ 60:85:60/hectare with, lowest length of root 12.17 cm was recorded at (S_2T_2) Vertical A type-NFT with nutrient combination NPK @ 50:75:50/hectare (Table1&fig.6). The finding conveyed by (Kay *et al*., 1990) in a study on nitrate reductase with various pH i.e., high ammonium nitrogen in nutrients resulted in depressed root metabolism which in turn produces shorter roots.

Fresh root weight (g)

The statistical analysis data on root weight recorded a significant difference among different treatments. The interaction effect also showed a significant difference. The highest root weight (20g) was recorded at (S_2T_1) Vertical A type-NFT with nutrient treatments NPK@ 40:65:40 / hectare, followed by 16g of root weight at Vertical A type-NFT with nutrient treatments NPK @ 50:75:50/ hectare, the lowest weight of root (5.67g) was recorded at (S_1T_3) with Horizontal type-NFT with nutrient treatment at NPK @ 60:85:60/hectare. These results were analogous to that of results of Oagile *et al*., (2016) on tomatoes where the growth parameters such as plant height, leaf number and area, and shoot fresh and dry weights revealed that bigger container size enhanced tomato seedlings growth and development when compared to smaller containers (Table 1& fig.7)

Root dry weight (g)

Significant variations existed between different treatments and their interaction effect also showed siginificant for dry weight of root. The maximum root dry weight (4.37g) was recorded at (S_2T_1)Vertical A type-NFT with nutrient treatments NPK@ 40:65:40 / hectare followed by 3.11g at (S_1T_2) with Horizontal type-NFT with nutrient treatment 50:75:50/ hectare, lowest dry weight (0.78g) was recorded at (S_1T_3) Horizontal type-NFT with nutrient treatment NPK @ 60:85:60/hectare (Table 1& fig.8)

Shoot length (cm):

The statistical analysis on length of shoot showed a significant difference for treatments and their interaction effect also showed significance for the length of a shoot. The maximum shoot length (68.67 cm) was recorded at (S_2T_1) Vertical A type-NFT with nutrient combination of NPK@ 40:65:40 / hectare, followed by 43.67 cm length of shoot at (S_2T_2) Vertical A type-NFT with a nutrient combination of NPK@ 50:75:50/hectare, the minimum length of the shoot (11.67cm) was recorded at (S2T3) Vertical A type-NFT with a nutrient combination of NPK @ 60:85:60/hectare (fig.9).Brown *et al*., (2003) reported that mint plants grown in vertical A type system produce maximum shoot length.

Shoot dry weight (g)

The data on shoot dry weight showed a significant difference among treatments and systems for dry weight of shoot. The interaction effect also showed a significant difference. The highest dry weight of shoot (9.49g) was recorded at (S_2T_1) Vertical A type-NFT with nutrient treatment NPK@ 40:65:40 per hectare followed by 7.96g of shoot dry weight at (S_1T_1) Horizontal type-NFT with nutrient treatment NPK@ 40:65:40 per hectare, lowest dry weight of shoot (1.93g) was recorded at (S_2T_3) Vertical A type-NFT with nutrient treatment NPK @ 60:85:60 per hectare (fig.10)

Plant fresh weight (g)

The statistical analysis of plant fresh weight showed a significant variation among treatments and their interaction effect also showed a significant difference for the fresh weight of the plant. The highest fresh weight of plant 73.33g was recorded at (S_2T_1) Vertical A type-NFT with a nutrient combination of NPK@ 40:65:40 per hectare followed by 54.33g of fresh weight at (S_1T_1) Horizontal type-

NFT with nutrient combination of NPK@ 40:65:40 per hectare, the lowest fresh weight (11.67g) was recorded at (S_2T_3) Vertical A type-NFT with nutrient combinations of NPK @ 50:75:50per hectare. In this experiment rooting volume was high in vertical A type (S_2) the yield and growth parameters were high these results were in accordance with the findings of Kemble *et al.*, (1994) where the differences were in altering the rooting volume of the plants greatly, affect plant growth. (fig.11)

Plant dry weight (g)

Data on plant dry weight showed a significant difference among different treatments for dry weight of the plant. The maximum dry weight (14.41g) was recorded at (S_2T_1) Vertical A type-NFT with nutrient combinations of NPK@ 40:65:40 per hectare followed by 11.27g dry weight at (S_1T_1) Horizontal type-NFT with nutrient combinations NPK @ 40:65:40per hectare, lowest dry weight (2.91g) was recorded at (S_2T_3) Vertical A type-NFT with nutrient combinations NPK @ 60:85:60 per hectare. These results were contemporary with the findings of Mancy (2018) who carried out an experiment in modified nutrient film technique (A-shape NFT and flat NFT) in celery plants and reported that fresh and dry weight was the highest in A-shaped NFT. (fig. 12)

Table 1. Effect of two different NFT systems and three different nutrient solutions on plant height, number of leaves, number of branches, root length, fresh root weight, root dry weight of mint plants.

Nutrient combinations		Plant height(cm)	Number of leaves	Number of branches	Root length(cm)	Fresh root weight(g)	Root dry weight(g)
S1T1		47.2	131.67	11.33	12.17	23.33	4.37
S1T2		41.4	91.67	8	18.83	13.17	2.69
S1T3		36	74	6.33	16	5.67	1.42
S2T1		77.67	184.67	20.67	24.67	20	2.407
S2T2		52.67	182.67	17	9	16	3.113
S3T3		56.67	85	10.67	20.33	10	0.78
C.D	Factor (A)	N/A	20.854	4.799	4.194	5.677	0.833
	Factor(B)	10.948	N/A	N/A	3.424	N/A	0.680
	Factor(AXB)	18.963	29.491	N/A	N/A	8.028	1.177
S.Ed	Factor (A)	5.941	9.240	2.127	1.858	2.515	0.369
	Factor(B)	4.851	7.544	1.736	1.517	2.054	0.301
	Factor(AXB)	8.402	13.067	3.007	2.628	3.557	0.522

Two systems i.e. Horizontal type (NFT)-S_1, Vertical A type (NFT)-S_2, and with three nutrient treatments viz., T_1-NPK@ 40:65:40 per hectare T_2-NPK @ 50:75:50per hectare, T_3-NPK @ 60:85:60 per hectare

Table 2. Effect of two different NFT systems and three different nutrient solutions on shoot length, stem dry weight, plant fresh weight, plant dry weight of mint plants.

Nutrient combinations		Shoot length(g)	Stem dry weight(g)	Plant fresh weight(g)	Plant dry weight(g)
S1T1		33.33	7.967	54.33	14.41
S1T2		21.67	4.073	30	6.85
S1T3		20	2.7	18.33	2.91
S2T1		68.67	9.49	73.33	11.27
S2T2		43.67	4.82	41.67	7.37
S2T3		11.67	1.93	11.67	3.31
C.D	Factor (A)	12.327	2.612	9.401	2.697

	Factor(B)	N/A	2.133	N/A	N/A
	Factor(AXB)	17.433	3.694	13.296	3.814
S.Ed	Factor (A)	5.462	1.157	4.166	1.195
	Factor(B)	4.460	0.945	3.401	0.976
	Factor(AXB)	7.724	1.637	5.891	1.690

Two systems i.e. Horizontal type (NFT)-S_1, Vertical A type (NFT)-S_2, and with three nutrient treatments viz., T_1-NPK@ 40:65:40 per hectare T_2-NPK @ 50:75:50per hectare, T_3-NPK @ 60:85:60 per hectare

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Originality and plagiarism

Authors should ensure that they have written and submit only entirely original works.

Ethics statement

No specific permits were required for the described field studies because no human or animal subjects were involved in this research.

Consent for publication

All the authors agreed to publish the content.

Competing interests

There were no conflicts of interest in the publication of this content.

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