Original Research Article

COMPARATIVE EVALUATION OF THE EFFECT OF DIFFERENT MEDIA IN FEEDER CUM OPERATION REGULATION AQUAPONICS SYSTEM ON THE PERFORMANCE OF CROP PARAMETERS OFLETTUCE

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ABSTRACT

Aims: Toevaluate the performance of lettuce grown in four different media in afeeder cum operation regulation and ebb and flow siphon arranged aquaponics system.
Study design:completely randomized design.
Place and Duration of Study: Hi-tech Research and Training Unit (HTR&TU), Instructional Farm (IF), Kerala Agricultural University, Vellanikkarabetween16-06-2021 to 29-07-2021and from 14-12-2022 to 26-01-2023
Methodology: The system was set up with 24 media beds with ebb and flow arrangements, a feeder cum operational regulation system,three filter tanks (sedimentation tank, mechanical filter & bio-filter), three fish tanks having 1000L capacity each, a submersible pump, and two aerators. Two hundred genetically improved farmed tilapia (GIFT) fingerlings were grown in the fish tanks. Four types of media *viz*. 20mm gravel, 8-20mm broken tiles, 8-15mm hydroton, and 8-10mm gravel were filled in the media beds.Two varieties of lettuce, Cherokee RZ and Starfighter RZ were raised in the media beds. Plant height, plant spread and average weight of foliage were observed to compare the crop performance in each media and identify the best-performing media in an aquaponics system.
Results: During the first season of Cherokee RZ in aquaponics system the plants grown in8-20mm broken tiles (M_2) and8-10mm gravel (M_4) media aided better growth and development than all other medias. The plant height, plant spreadand average weight of foliage were recorded to be28.573cm, 29.173 cm and 264.193g respectively in M_2 medium and28.373cm, 28.973 cm and 254.620g respectively in M_4 medium. In the second season of Cherokee RZ also, the observed plant height, plant spread and average weight of foliagein M_2 medium were 28.687cm, 29.313cm and265.887g respectively which were comparable to that of plants grown in M_4 medium. In the trial with Starfighter RZ, M_2 media supported highest plantheight, plant spread and yield (27.967cm, 28.553cm and 240.020g respectively) in the first and second seasons (28.073cm, 28.073cm and 234.40g respectively).
Conclusion: The 8-15 mm broken tile media was found to be the ideal one supporting better crop performance.

Keywords: Aquaponics, soilless media, lettuce, crop growth, weight of foliage

1. INTRODUCTION

Aquaponics stands as an exceptionally productive and environmentally sustainable food production system in the realm of self- sufficiency and food security under Kerala conditions. Nitrifying bacteria play a pivotal role in aquaponic systems.This approach utilizes the nutrient-rich water from fish tanks to irrigate plants in the hydroponic system [1].Thefish waste transforms into a nutrient source for the nitrifying bacteria.These bacteria convert the potentially harmful byproducts of fish waste into valuable nutrients for plants. Plants extract this nutrient like nitrate and maintain it to the safest level (150-200ppm) for fish. These sophisticated systems incorporate cutting-edge technology, featuring automated monitoring and control systems, advanced pumps and filters, environmental sensors, and data loggers.Generally, three types of aquaponic systems are employed for commercial production, classified based on the types of grow beds, namely Nutrient Film Technique (NFT), Deep Water Culture (DWC), and media-filled or flood and drain systems [2]. Among these approaches, media-based aquaponics is esteemed for its superior efficiency in nitrogen utilization, offering a larger surface area for microbes compared to the other two methods. Consequently, it has emerged as the most prevalent and favoured technique for cultivating vegetable crops [3]. Those crops possessing low to medium nutritional requirement such as lettuce, microgreens, and herbs like chives, basil, spinach, and watercress are exceptionally well-adapted to aquaponics [4].Hence a study was conducted to evaluate the effect of different media on performance of two varieties of lettuce in an automatic aquaponic system in two different seasons andto identify the best media giving better result with each variety.

2. MATERIAL AND METHODS

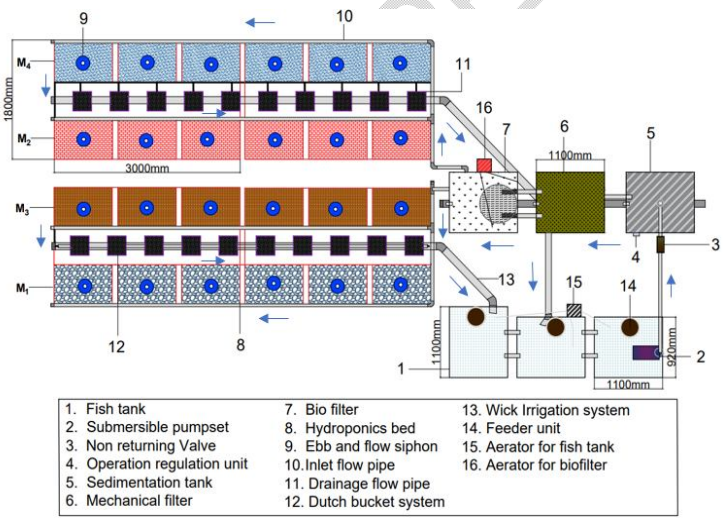

Fig.1.The schematic representation of system

Study was carried out at Hi-tech Research and Training Unit (HTR&TU), Instructional Farm (IF), Kerala Agricultural University, Vellanikkara. The experiment was conducted in a polyhouse located at 10°32'50" North latitude and 76°16'18" East longitude. The system was

set up with 24 media beds with ebb and flow arrangements, a feeder cum operational regulation system,three filter tanks (sedimentation tank, mechanical filter & bio-filter), three fish tanks having 1000L capacity each, a submersible pump, and two aerators.With the help of this system nutrient-rich water was circulated only from 7 am to 7 pm for 15min at every 1h intervals.

Field experiment was laid out in a completely randomized design. A naturally ventilated polyhouse with a floor area of 150 m² was selected for the study [5]. Three intermediate bulk container (IBC) tanks (1.1m x 0.92m x 1m) served as nutrient water reservoir as well as fish culture tank. In each and every bed of the system ebb and flow-type siphons operating with a feeder cum operational regulation system were installed. The nutrient rich water from the fish tank was allowed to flow into the sedimentation tank, then to mechanical filter and biofilter further**.**After completing the filtration process through three filter tanks (sedimentation tank, mechanical filter and biofilter), water was allowed to flow into media beds.Two hundred genetically improved farmed tilapia (GIFT) fingerlings were introduced into the fish tanks in proportions of 70, 70, and 60 in the first, second, and third tanks, respectively.Used barrels were cut horizontally into two equal halves and were used for making two media beds. Four types of media *viz.* 20mm gravel, 8-20mm broken tiles, 8-15mm hydroton, and 8-10mm gravel were filled in the beds. The comparative evaluation of the media was conducted by raising two varieties of lettuce,Cherokee RZ and Starfighter RZ during the periods from 16-06-2021 to 29-07-2021and from 14-12-2022 to 26-01-2023. Two tomato varieties were transplanted in groups of three in each bed with 30cmx20cm spacing. The growth parameters like plant height, plant spread and total weight of foliageof both varieties, in accordance with fish growth, were monitored**.**The comparison of media within the system was statistically analysed using Analysis of Variance (ANOVA).

3. RESULTS AND DISCUSSION

The Statistical analysis of crop parameters of Cherokee RZ in aquaponics system in the first revealed that (Table 1) the plants grown in8-20mm broken tiles (M_2) and8-10mm gravel (M_4) media aided better growth and development than all other medias during the first season. There was no significant difference between M_2 and M_4. The plant height and plant spread of plants grown in M_2 were recorded to be 28.573cm and 29.173cm respectively whereas 28.373cm and 28.973cm respectively in the case of plants grown in M_4 media during the first season**.**The highest yield in terms oftotal weight of foliage was achieved in M_2 (264.193g) followed by M_4 (254.620g).

Table 1**.** Crop parameters of Cherokee RZ in aquaponics system during first season

Media	Plant height	Plant spread	Total weight of foliage
M_1	27.620 ± 0.283 b	28.207 ± 0.291 b	244.240 ± 4.447 c
M_2	28.573 ± 0.183 a	29.173 ± 0.183 a	264.193 ± 6.006 a
M_3	27.200 ± 0.391 c	27.987 ± 0.177 b	230.087 ± 5.106 d
M_4	28.373 ± 0.320 a	28.973 ± 0.320 a	254.620 ± 4.037 b
F- Value	67.191	79.272	130.485
P- Value	< .001	< .001	< .001
CD (0.05)	0.222	0.183	3.619

During the second season also, the treatments M_2 and M_4 were superior ones and had no significant difference between them (Table 2). The plant height recorded in M_2 and M_4 media were 28.687cm and 28.520cm respectively.The highest plant spread was observed in plants grown in M_2 (29.313cm) and M_4(29.147cm) media. The foliage obtained per plant was higher in plants grown in M_2 media (265.887g) followed by M_4 media (253.533g).

Table 2. Crop parameters of Cherokee RZ in aquaponics system during second season

Media	Plant height	Plant spread	Total weight of foliage
M_1	27.967 ± 0.344 b	28.513 ± 0.331 b	231.667 ± 5.164 c
M_2	28.687± 0.245 a	29.313 ± 0.272 a	265.887 ± 4.941 a
M_3	27.333 ± 0.274 c	27.913 ± 0.223 c	219.533 ± 5.668 d
M_4	28.520 ± 0.305 a	29.147 ± 0.334 a	253.533 ± 5.975 b
F- Value	64.876	71.169	220.929
P- Value	< .001	< .001	< .001
CD (0.05)	0.215	0.214	3.982

The statistical analysis of crop parameters of variety Starfighter RZ cultivated in each media during first and second season are detailed in Table 3 and 4 respectively. When Starfighter RZ crop was raised, the superiority of M_2 medium was evident over all other media. The results obtained during first season is presented in Table 3. The broken tile media supported highest plant height (27.967cm), plant spread (28.553) and yield (240.020g) in the first season of trial. All crop parameters were recorded to be lower in 8-15mm hydroton medium compared to other media. During the second season also, the results obtained with M_2 medium were statistically superior and most promising. 8-20mm broken tiles was regarded as the best media in supporting highest vegetative growth. The highest plant height was observed in M_2 media (28.073cm) followed by M_4 media (27.660cm) in the feeder cum operational regulation system arranged aquaponics system. The variation in growth characteristics reveal that crops grown in broken tiles yielded the highest, whereas those in hydroton showed the lowest yield. This variation is attributed to differences in the physical and biological properties of the media used for cultivation. In aquaponics systems, the size and shape of the media are critical factors influencing plant growth. Smaller, flatter media particles offer increased surface area for root contact with nutrient-rich water compared to round particles. Therefore, broken tiles, which are flatter in shape compared to gravel, promoted greater plant spread, whereas hydroton, nearly round in shape, exhibited minimal plant spread. The result is in close agreement with Suseela [6]. The findings of Blidariu et al[7]was not in confirmation with the results of the study who reported the superiority of hydroton media in giving higher biomass and yield compared to plants grown in gravel media.

Table 3. Growth parameters of Starfighter RZ in aquaponicssystem during first season

Media	**Plant height**	**Plant spread**	**Total weight of foliage**
M_1	26.993± 0.212 ^{c}	27.573 ± 0.212 ^{c}	210.973 ± 5.101 ^{c}
M_2	27.967 ± 0.180 ^{a}	28.553 ± 0.185 ^{a}	240.020 ± 6.587 ^{a}

M_3	26.720 ± 0.221 [d]	27.333 ± 0.244 [d]	193.767 ± 4.664[d]
M_4	27.667 ± 0.172 [b]	28.307 ± 0.175 [b]	230.007 ± 5.880[b]
F- Value	128.948	119.725	201.016
P- Value	< .001	< .001	< .001
CD (0.05)	0.144	0.150	4.094

Table 4. Growth parameters of Starfighter RZ in aquaponicssystem during second season

Media	Plant height	Plant spread	Total weight of foliage
M_1	26.980 ± 0.246 [c]	26.980 ± 0.246 [c]	209.067 ± 4.758 [c]
M_2	28.073 ± 0.167 [a]	28.073 ± 0.167 [a]	234.400 ± 6.759 [a]
M_3	26.560 ± 0.168 [d]	26.560 ± 0.168 [d]	193.800± 5.144[d]
M_4	27.660 ± 0.180 [b]	27.660 ± 0.180 [b]	226.600 ± 4.748 [b]
F- Value	184.797	184.797	169.075
P- Value	< .001	< .001	< .001
CD (0.05)	0.140	0.140	3.955

4. CONCLUSION

The 8-15 mm broken tile media was found to be the most congenial substrate for the better growth and yield of lettuce. The highest plant height, plant spread and average weight of foliage was obtained from plants grown in broken tile medium followed by 8-10mm gravel medium.

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