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STUDY ON GROWTH PERFORMANCE OF COMMON CARP (*CYPRINUS CARPIO* VAR. *COMMUNIS* L.) FINGERLINGS AT DIFFERENT STOCKING DENSITIES AND SPINACH (*SPINACIA OLERACEA*) PLANT, GROWN IN DEEP WATER AQUAPONICS SYSTEM

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ABSTRACT : The present study was conducted for a period of 60 days to determine the growth performance of Common carp (*Cyprinus carpio* var. *communis*) fingerlings at different stocking densities and Spinach (*Spinacia oleracea*) plant, grown in deep water aquaponic system. The experiment, was conducted with five treatments each with three replicates. A homogenous stock of fingerlings was randomly distributed in five treatment groups with stocking density of 5, 10, 15, 20 and 25 fish in T_1, T_2, T_3, T_4 and T_5, respectively with addition of 10 plants in each tank. The fish was fed at 3% of their body weight. The result of the study shows that fish in treatment-T_3 with stocking density 15 had shown maximum and significantly higher growth then other treatments. SGR (2.185±0.010) and GCE (0.873±0.008) were also significantly higher in T_3, whereas, the FCR was lowest (1.145±0.010) in T_3. The net length gain and root length gain were significantly higher in spinach plant in T_5 compared to other treatments. Increment in number of leaves was also significantly higher in T_5 compared to other treatments. Variation in water quality between all treatments in all the parameters was non-significant throughout the experimental period. The results showed the highest plant growth observed in T_5, which had a stocking density of 25 fishes. Through this experiment, we can conclude that plant growth in the present aquaponic system was found to increase with increase in stocking density of fish. But the fish growth was observed maximum in T_3 with stocking density of 15 fishes per tank.

Key words : Aquaponics, stocking density, *Cyprinus carpio*, *Spinacia oleracea.*

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INTRODUCTION

Millions of people depend on fisheries and aquaculture industries for food, nourishment, and livelihood in order to sustain their livelihood. Approximately 88% of the 179 million tonnes of the fish produced worldwide in 2018 were used for direct human consumption (SOFIA, 2020). The amounts intended for human consumption (without algae) was 20.2 kg per capita. In 2020, global capture fisheries production (excluding algae) was 90.3 million tonnes, with an estimated value of USD 141 billion, with 78.8 million tonnes from marine waters and 11.5 million tonnes from inland waters (SOFIA, 2022). In 2018, in India, carps make up around 85 per cent of the overall production in fish farming, which is largely dependent on them. Common Carp (*Cyprinus carpio* var. *communis*) is a very popular type of fish in India and fetch a good price in market. To other extended opportunity of earning by utilizing fish west with the alteration in the system new techniques e.g. hydroponics and aquaponics have emerged. Aquaponics system offers several benefits. It boosts water productivity by simultaneously producing two crops: fish and plants under the same group. The plant recovers waste nutrients that have been dissolved decreasing environmental discharge and increasing water use. In an aquaponic system, minimising water exchange lowers the operating coast. A system's potential for profit is increased by having a secondary plant crop that receives the majority of the nutrients it needs without

Table 1 : Summary of growth parameters of *Cyprinus carpio* in Aquaponic system.

Treatments	Net wt. gain (gm)	Per cent wt. gain	SGR	FCR	GCE
T_1 (control)	0.660^{a}±0.035	178.37^{a}±9.491	1.676^{a}±0.055	1.614^{c}±0.076	0.622^{a}±0.030
T_2	0.863^{c}±0.033	233.33^{c}±9.009	1.972^{c}±0.043	1.275^{ab}±0.042	0.786^{bc}±0.027
T_3	1.033^{d}±0.008	279.27^{d}±2.383	2.185^{d}±0.010	1.145^{a}±0.010	0.873^{d}±0.008
T_4	0.880^{c}±0.026	237.83^{c}±7.150	1.995^{c}±0.034	1.238^{ab}±0.048	0.809^{cd}±0.027
T_5	0.773^{b}±0.008	209.00^{b}±2.383	1.849^{b}±0.012	1.373^{b}±0.018	0.728^{b}±0.009

Discussion

The growth performance of *Spinacia oleracea* and *Cyprinus carpio* was found to be significantly different among all treatment groups and the control group. Treatment group T_3 has greatest growth performance of all fishes and T_5 has shown the best performance of plant growth. Optimal stocking is one of the basic factors for the success of aquaponic system. In the present study, *Cyprinus carpio* var. *communis* stocked at different stocking density 5, 10, 15, 20, 25 per tank showed different growth rate by the end of experiment. The total net weight gain, SGR and GCE performance of experimental fish *Cyprinus carpio* was observed significantly higher in T_3, which were stocked at a plant: fish ratio of 10:15 followed by T_4 (10:20); T_2 (10:10); T_5 (10:25); T_1 (10:5). The FCR was lowest in T_3 as related to other treatments showing better feed utilization. Whereas, increase in FCR with increased stocking density was observed in *Cyprinus carpio* as reported by Immanpoor *et al* (2009). Lenard (2013) observed that the Fish stocking density is most sensitive factor determining the production of a culture system as it affects growth rate, size variation and mortality of fish. Stocking density of fish is directly related to plant growth. Hussain *et al* (2014) studied to optimize stocking density of koi carp with spinach in an aquaponic system and outcome of the study showed that the increased stocking density significantly reduced fish growth rate. Spinach (*Spinacia oleracea*) yield at the end of trial both of harvested at the end of one month indicated significant variation. *Spinacia oleracea* plant yield, compared between treatments was highest in T_5 due to highest stocking density, which is directly related to the maximum feed given and fish waste produced in this system. Similarly plant growth was highest in T_5 followed by T_4, T_3, T_2 and T_1. However, there was no significant difference between T_4 and T_3, T_2 and T_1, but there was significant difference with T_5. Spinach yield harvested at end of first month also showed significant variation and the lowest production of spinach was observed in T_2. It may be concluded from the present study that the quantity of fish waste produced is directly connected to the quantity of fish feed. The number of plants grown is directly related to quantity of nutrients available which is connected to amount of waste produce by fish. That is in turn dependent on the quantity of feed given (Lennard, 2013).

CONCLUSION

It can be concluded from the current experiment that spinach plants may be grown very well in aquaponic system with simultaneously culture of *Cyprinus carpio* fingerlings. Further, it also depict the suitable limit which is most favourable for the growth of fish at suitable stocking densities of (10:15) 10 spinach plant saplings with 15 common carp fish fingerlings suitable to be grown in aquaponic system. While the growth of plants was highest in stocking density of 10:25 (plant: fishes), by this it can be concluded that plant grow higher in high stocking density as the nutrient's availability is more. It may be noted that the aquaponic system is able to produce sufficient fish and vegetables by reusing the tank's fish waste (Hussain *et al*, 2014). The water quality parameters were suitable for both plant and fishes throughout the whole experimental period as also supported by earlier authors (Shete *et al*, 2015).

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