*Biological Forum – An International Journal* 13(3): 444-449(2021)

**ISSN No. (Print): 0975-1130**
**ISSN No. (Online): 2249-3239**

# Rearing of Fish, *Puntius gonionotus* seed and Marigold, *Tagetes patula* Plant in NFT Aquaponics System for Economic Returns

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*(Received 05 June 2021, Accepted 11 August, 2021)*
*(Published by Research Trend, Website: www.researchtrend.net)*

**ABSTRACT: An experiment was conducted for 75 days (5 November 2020 to 21 January 2021) at ICAR-CIFA, Bhubaneswar, Odisha focusing on economic evaluation of Nutrient Film Technique (NFT) aquaponics system on a pilot-scale mode for rearing puntius (*Puntius gonionotus*) seed and marigold (*Tagetes patula*) plant in it. Fish culture tank, biofilter, hydroponics tank and sump are the integral parts of one NFT aquaponic system. The experiment was conducted in six units of aquaponics system; taking three treatments in duplicate. Culture tanks of each unit were stocked with 200 numbers of puntius advanced fry of 44-63 mm length and 3-5 g weight. Hydroponics tanks were planted with marigold plants with varying densities, *i.e.*,42, 63 and 84 numbers as T1, T2 and T3 respectively. Random sampling method was followed for data analysis. After 75 days, advanced fingerlings were harvested with size 100-147 mm length and 20-56 g weight with survivability rate of 92.33±2.31%. As there was no significant difference ($P>0.05$) in the plant growth rates among 6 units, the unit with the highest plant density *i.e.*, 23 plants/m$^2$ was assessed for the economic feasibility and the net profit was calculated to be INR 498 per m$^2$land in a year.**

**Keywords:** NFT aquaponics; Hydroponics; Fish seed rearing; Marigold production; Economics returns

## INTRODUCTION

Aquaculture was traditionally carried out in large ponds and tanks, which consumed more land space and water. In addition, the rapidly increasing world population is posing a critical challenge for maintaining food security and justifiable use of water resources. Sustainable food production by saving and recycling water and nutrients is considered as one of the possible solutions (Wongkiew *et al.,* 2017). Aquaponics is a technology that comes under a broader agricultural approach known as integrated agri-aquaculture systems (IAAS) (Gooley and Gavine, 2003). It is a cooperation of fish and plants, and the term originates from the two words aquaculture (the growing of fish in a closed environment) and hydroponics (the growing of plants usually in a soil-less environment). In this the excretions from the aquatic animals and the leftover feed in the fish rearing tanks are procured by a hydroponic system, that acts as a nutrient absorbing basin, the by-products break down as nitrites and nitrates, which are utilized by the plants as nutrients. The whole process in return filters the water used for fish rearing purposes; hence, it is beneficial for plants and organisms in the process as well. Various experiments were carried out to determine the efficiency of aquatic plants in filtering and consuming the nutrients from wastewater in aquaculture farms (Mohd Nizam *et al.,* 2020; Dhir, 2010). Aquaponics research also tested the terrestrial plants and these proved to be an effective method for water purification (Anantharaja *et al.,* 2018; Mohapatra *et al.,* 2020).

The noted benefits of combining these two technologies led to the combination of aquaculture and hydroponics as integrated industries presently referred to as aquaponics. Aquaponics being a versatile technology, can be implemented using cost-effective materials, which keeps capital overhead modest making it more attractive for small farm adoption. Also, the multiple crops produced in an aquaponics system (plants and fish) allow small-scale family farmers to diversify their incomes, which reduces the risk of crop failure and increases revenue by providing products for multiple markets (Integrated Aquaculture and Aquaponics, 2019). Among other food production technologies, aquaponics can compensate for the most critical animal protein of fish and essential nutrients from vegetables. There is tremendous potential to increase the economic, social and environmental sustainability of agriculture through aquaponics (Blidariu and Grozea, 2011). In the structural aspect, aquaponics is of three types; Nutrient Film Technique (NFT), Media Bed Culture (MBC) and Deep Water Culture (DWC). Among the variants of aquaponics, the NFT method is chosen because of its simplicity and lower water requirement (Mohapatra *et al.,* 2021). In NFT aquaponics, water flow starts from the rearing tank to the hydroponic tank through a biofilter and then returns to the rearing tank through a sump. Being inspired by the FRP (Fiberglass Reinforced Plastic) evolution in the aquaculture sector, a pilot-scale NFT aquaponics system has been designed and developed at ICAR-CIFA, Bhubaneswar to assess the growth of fish and plants in it (Mohapatra *et al.,* 2020).

In the present experiment puntius fish and marigold plants were chosen, because of their commercial value. *Puntius gonionotus*is found at mid water to bottom depths in rivers, streams, flood plains and occasionally in reservoirs. Seems to prefer standing water habitats instead of flowing waters. This fish was introduced in India in 1972 (Phen *et al.*, 2005).

*Tagetes patula*, the French marigold is a species of flowering plant in the daisy family, native to Mexico and Guatemala with several naturalised populations in many other countries. It is widely cultivated as an easily grown bedding plant, with thousands of different cultivars in brilliant shades of yellow and orange (Rojas-Sandoval, 2020).

The main objective of this study is to assess the productivity potential of the NFT aquaponics system developed at ICAR-Central Institute of Freshwater Aquaculture (ICAR-CIFA), Bhubaneswar (Mohapatra *et al.*, 2020) with the selected puntius fish and marigold plant species. Developing an economic model is another aspect, which is kept in focus during the study for establishing sustainable characteristics of aquaponics for farmers, entrepreneurs and consumers.

## MATERIALS AND METHODS

This study incorporated the following materials and methods for carrying out the experiment.

*A. Non-living materials*

Six NFT aquaponics units were developed majorly in FRP along with other plastics by All India Coordinated Research Project on Plastic Engineering in Agriculture Structures and Environment Management (AICRP on PEASEM) at ICAR-CIFA, Bhubaneswar Centre (Fig. 1). Fish culture tank, biofilter, hydroponics tank and sump all are integral parts of one NFT aquaponic system.

**Fig. 1.** NFT Aquaponics System at ICAR-CIFA.

**Fish culture tank:** Fabricated in FRP, the tank has a diameter of 2.15 m, a wall height of 0.9 m, a bottom slope of 1:22 towards the centre of the tank and maximum water holding capacity of 3,450L. However, during the operation, the water volume was kept at 2800 L.

**Biofilter:** One 100 L polypropylene (PP) bucket is used for the establishment of the bio-filtration unit, which receives water from the fish culture tank through a 2″ bottom inlet. The bucket has a base diameter of 36 cm, upper rim diameter of 52 cm and height of 65 cm. The surface area of the biofilter in use is 1.22 sq. meters. In the biofiltration bed, seashells of 13.3 kg covering 0.05 $m^3$ volume are kept on thetop layer, below which gravels of varying sizes (20−25 mm) are kept consuming 0.03 $m^3$ of filter volume. The surface area to volume ratio (specific surface area) of the biological filter media is 12.77. The gravel onthe bottom acts as a mechanical particulate filter, which holds and prevents solid faecal matter from fish to get into the seashell layer, which acts as the colonizing base for the microbes.

**Hydroponics tank:** It is a rectangular FRP tank with a length of 4.0 m and a width of 0.9 m. The depth of the tank is 0.35 m and a total volume of 1260 L, but referring to hydroponics plantation habits in NFT systems, the water height in the tank is kept at 0.25 m. For plantation, 3" diameter hydroponics PP (Poly Propylene) cups are placed in the perforations made in the FRP plantation trays (0.95 m × 0.80 m). Four plantation trays are placed in one hydroponics tank. The plant saplings are planted with the help of gravels packed inside the hydroponics cups.

**Sump:** An HDPE (High-density Polyethylene) cylindrical water tank (diameter 70.8 cm and height 58.2 cm) of 200 L capacity is fitted as the sump next to the fish culture tank. It is kept underground in such a way that it can easily intake 180 L of water (90 % of total capacity) from the hydroponics tank by gravity. The sump is also integrated with calibrated water level conductive sensors wired with a custom-programmed control unit to drive the submersible water pump with an energy consumption of 60 W.

*B. Living materials*

**Fish:** Puntius, *Puntius gonionotus* advanced fry of 44-63 mm length and 03-05 g weight were stocked at a density of 200 numbers per fish rearing tank of volume 2800 L. Total six tanks of six aquaponics units were stocked.

**Plants:** Marigold plants, *Tagetes patula* were planted in the hydroponics tanks as per the following design (Fig. 2).

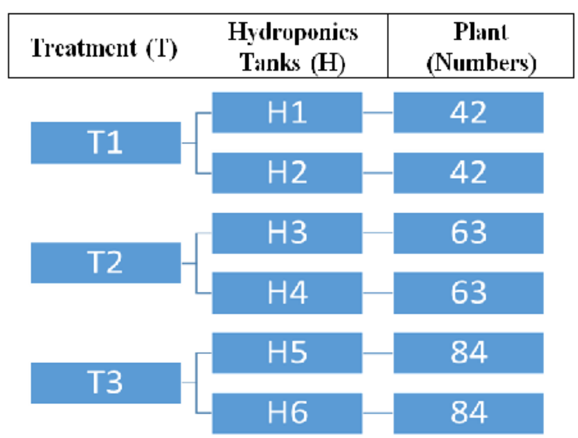


**Fig. 2.** Experimental design of marigold plant stocking in hydroponics tanks.

**Fig. 3.** Marigold plant in the aquaponics system.

*C. The operational method*

The aquaponics system was operated for 75 days (5 November 2020 to 21 January 2021) with puntius advanced fry in the culture tanks and marigold plants in the hydroponics tanks. Fish excreta, metabolic wastes and unused food from the culture tanks were converted to nutrients for use by the plants. The water from fish culture tanks in each unit was taken to the biofilters for filtration. The nutrient-rich water then trickled into the hydroponics tanks, where the nutrients were absorbed by the submerged roots of the plants. The overflow water from the hydroponics tanks was then collected in the sumps attached to those and pumped back into the fish culture tanks of the NFT aquaponics system, in turn completing the cycle.

**Sampling.** The length and weight of fishes were taken initially before stocking in the fish culture tanks, and final length and weight measurements were taken at the time of harvesting. The data are tabulated in Table 1. The initial and final plant heights of 10 random plant samples were taken from each hydroponics tank for data analysis and tabulated in Table 2. The initial and final heights measurements were taken at the sapling stage and final harvest time, respectively. The marigold flower numbers were counted over the experimental period and tabulated in Table 3 for analysis. The water quality parameters, such as pH, total alkalinity (mg/l), total hardness (mg/l) and ammonium-N (ppm) of the aquaponics systems were estimated as per standard laboratory procedures (APHA-AWWA-WPCF, 1989) every 15 days and recorded. The ranges of those parameters are given in Table 4. Suitable statistical analyses were performed on the data recorded from the experiments.

**Fig. 4.** *P. gonionotus* advanced fingerling sampling.

## RESULTS AND DISCUSSION

*A. Fish seed production*

During the experimental period of 75 days, the advanced fry of puntius fish (size 44-63 mm & 3-5 g) grew to advanced fingerlings (size 106-147 mm & 19-56 g). The survivability was more than 90% in all the treatments (Table 1). Mohanta *et al.* (2006) had reared seed of *Puntius gonionotus* for 60 days in a 0.04 ha nursery pond. The data of the fish seed rearing showed a survivability rate of 89.64% in pond conditions, whereas in the present study in the NFT aquaponics system the average puntius fish survivability was found to be 92.33%. In the experiment conducted by Jena *et al.* (2011) a similar survivability rate (87.7 ± 5.7%) is reported from the seed rearing in an outdoor cement nursery tank for 90 days at CIFA, Bhubaneswar. Comparable results have been reported from the present study conducted in the NFT aquaponics system at ICAR-CIFA.

**Table 1: Final fish count, length and weight of *Puntius gonionotus* seeds in aquaponics experiment.**

| | T1 | | | T2 | | | T3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | C1 | C2 | Avg. | C3 | C4 | Avg. | C5 | C6 | Avg. |
| Fish count | 191 | 189 | 190 | 180 | 183 | 181.5 | 183 | 186 | 184.5 |
| Length (mm) | 111-145 | 110-147 | 110-147 | 106-138 | 100-141 | 100-141 | 110-143 | 111-145 | 110-145 |
| Weight (g) | 24-54 | 24-51 | 24-54 | 20-47 | 21-47 | 20-47 | 27-56 | 23-55 | 23-56 |

*B. Marigold production*

Marigold plants in 75 days of experimentation grew from the heights 90-110 mm to 182-358 mm (Table 2). Among the treatments, the plant heights were better in hydroponics tanks with less number of plants. But, the ANOVA showed no significant differences among the plant heights of different hydroponics tanks of different treatments. The marigold flowers were harvested three times during the experimentation. The hydroponics tanks with higher plant densities gave a maximum harvest of flowers (Fig. 5) and thus, were taken for calculation of economics from one unit of the system for use by the farmers and entrepreneurs. The economics calculated in this study shows the profit of INR 498/$m^2$/annum with the present design and given fish and plant combination.

*T. patula* plant is grown annually and occasionally reaching 500 mm in height in both sandy and clay soils (Wikipedia contributors, 2021). In the present study, in the soilless aquaponics system, the highest height attained by the plant was 372 mm. An experiment by Mirzaei *et al.* (2016) concluded that 60 numbers of plants per square meter of land are the most suitable for the marigold culture in a soil-based floriculture system.

On the contrary, the present study was conducted with a maximum of 23 marigold plants per $m^2$ of a soilless culture system that produced better flower production. With the present plant density, the aquaponic system was found to be economical for operation and technology dissemination.

The marigold production was done in the research field of the horticulture research center, BARI, Gazipur by Ahmed *et al.* (2017). It was reported to average production of 2.51 $kg/m^2$ flower with the highest benefit-cost ratio 7.14 in various quantities of fertilizer application. In the present study, with the fish effluents, the marigold production was 2.49 $kg/m^2$ and no external fertilizer was applied. The marigold production can be enhanced with the application of fertilizers from an external source. The aquaponics experiment conducted in PVC grows pipes produced an average of 13 numbers of marigold flowers per plant in 90 days involving tilapia, *Oreochromis niloticus* and marigold, *Tagetes erecta* (Anantharaja *et al.*, 2018). In comparison, the marigold flower harvest in the present study is 12 numbers per plant.

**Table 2: Final height of marigold, *Tagetes patula* plants in aquaponics experiment.**

| | T1 | | | T2 | | | T3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | **H1** | **H2** | **Avg.** | **H3** | **H4** | **Avg.** | **H5** | **H6** | **Avg.** |
| Height (mm) | 296.9±27.09 | 294.6±39.35 | 295.75±32.90 | 299.5±49.50 | 292.3±51.41 | 295.9±49.26 | 298.2±47.59 | 294.7±51.74 | 296.45±48.42 |

Data represented as Mean ± S.E, (n=10 for each tank))

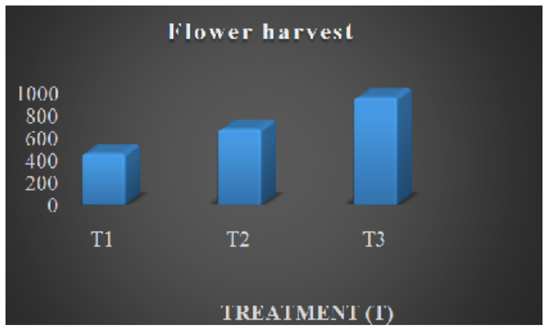


**Fig. 5.** Comparison of flower production among different treatments in the aquaponics system.

**Table 3: Marigold flower (count) harvest from aquaponics experiments.**

| Harvest | T1 | | | T2 | | | T3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | H1 | H2 | Avg. | H3 | H4 | Avg. | H5 | H6 | Avg. |
| 1st | 444 | 420 | 432 | 632 | 650 | 641 | 879 | 863 | 871 |
| 2nd | 457 | 469 | 463 | 663 | 707 | 685 | 987 | 991 | 989 |
| 3rd | 483 | 451 | 467 | 687 | 697 | 692 | 1012 | 982 | 997 |
| Total avg. | 454 | | | 673 | | | 952 | | |

*C. Physicochemical properties of water*

In the aquaponics system during the experimentation period the physicochemical parameters such as pH ranged between 7.1-7.9, total alkalinity 68-96 mg/l, total hardness 68-100 mg/l, total ammonia 0.02-0.71, $NO_2$ 0-02 mg/L, $NO_3$ 0.20-1.82 mg/L and $PO_4$ 0.21-1.53 mg/L (Table 4). The sampling data revealed that the water parameters of the aquaponics system were suitable for aquaculture purposes. The recorded parameters are in agreement with the values given in the book of Mohapatra and Saha, 2000. The water quality requirement for carp culture in ponds is 100-200 mg/l total alkalinity and more than 40 mg/l total hardness (Mohapatra *et al.*, 2013). The culture experiment by Anantharaja *et al.* (2017) in NFT aquaponics using PVC tubes reported a maximum TAN concentration of 0.49 mg/L which when compared to the present study, showed 0.71 mg/L during the 75 days of operation period with *P. gonionotous* fish. This suggests the TAN level is within the safe operational limit for aquaculture.

*D. Economics of the aquaponics system*

The cost of investment for the aquaponics unit mainly involves the cost of the components and the operational cost involving energy and resources consumed during operation (Table 5). The lifespan of the system is considered to be 15 years, hence the operational cost includes the depreciation as well as approximate maintenance cost. In 75 days of operation with a total cost of INR 3008, one can earn a maximum annual profit of INR 498 per $m^2$ land area with the present setup. However, the present design can be easily scaled up according to the demand and crop which will improve the profit proportionally.

**Table 4: Physicochemical parameter.**

| | T1 | | | | | | T2 | | | | | | T3 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C1 | C2 | H1 | H2 | S1 | S2 | C3 | C4 | H3 | H4 | S3 | S4 | C5 | C6 | H5 | H6 | S5 | S6 |
| **pH** | 7.3 - 7.5 | 7.2-7.4 | 7.4-7.8 | 7.3-7.8 | 7.2-7.5 | 7.1-7.4 | 7.4-7.6 | 7.5-7.6 | 7.4-7.8 | 7.4-7.8 | 7.2-7.4 | 7.4-7.5 | 7.2-7.7 | 7.2-7.5 | 7.6-7.9 | 7.3-7.6 | 7.3-7.4 | 7.1-7.6 |
| **Mean range=** 7.1-7.9 | | | | | | | | | | | | | | | | | | |
| **Alka-linity** | 76-92 | 72-96 | 72-92 | 72-96 | 72-88 | 72-92 | 80-88 | 80-92 | 76-92 | 68-92 | 80-92 | 76-96 | 72-96 | 72-88 | 68-96 | 76-96 | 76-96 | 72-88 |
| **Mean range=** 68-96 | | | | | | | | | | | | | | | | | | |
| **Har-dness** | 76-92 | 72-92 | 72-92 | 72-100 | 729 6 | 68-96 | 76-96 | 76-10( | 80-96 | 68-92 | 76-100 | 76-92 | 80-96 | 80-88 | 76-92 | 76-92 | 72-92 | 72-96 |
| **Mean range=** 68-100 | | | | | | | | | | | | | | | | | | |
| **$NH_4$** | 0.03-0.506 | 0.03-0.519 | 0.04-0.553 | 0.04-0.510 | 0.02-0.603 | 0.03-0.630 | 0.04-0.557 | 0.04-0.523 | 0.04-0.269 | 0.03-0.323 | 0.03-0.562 | 0.03-0.562 | 0.02-0.566 | 0.03-0.422 | 0.04-0.505 | 0.04-0.737 | 0.04-0.710 | 0.03-0.489 |
| **Mean range=** 0.02-0.710 | | | | | | | | | | | | | | | | | | |
| **$NO_2$** | 0.00-0.01 | 0.00-0.01 | 0.02-0.05 | 0.02-0.04 | 0.25-0.06 | 0.03-0.06 | 0.00-0.01 | 0.00-0.01 | 0.02-0.05 | 0.02-0.04 | 0.25-0.06 | 0.03-0.06 | 0.00-0.01 | 0.00-0.01 | 0.02-0.05 | 0.02-0.04 | 0.25-0.06 | 0.03-0.06 |
| **Mean range** = 0-0.06 | | | | | | | | | | | | | | | | | | |
| **$NO_3$** | 0.2-0.51 | 0.2-0.49 | 0.5-1.82 | 0.5-1.75 | 0.40-0.63 | 0.35-0.63 | 0.21-0.57 | 0.36-0.53 | 0.9-1.49 | 0.85-1.63 | 0.36-0.56 | 0.28-0.59 | 0.24-0.57 | 0.3-0.52 | 0.79-1.65 | 0.83-1.69 | 0.25-0.42 | 0.29-0.64 |
| **Mean range** = 0.20-1.82 | | | | | | | | | | | | | | | | | | |
| **$PO_4$** | 0.72-1.46 | 0.73-1.53 | 0.34-0.63 | 0.36-0.60 | 0.21-0.42 | 0.26-0.51 | 0.71-1.36 | 0.67-1.49 | 0.33-0.62 | 0.36-0.62 | 0.21-0.42 | 0.26-0.52 | 0.75-1.52 | 0.74-1.53 | 0.32-0.67 | 0.35-0.64 | 0.21-0.32 | 0.26-0.31 |
| **Mean range** = 0.21-1.53 | | | | | | | | | | | | | | | | | | |

Alkalinity, Hardness, $NH_4$, $NO_2$, $NO_3$ and $PO_4$ values are in mg/L.

**Table 5: Economics of aquaponics operation with puntius sand marigold.**

| Sr. No. | Items | Approx. price in Indian Rupees (INR) |
|---|---|---|
| **A.** | **Fixed Capital** | |
| 1. | Land (Own) | 0 |
| 2. | Culture tank (1 no), Hydroponics tank (1 No.) | 23,000 |
| 3. | Biofilter and filtrate materials | 3,000 |
| 4. | Sump and water level sensor | 2,000 |
| 5. | Pipes and fittings | 2,000 |
| 6. | Water pump (1 no) | 2,000 |
| 7. | Electrification | 1,000 |
| 8. | Aerator (1 no) | 2,000 |
| | **Sub-total** | **35,000** |
| **B.** | **Variable Cost** | |
| 1 | Fish (200 nos) | 200 |
| 2 | Plants (84 nos) | 168 |
| 3 | Electricity and fuel | 100 |
| 4 | Wages (@ Rs. 400/- per day) | 1200 |
| 5 | Feed (10 kg) | 500 |
| | **Sub-total** | **2168** |
| **C.** | **Other Cost** | |
| 1. | Total Variable cost | 2168 |
| 2. | Depreciation cost on fixed capital @ 6.66% yearly | 480 |
| 3. | Interest on fixed capital @5% per annum | 360 |
| | **Total Cost** | **3008** |
| II. | **Gross Income** | |
| 1. | Flowers (2857 nos. from three harvests (@ 1/- per flower) | 2857 |
| 2. | Advanced fingerling (185 nos) (@ 8/- per fingerling) | 1480 |
| | **Gross Return** | **4337** |
| III. | **Net Income (Gross income - Total costs)** | 1329 |

Total operational area = 13 $m^2$ and culture duration was for 75 days. Hence, gross profit in a yearcomes to INR 498 per $m^2$ of land.

## CONCLUSION

The present experiment revealed that the rearing of pangas seed along with marigold plants is economically viable. The production of puntius and marigold can be increased by scaling up the present design. However, for optimum plant holding capacity for the present fish culture unit, future experimentation of nutritional analysis may be helpful for maximum possible economics out of the developed NFT aquaponics model. The beneficial outcomes of the study are; an annual return of INR 498 per $m^2$ land area; greener environment; integrated aquaculture; minimizes the wastage of water; organic and healthy food availability; etc. With the current depletion rate of arable land and water scarcity, the present system can prove to be sustainable in producing crops with limited resource usage. Also as a hobby, this type of system in the backyards can provide a greener environment and healthy food to common people. This type of integrated system could also become a reliable agriculture method that plays a crucial role in future smart cities, in the aspects of environmental, socio-economic and sustainability, as it employs innovative systems to provide fresh food.

**Acknowledgements.** The authors thank the ICAR-All India Coordinated Research Project on Plastic Engineering in Agriculture Structures and Environment Management, Ludhiana for research funding. The authors also thank the Director, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar for providing research facilities.

## REFERENCES

Ahmed, R., Hussain, M., Ahmed, S., Karim, M., & Siddiky, M. (2017). Effect of Nitrogen, Phosphorus and Potassium Fertilizers on Yield and Yield Attributes of Marigold (*Tagetes patula* L.). *The Agriculturists*, *15*(1), 101–109.

Anatharaja, K., Mohapatra, B., Pillai, B. R., Kumar, R., Devaraj, C., & Majhi, D. (2017). Growth and survival of climbing perch, Anabas testudineus in Nutrient Film Technique (NFT) aquaponics System. *International Journal of Aquatic Studies* 5(4), 24-29.

Anantharaja, K., Mohapatra, B.C., Pillai, B.R., Routray, P., Sundaray J.K., Majhi, D., Sahu, A.D., Behera, A. and Shetty A.K. (2018). Evaluation of fish and plant production in the NFT aquaponics system. In: *Ibid*. AQ 24, p 154.

APHA-AWWA-WPCF, (1989). Standard methods for the examination of water and wastewater. American Public Health Association, New York: 1-1193.

Blidariu, F.and Grozea, A. (2011). Increasing the economical efficiency and sustainability of indoor fish farming by means of aquaponics-review. *Scientific Papers Animal Science and Biotechnologies*, *44*(2), 1-8.

Gooley, G. J., Gavine, F. M. (2003). Integrated agri-aquaculture systems: a resource handbook for Australian industry development. *RIRDC Publication*. No. 03/012

Jena, J., Das, P. C., Mitra, G., Patro, B., Mohanta, D., & Mishra, B. (2011). Evaluation of growth performance of *Labeo fimbriatus* (Bloch), *Labeo gonius* (Hamilton) and *Puntius gonionotus* (Bleeker) in polyculture with *Labeo rohita* (Hamilton) during fingerlings rearing at varied densities. *Aquaculture*, *319*(3–4), 493–496.

Mahanta, K. N., Jena, J. K., & Mohanty, S. N. (Eds.). (2006). Nursery rearing of *Puntius gonionotus*: A preliminary trial. In *Research & farming techniques: Vol. XI* (1st ed., pp. 7–10). Aquaculture Asia.

Mirzaei, M., Zehtab-Salmasi, S., Nassab, A. D. M., & Shaker-Kouhi, S. (2016). Effects of sowing date and plant density on marigold (*Calendula officinalis*) morphology and flower yield. *Journal of Medicinal Plants*, *4*(3), 229-232.

Mohapatra, B.C. and Saha, C., (2000). Aquatic pollution and management. Central Institute of Freshwater Aquaculture, Bhubaneswar: 1-363.

Mohapatra, B. C., Das, B. K., Mahanta, K. N., Chakrabarti, P. P., Barik, N. K. and Jayasankar, P. (2013). Carp culture in freshwater ponds. ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar: 1-36.

Mohapatra, B. C., Chandan, N. K., Panda, S. K., Majhi, D., & Pillai, B. R. (2020). Design and development of a portable and streamlined nutrient film technique (NFT) aquaponic system. *Aquacultural Engineering*, *90*, 102100.

Mohapatra, B. C., Chandan, N. K., Anantharaja, K., Bairwa, M. K., and Pillai, B. R. (2021). Aquaponics system [E-book]. In: B. R. Pillai, S. Ferosekhan, & S. K. Swain (Ed.), *System Diversification in Aquaculture*, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, Odisha, India, pp 38–48.

Mohd Nizam, N. U., Mohd Hanafiah, M., Mohd Noor, I., & Abd Karim, H. I. (2020). Efficiency of Five Selected Aquatic Plants in Phytoremediation of Aquaculture Wastewater. *Applied Sciences*, *10*(8), 2712.

Phen, C., Thang, T. B., Baran, E., & Vann, L. S. (2005). Biological reviews of important Cambodian fish species, based on Fish Base 2004. *World Fish Center, Phnom Penh*.

Rojas-Sandoval, J. (2020). *Tagetes erecta* (Mexican marigold). Invasive Species Compendium. *Wallingford, UK: CABI*. https://doi.org/10.1079/isc.52641.20203483362

Wikipedia contributors. (2021). *Tagetes patula*. Wikipedia. https://en.wikipedia.org/wiki/Tagetes_patula.

Wongkiew, S., Hu, Z., Chandran, K., Lee, J.W., Kumar Khanal, S. (2017). Nitrogen transformations in aquaponic systems: a review. *Journal of Aquaculture Engineering and Fisheries Research. 76*, 9–19.

**How to cite this article:** Mohapatra, B.C., Sahoo, P. K., Chandan, N.K., Mahapatra, M., Panda, S.K., Majhi, D. and Pillai, B.R. (2021). Rearing of Fish, *Puntius gonionotus* seed and Marigold, *Tagetes patula* Plant in NFT Aquaponics System for Economic Returns. *Biological Forum – An International Journal*, *13*(3): 444-449.