Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(3): 1454-1457

Received: 01-03-2020
Accepted: 03-04-2020

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Production performance of cultivable fish species in integrated fish cum pig farming system under eco-climatic conditions of Assam

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Abstract

Integrated fish cum pig farming experiments were carried out with the prime objective of developing a suitable strategy of low cost aquaculture in bigger fish ponds of ≥0.5ha. The experiments were conducted at the pig density of 30, 40 and 50 nos. ha^{-1} keeping the fish density constant at 8500nos. ha^{-1}. The six species of carp polyculture *viz.*, catla, *Catla catla*, rohu, *Labeo rohita*, mrigal, *Cirrhinus mrigala*, silver carp, *Hypopthalmichthys molitrix*, grass carp, *Ctenopharyngodon idella* and common carp, *Cyprinus carpio* were used in the study. The best fish production among all the components of integrated fish and pig farming was achieved in treatment T_3 (50 pigs ha^{-1}) which was reported to be 2923.22 kg ha^{-1} yr^{-1}. Grass carp recorded the highest growth of 2.33kg in both treatments T_1 and T3, followed by silver carp 1.58±0.12 kg in treatment T_3. The physico-chemical parameters were recorded throughout the culture period of 1 year which is within the optimal range for fish culture.

Keywords: integration, pond, fish culture, aquaculture

Introduction

Fish culture is a system which can go a long way in augmenting protein production and generating gainful employment. The modern fish culture technologies have immense potential for increasing fish production, but they push up the prime cost due to intensive use of feed and mineral fertilizers. Fish cum livestock farming is considered as an excellent innovation for judicious recycling of organic waste and optimum production of high class protein at low cost [1]. This is also one of the best methods of both waste disposal and waste utilization. The raising of pigs can be fruitfully combined with fish culture where pig dung acts as excellent pond fertilizer and raises biological productivity of the pond water and consequently increases fish production. Further fish also feed directly on the pig excreta which contains 70% digestible food for the fish [2]. As pigs attain slaughter maturity in about 6 month's time, the system envisages raising of two lots of pigs and one crop of fish during culture period of one year. Fish yielding from 2500-3500 kg ha^{-1} yr^{-1} is generally obtained along with 4200-4500 kg pig meat [3]. Hence, this research work was carried out with the prime objective of developing a suitable strategy of low cost aquaculture by applying pig manure in bigger fish ponds of size (≥0.5ha).

Materials and Methods

Location of the study:

The research work was carried out the fish farm of College of Fisheries, Assam Agricultural University, Raha within 92°30′ E longitude and 26°15′ N latitude in Nagaon District, Assam. The farm was earlier known as Raha Fish Seed Production and Distribution Centre. As the Jonghal Balahu Garh Fish Farm, the biggest state owned fish farm situated at Raha started producing fish seeds on commercial scale, the Farm was converted to fish production farm in 1972. Bigger size fish ponds of size ≥0.5ha. Were selected for conducting the study.

Pond Management

Ponds are generally infested with different types of weeds which are not desirable for healthy growth of fish. The weeds in small and large water bodies are controlled by either of the three ways which are (i) Manual method (ii) Chemical method and (iii) Biological method. The predatory fish directly prey upon the stocked fingerlings, whereas the weed fishes compete with them for food and oxygen. As such, complete eradication of such fishes from stocking pond is essential and netting, draining out or by applying fish toxicants to the pond. Drain and dry the pond to remove all the weeds and fish fauna remaining in the pond. If it is not possible to drain the pond, all the fish can be killed by applying 15 kg of both bleaching powder and urea for a 1000 m2 pond. Alternatively, 250 kg Mahua oil cake can be applied which kills all the fishes and also acts as organic pond fertilize. Pigs are brought to the pond before stocking the fish, so no basal application of manure is required. Lime is applied @ 500 kg ha-1 year-1. The first installment is 1/3rd of the total yearly requirement, applied evenly over the bottom soil. The rest is applied at equal monthly installments. If an old pond is to be renovated for integration with pigs, the pond is to be dewatered, the aquatic weeds removed manually and the bottom is exposed to the sun at least for 10 days. The bottom is excavated so that minimum water depth in pre/post monsoon is not less than 1.5 m and not more than 3.0m in the monsoon months. The excavated soil is used to repair the dykes. The fertile first layer of bottom soil (6.0cm) is deposited on the terraced part of the dykes where the horticultural crops are grown.

Stocking of Fishes:

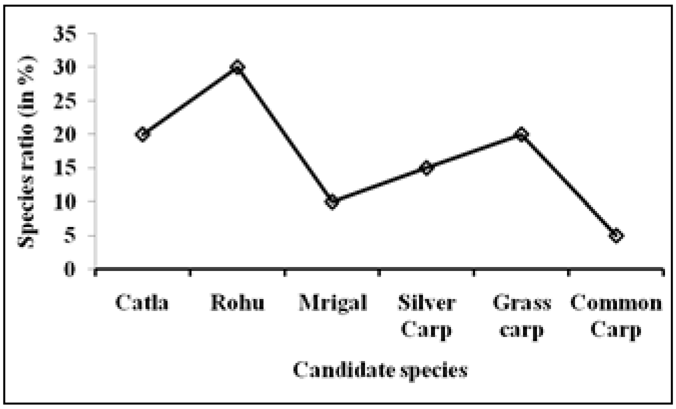


Fig 1: Species ratio (%) of candidate species stocked in the treatment ponds

The fishes are stocked after the pond water gets properly detoxified. The stocking rates vary from 8500 fingerlings (15cm) per hectare and a species ratio of 40% surface feeders (Catla and Silver Carp), 20% column feeders (Rohu), 30% bottom feeders (Mrigal and Common carp) and 10% macro vegetation feeders (Grass carp) is preferred for high fish yields. To control the weed fishes which compete for food, space and dissolved oxygen with the target fishes, feather backs (*Notopterus notopterus)* can be stocked @100 nos. ha^{-1}.

Results and Discussion:

The results of average final weight of the Indian major carps and exotic carps are presented in Table 1. The results elucidates that the experiment was conducted with four treatments with one control. In the control pond fishes were reared under normal polyculture conditions without pig–fish integration and hence the fish production in the control ponds was reported to be lowest within the range of 1000-1500 kgha^{-1}yr^{-1} which is far below the national average fish production of India [4]. The fish culture practice in the treatment ponds were integrated with different stocking numbers of pigs as mentioned in the Table 1. In all the treatment tanks fishes were reared maintaining the same stocking density of 8500 nos. ha^{-1}.

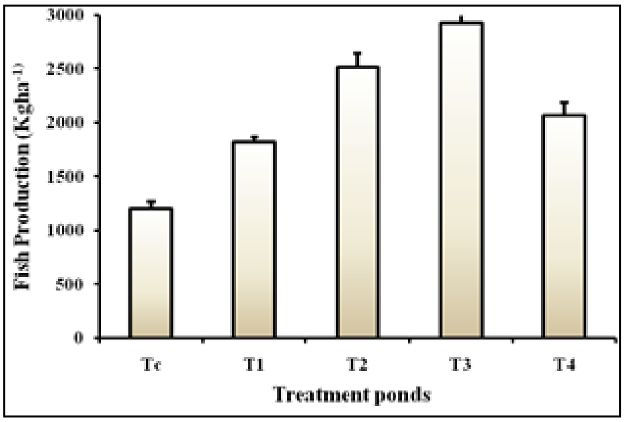
Table 1: The average final weight (kg) of 6 species of Indian Major carps and Exotic carps with a stocking density of 8500nos. ha^{-1}

	T_c	T_1	T_2	T_3	T_4
Catla	0.35±0.01	0.85±0.03	0.77±0.03	0.85±0.04	0.45±0.02
Rohu	0.17±0.08	0.46±0.03	0.46±0.01	0.48±0.02	0.32±0.01
Mrigal	0.19±0.09	0.38±0.01	0.38±0.00	0.42±0.02	0.26±0.02
Silver carp	0.34±0.01	1.52±0.10	1.27±0.02	1.58±0.12	0.80±0.05
Grass carp	0.31±0.03	2.33±0.18	1.87±0.14	2.33±0.04	1.02±0.08
Common carp	0.24±0.01	0.70±0.00	0.74±0.04	0.70±0.04	0.50±0.02

(Values are expressed in Mean ± SE)T_c= Control pond with no pig-fish integration
T_1= Treatment ponds with fish-pig integration (30nos. of pigs ha^{-1})
T_2= Treatment ponds with fish-pig integration (40nos. of pigs ha^{-1})
T_3= Treatment ponds with fish-pig integration (50nos. of pigs ha^{-1})
T_4= Treatment ponds with fish-pig integration (60nos. of pigs ha^{-1})

*Catla: *Catla catla*; Rohu: *Labeo rohita*; Mrigal: *Cirrhinus mrigala*; Silver carp: *Hypopthalmichthys molitrix*; Grass carp: *Ctenopharyngodon idella*; Common carp: *Cyprinus carpio*

The highest growth rate among the candidate species was exhibited by grass carp, *Ctenopharyngodon idella* (2.33±0.04kg) in treatment T_3 (50pigs ha^{-1}) followed by silver carp, *Hypopthalmichthys molitrix* (1.58±0.04kg) in the same treatment which substantiates the herbivorous and planktivorous feeding habit of grass carp and silver carp respectively where they were able to efficiently metabolize the un-decomposed waste matter from the pig manure as pig dung contains 70% digestible food for the fish [5]. However the overall fish growth in the treatment T_4 (60 pigs ha^{-1}) was not satisfactory considering the high organic load accumulated in the fish pond integrated with 60 nos. of pigs ha^{-1} which explains that pond with high organic load of animal excreta causes stress and growth retardation in fish [6]. The fishes are stocked in different species combinations as referred to Fig.1. which mentions that in polyculture multispecies stocking is recommended to effectively utilize natural food and space without hampering the feeding habits of the other species and thriving in a compatible manner which helps in achieving desirable production to the tune of 2500-3000kg ha^{-1} yr^{-1} [7].



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T_4= Treatment ponds with fish-pig integration (60nos. of pigs ha^{-1})

Fig 2: Details of fish production in the treatment ponds with fish stocking density 8500nos. ha^{-1}

Table 2: Physico-chemical parameters and nutrient status of water during the one year culture period.

Sl. No.	Parameters	Values
1.	Water temperature (°C)	22.6 -30.0
2.	pH	7.5-8.5
3.	Dissolved oxygen (mgl^{-1})	3.9-5.67
4.	Free carbon-dioxide (mgl^{-1})	0.68-1.20
5.	Total alkalinity (mgl^{-1})	80.40-126.20
6.	Ammonical nitrogen (mgl^{-1})	0.04-0.08
7.	Nitrate nitrogen (mg/100gm)	0.76-2.45
8.	Orthophosphate (mg/100gm)	5.05-8.04
9.	Turbidity (NTU)	15.0-46.2

In Figure 1, the percentage species ratios of the candidate species were mentioned as per the standards of scientific fish farming [8]. The percentage rate of stocking candidate fish species for carp polyculture depends upon the effective utilization of natural food and available space in a fish pond where there is no competition among the fish species and they share a compatible feeding habit that helps in enhancing productivity in fish ponds [9].

Figure 2 refers the fish production in the ponds integrated with fish cum pig farming practice where highest production of 2923.22 kg ha^{-1} yr^{-1} was achieved in treatment T_3 (50 pigs ha^{-1}) which is within the national average fish production in India [10]. The production in control (T_c) ponds was reported to be minimum as there was no integration with the livestock and which resulted in the dearth of natural food and low productivity. The physico-chemical parameters of the cultured ponds were mentioned in the Table 2 which falls within the optimum range desirable for fish culture. Throughout the study period, in all the treatment ponds there is variation of pH of pond water between 7.5-8.5 which is within the optimal range under integrated farming system [11]. The water temperature (22.6-30.0^{0}C) and dissolved oxygen concentration (3.9-5.67 ppm) were within the tolerated limit for optimum growth and survival of fish in all the treatment ponds [12]. Free carbon dioxide and total alkalinity was in the range of 0.68-1.20 mg/l and 80.40-126.20 mg/l respectively which are having profound effects on pond productivity enabling healthy growth and higher survival of fish in ponds [13]. Ammonical nitrogen (0.04-0.08 mg/l), Nitrate-nitrozen (0.76-2.45 mg/100gm) and orthophosphate concentration (5.05-8.04 mg/100gm) are favourable for luxuriant growth of phytoplankton and microscopic aquatic primary producers which are responsible for most of the oxygen (photosynthesis) and primary productivity in ponds [14]. High turbidity of water can decrease fish productivity, as it will reduce light penetration into the water and thus oxygen production by the water plants [15]. During the study period, the water turbidity concentration was 15.0-46.20 NTU (Nephelometric *Turbidity* Units) which is within the favourable range to enhance better yield and quality of fish [16].

Conclusion

Within the broad concept of sustainable agriculture "Integrated Farming Systems" hold special position as in this system nothing is wasted, the byproduct of one system becomes the input for other. Integrated farming is an integrated approach to farming as compared to existing monoculture approaches. It refers to agricultural systems that integrate livestock and crop production. Moreover, the system helps poor small farmers, who have very small land holding for crop production and a few heads of livestock to diversify farm production. In the present study, the experiment was carried out with the prime objective of developing a suitable strategy of low cost aquaculture by applying pig manure for improving the biological productivity of the pond which tends to achieve the target production in a sustainable manner.

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