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Utilization of poultry manure in fish seed rearing under mid-hill condition

S K DAS*, A DAS, S G SINGH, N P DEVI and P MAHANTA

ICAR Research Complex for NEH Region, Division of Fisheries Umiam, Meghalaya 793 103 India

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Under mid hill condition (Altitude 600–1,400 m above Mean Sea level), the growing period of most warm water cultivable fish species is restricted to only about 6 to 7 months in a year (Das and Singh 2017) due to cold climatic condition. Another important bottleneck in promoting mid hill aquaculture in the North East Hill region is the non-availability of quality fish seeds. Thus, there is tremendous scope for enhancing productivity through production of appropriate size quality fish fingerlings of suitable fast growing fish species in the region. In general, fingerling size of fish seeds measuring 6–10 cm in length is ideal for fish culture. Nursery rearing of fish fry has always been a very challenging task due to higher percentage of mortality during juvenile stage. These tender fish seeds are highly prone to predation by frogs, water snakes and aquatic insects etc. in nursery ponds resulting in poor survival percentage.

At early life stages, most of the widely cultivated fish species are known to prefer natural food items produced in pond or tanks. Application of inorganic and organic fertilizers in pond is the common practice to enhance natural fish food organisms especially the plankton. The availability of appropriate food, i.e. planktonic life and ecological parameters for fish in the pond, are the basic requirements for obtaining a high fish yield (Jha *et al*. 2004, Jasmine *et al*. 2011). The use of organic manure to increase production of fish was known to Chinese as far back as 4th and 5th centuries (Ali 1993). Among manure used, chicken's is preferred because of its ready solubility and high level of phosphorus concentrations (Knud-Hansen *et al*. 1991). Soluble organic matter supplied to ponds by using manure stimulates phytoplankton growth (Sevilleja *et al*. 2001). Moreover it increases biomass of zooplankton and benthic organisms (Atay and Demir 1998). Literatures on use of poultry droppings for fish seed raising, under mid hill condition is scanty. Further, indiscriminate use of this manure in fish ponds may deteriorate the water quality of the pond. Therefore, it is necessary to know the standard doses of these manures which would keep the physico-chemical parameters of pond water in favourable ranges for survival and growth of fishes. Excess use of poultry dropping as pond manure may avert many problems like eutrophication, algal bloom and fish mortality (Dhawan and Toor 1989). Common carp plays an important role in augmenting fish production especially in the hill states of the region and among the indigenous carps, minor carp *Labeo gonius* was observed to perform well in the mid hill region (Das and Ngachan 2017). Since there is increasing demand for the fingerlings of these two species, the present study was undertaken with a primary objective to improve survival and growth of juvenile fish and to standardize an optimum dose of poultry manure in concrete nursery tanks under mid hill condition.

Experiments were conducted at the fish farm in mid hill region (sub-tropical), located at 900 m above msl for raising fry to fingerling size common carp in a period of 45 days (12th May, 2016 to 27th June, 2016) and to raise the spawn of *Labeo gonius* to fingerling size for a period of 75 days during the months of July–September 2016.

Altogether 9 concrete tanks each with an area of 0.0002 ha and a depth of 1.2 m.(dimension 2.0 m× 1.0 m× 1.2 m) were utilized to conduct the experiments in triplicates. In each tank a 5–7 cm thick layer of soil was spread uniformly to facilitate the decomposition of manure. Three treatments, viz. control T_0 (no manure), T_1 (poultry manure @5,000 kg/ha) and T_2 (poultry manure @10,000 kg/ha) were selected based on standard practices (Annon 2006). Poultry manures were collected from the poultry shed maintained at the fish farm under dip litter system. Total amount of poultry manure for one year was calculated according to the area of the tank and initially one third was applied 15 days prior to stocking of fish seed. The remaining amount was applied in equal monthly installments. The water volume in each tank was around 2,000 litres.

The fry of common carp, *Cyprinus carpio* was stocked in each tank at an uniform density of 5 lakh/ ha for a period of 45 days while the spawn of *Labeo gonius* were stocked at an uniform density of 3 million per ha for a period of 75 days to observe the survival percentage and growth at two different doses of poultry manures. The initial average total length and weight of common carp (*Cyprinus carpio*) fry at the time of stocking were 3.47 cm and 0.70 g while the initial average total length and weight of *Labeo gonius*

*Corresponding author e-mail: skdas01@yahoo.com

spawn were 0.58 cm and 0.143 g. The juvenile fishes were fed once in the morning with rice polish and mustard oil cake at 1 : 1(w/w) ratio daily to apparent satiation.

Water parameters such as temperature, *p*H, dissolved oxygen and total alkalinity were recorded fortnightly during the rearing period following standard protocol (APHA 2005). The plankton samples were collected by filtering 50 litres of water through plankton net (mesh no.25, pore size 60 µm). The filtrate collected in the collecting vial were transferred and concentrated in a measuring cylinder and quantitative analysis of plankton was done following the drop count method (Lackey 1938).

The growth of reared fish was recorded in terms of length and weight by collecting ten individual randomly from each tank at 15 days interval for common carp fry and at 25 days interval in case of *L. gonius* spawns.

The following parameters and formulas were used to evaluate the growth performance of the juvenile fish reared under controlled conditions.

Survival rate (%)	=	Number of fish harvested × 100/ Number of fish stocked.
Length gain (cm)	=	Average final length – Average initial length
Weight gain (g)	=	Mean final weight – Mean initial weight
Specific growth rate (SGR)	=	(Final weight – initial weight) / Rearing period in days

The water parameters such as temperature, *p*H, dissolved oxygen and total alkalinity recorded during the rearing period are highlighted in Table 1. In general, the period between May to September is considered the best for fish growth under mid hill conditions due to higher temperature. The water parameters recorded were within the favorable limits for fish farming.

The plankton densities in each treatment tanks were observed after every 15th days of manuring. The plankton population (Table 2) was observed to be significantly higher in the T_1 and T_2 tank than the control tank (T_0). The enhanced density of plankton in T_1 and T_2 was primarily due to the effect of poultry manure which contains high level of nitrogen and phosphorus. The nutrients released by the poultry manure enriched the bottom soil of the T_1 and T_2 tanks resulting in high growth of phytoplankton and zooplankton- the most preferred natural food of the juvenile fish. The phytoplankton population chiefly comprised of *Skeletonema*, *Volvox*, *Microcystic*, *Scenedesmus*, *Nitzchia*, *Euglena* and *Navicula* while zooplankton population contained Cyclops, *Diaptomus*, *Daphnia*, *Moina* and *Brachionus*. However, the most predominant was skeletonema among the phytoplankton and cyclops among the zooplankton in all the treatments.

Survival and Growth performance of common carp fry: The survival percentage of common carp fry after 45 days of rearing in three different treatments were 68.12 (T_0), 84.66 (T_1) and 87.66 (T_2). While there was no significant difference among the two treatments T_1 and T_2, the percentage survival in control tank (T_0) significantly differedfrom survival percentage recorded in both T_1 and T_2 (Table 3).

The growth parameters recorded in terms of length and weight at the end of 45th days of rearing was observed to be significantly different in all the treatments (Table 3). The highest mean length and weight were observed in T_2 (7.02 cm, 5.25 g) followed by T_1 (6.11 cm, 3.56 g) and T_0 (5.67 cm, 2.48 g). The specific growth rate in terms of length and weight was maximum in T_2 (0.080 and 0.101).

Survival and growth performance of Labeo gonius: The survival percentage of spawn of *L. gonius* reared for 75 day was the highest in the T_2 followed by T_1 and T_0 (Table 4). While there was no significant difference between the T_1 and T_2, the control (T_0) with no poultry manure significantly differed from the both T_1 and T_1.

Similarly, the maximum growth of spawn of *L. gonius* in terms of length and weight was recorded in T_2 followed

Table 1. Water quality parameters in experimental tanks during May to September, 2016

Parameter	May to June			July to September		
	Control	T_1	T_2	Control	T_1	T_2
Mean Water Temp (°C)	26.0	26.50	27.8	27.5	26.2	25.2
*p*H Range	6.5–7.0	7.0–7.5	7.3–8.0	6.8–7.3	7.2–8.0	7.0–7.8
Dissolved Oxygen (in mg/l) Range	7.3–9.0	8.8–9.3	8.0–10.0	9.0–10.3	8.3–10.8	9.3–10.5
Total Alkalinity (mg/l) Range	55–63	62–70	65–78	50–62	68–74	70–76

Table 2. Plankton population

Treatment	15 DAM		30 DAM		45 DAM		60 DAM	
	No. per litre	Total plankton	No. per litre	Total plankton	No. per litre	Total plankton	No. per litre	Total plankton
T_0	$22±2.31^a$	44,000	$20.5±0.29^a$	41,000	$29.5±3.75^a$	59000	$32±2.31^a$	64,000
T_1	$85±0.81^b$	170,000	$48±0.46^b$	95,200	$100±1.04^b$	200400	$96±1.44^b$	191,000
T_2	$105±3.64^c$	209,400	$88±1.27^c$	176,400	$131±3.18^c$	261000	$123±1.44^c$	245,000

Means with different superscripts are different at 5% level of significance; DAM, Days after manuring; Total water volume = 2,000 litres.

Table 3. Growth performance and survival percentage of common carp (fry to fingerling)

Treatment	Initial mean length (cm)	Initial mean weight (g)	15^{th} day mean length (cm)	15^{th} day mean weight (g)	45^{th} day mean length (cm)	45^{th} day mean weight (g)	SGR (Length)	SGR (Weight)	Survival (%)
T_0	3.46 ± 0.01^a	0.67 ± 0.03^a	3.61 ± 0.04^a	0.72 ± 0.04^a	5.67 ± 0.05^a	2.48 ± 0.02^a	0.046	0.040	68.12^a
T_1	3.46 ± 0.05^a	0.71 ± 0.01^a	4.42 ± 0.05^b	1.15 ± 0.04^b	6.11 ± 0.21^b	3.56 ± 0.06^b	0.066	0.063	84.66^b
T_2	3.51 ± 0.05^a	0.72 ± 0.02^a	4.93 ± 0.11^c	1.89 ± 0.07^c	7.02 ± 0.07^c	5.25 ± 0.16^c	0.080	0.101	87.66^b

Means with different superscripts are different at 5% level of significance.

Table 4. Growth performance and survival percentage of *Labeo gonius* (spawn to fingerling)

Treatment	Initial mean length (cm)	Initial mean weight (g)	25^{th} day mean length (cm)	25^{th} day mean weight (g)	50^{th} day mean length (cm)	50^{th} day mean weight (g)	75^{th} day mean length (cm)	75^{th} day mean weight (g)	SGR (Length)	SGR (Weight)	Survival (%)
T_0	0.58 ± 0.01^a	0.15 ± 0.01^a	1.45 ± 0.10^a	0.20 ± 0.01^a	2.90 ± 0.08^a	0.41 ± 0.01^a	3.38 ± 0.11^a	0.84 ± 0.02^a	0.037	0.009	29.46^a
T_1	0.60 ± 0.01^a	0.14 ± 0.00^a	1.85 ± 0.05^b	0.23 ± 0.01^b	3.42 ± 0.02^b	0.60 ± 0.03^b	4.75 ± 0.18^b	1.38 ± 0.06^b	0.055	0.016	70.94^b
T_2	0.57 ± 0.01^a	0.14 ± 0.01^a	2.10 ± 0.05^c	0.26 ± 0.01^c	4.13 ± 0.09^c	0.74 ± 0.04^c	6.99 ± 0.07^c	3.96 ± 0.08^c	0.086	0.051	76.75^b

Means with different superscripts are different at 5% level of significance.

by T_1 and T_2 (Table 4). The difference in growth at the end of 75^{th} days of rearing was found to be significant ($P<0.05$) among the three treatments. The highest SGR was recorded in T_2 followed by T_1 and T_0.

The water quality and food availability are the vital parameters in survival and growth of juvenile fish. The maximum mean water temperature of 27.8°C was recorded during May–June while the minimum temperature of 25.2°C was recorded in the month of September. Water temperature greater than 18°C was best for survival and growth of warm water fishes and many species suffered and died below 12°C (Nagel 1979). In general, the water temperature ranging between 24°C to 30°C is found to be the most suitable for raising carp fishes in pond environment. The *p*H value varied between 6.5–8.0 during the experimental period. The higher values were observed in T_1 and T_2 which were fertilized with the poultry manure. The higher *p*H value is normally associated with higher photosynthetic activities in water (Hujare 2008) and the variation of *p*H in poultry manure treated tanks were probably because of cumulative effects of other biotic and abiotic factors, along with input of additional manure (Pillay 1990). The *p*H ranging from 5–9 was found reasonably appropriate for carp farming as well as for biological productivity (Bhatnagar and Devi 2013, Laha and Mitra 1987). The *p*H values recorded in the present experiment were within the acceptable range. The dissolved oxygen in the experimental tanks varied between 7.3 and 10.8 mg/l and was within the acceptable range for fish farming. The variation in the DO concentration in aquatic bodies might be caused due to seasonal variation in temperature and fluctuations of photosynthetic and respiratory activities of the aquatic biomass (Chakrabarty *et al*. 2009, Gogoi *et al*. 2015). The total alkalinity varied between 50 to 78 mg/l in the experimental tanks which is within the desirable range. The fluctuation of total alkalinity may be due to the effect of poultry manure. The desired total alkalinity level for most aquaculture species lies between 50–150 mg/l $CaCO_3$, but no less than 20 mg/l (Wurts 2002).

The biological productivity of any aquatic system is generally judged through the qualitative and quantitative estimation of plankton, which form the natural food for fish (Ahmed and Singh 1989). The optimum water quality parameters together with the poultry manure provided conducive environment for plankton production in the experimental tanks. In the present study, the plankton density was significantly higher in T_2 followed by T_1 and T_0. The high population density is attributed to the presence of poultry manure which is known to contain high level of nitrogen and phosphorus required for plankton production. Our findings were in conformity with the study of (Kaur and Kaur 1987, Safi *et al*. 2016). High density and diversity of plankton were also found in the pond fertilized with poultry and cow manure than non-fertilized pond (Ei-Sayed 1998).

During the present investigation all the physico-chemical characteristics remained well within the range and reported to be optimal for common carp (Swingle 1969, Jhingran 1982). A uniform stocking density of fry and spawn in the experiments were maintained based on the standard recommendation (Annon 2006) and our earlier studies (Das *et al*. 2017). The survival percentage of common carp (fry to fingerling) was the highest in T_2 treatment and lowest in control (T_0). However, there were no significant differences in survival percentage of T_1 and T_2 (Table 3). Similarly, Sehgal and Thomas (1985) observed 62.6–78.6% survival rate of common carp in tanks manured with poultry droppings at the rate of 17,000 kg/ha/year, while Kaur and Kaur (1987) recorded as high as 90–95% in poultry manure treated tanks than control. In the present study the highest growth of common carp fry was recorded in T_2. The initial mean length almost doubled in 45 days (Table 3). The growth of common carp fingerlings at the end of 45 days of rearing were significantly higher in tanks treated with poultry manure. In case of *Labeo gonius* (spawn to fingerlings) the highest survival was recorded in T_2 tanks with 76.75% (Table 4). There was no significant difference in survival percentage between T_1 and T_2. The lowest percentage of survival (29.46%) was recorded in control tank which is attributed to inadequate natural fish food organisms. At the end of 75 days of rearing, the highest growth of fingerlings of *Labeo gonius* was recorded in T_2 treatment followed by T_1 and T_0 (Table 4). The significantly higher survival and growth rates in tanks manured with poultry excreta than in control was primarily due to the abundance of natural food and supplementary feed provided *ad lib*. Similar observations were also reported by Kaur and Kaur (1987), Singh and Singh (1975), Murty *et al.* (1978) and Safi *et al*. (2016) in Indian major carps and common carp. The increase in the growth of the fish after the application of manure has been reported by Hassan and Javed (1999) and Mahboob (1992). Jha *et al*. (2004) reported cow-dung efficiently enhanced the production of plankton. Safi *et al*. (2016) affirmed that the fish production in foothills can be increased through poultry-cum-fish culture.

In our study we have observed that application of poultry manure at the rate of 10,000 kg/ha/yr is optimal for raising fish fingerling in tanks under mid hill conditions. Significantly higher survival and growth rates of the two fish species, common carp and *L. gonius* were obtained at the recommended stocking density in tanks manured with poultry droppings than in control. Both the fish species feed low in the food web and thus utilize plankton, benthic and detrital food organisms effectively.

SUMMARY

The availability of quality seed is the prerequisite for rapid expansion and growth of aquaculture. Fingerling size fish seeds are always in great demand for any type of aquaculture operations. In absence of nursery ponds, the concrete tank fertilized with poultry manure may be one of the alternatives to the rural farmers to increase the survival percentage and growth of fish fry in order to stock their fish ponds with quality fish fingerlings for augmenting fish production.

The study highlights the importance of optimum doses of poultry manure, favourable water quality and optimal density of plankton population for higher survival and growth in fish seed nursing. In the changing climate scenario, the environment friendly integrated fish farming with poultry may be one of the best options for improving the fish seed production in Meghalaya and other hilly region of the northeast India.

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