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GROWTH PERFORMANCE OF SILVER BARB, PUNTIUS GONIONOTUS WITH MAJOR CARPS UNDER POLYCULTURE

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ABSTRACT
The present investigation was carried out to study the growth performance of silver barb, *Puntius gonionotus* with Indian major carps under polyculture system. Uniform sized fingerlings of silver barb and carps were stocked in cement cisterns at a rate of 10,000 numbers of fingerlings/ha for a period of 150 days. The treatments comprised of T_0 with catla, rohu, mrigal and common carp stocked at a ratio of 3:4:1:2, T_1 with catla, rohu, mrigal, common carp and silver barb at a ratio of 3:3:1:2:1, T_2 with catla, rohu, mrigal, common carp and silver barb at a ratio of 3:2:1:2:2, T_3 with catla, rohu, mrigal, common carp, and silver barb at a ratio of 3:1:1:2:3. The average weight gain by silver barb in T_1, T_2 and T_3 were recorded to be 43.34 ± 0.73 g, 55.65 ± 1.16 g, 88.41 ± 0.68 g whereas among carps, the catla recorded highest weight gain (93.14 ± 1.52 g) followed by common carp (74.79 ± 1.33 g), mrigal (66.19 ± 0.93 g) and rohu (53.38 ± 1.01 g). The analysis of data indicates a significant difference ($p < 0.05$) between the treatment T_3 and T_0 which further strengthens the fact that polyculture of silver barb with four species of carps is beneficial in terms of enhancing the yield from the polyculture system.

INTRODUCTION

The concept of polyculture of fish is based on the basic principle of efficient utilization of different trophic and spatial niches available in a pond ecosystem for maximizing the fish production per unit area per unit time. Compatible fish species with different feeding habits are raised together in the same pond which utilizes the natural food available in the different trophic level or strata of the pond. Polyculture has been well acknowledged from ecological and economical benefit point of view (Lalramchhani *et al*., 2019; Debnath *et al*., 2018; Saxena and Saksena, 2009).

Puntius gonionotus is an exotic fish to India belonging to the family Cyprinidae, commonly known as silver barb. The species was introduced to India with a purpose for control submerged aquatic weeds like *Hydrila, Najas* and *Ceratophyllum*. It attains a marketable size within three to four months of culture and can survive in shallow, turbid water which opens up an avenue for proper utilization of small seasonal water bodies by the small and marginal farmers for additional animal protein production. The species under study exhibits herbivorous column feeder habit with right silvery white colour with characteristic taste with an ability to withstand salinity up to 7.0 ppt ((Phaohorm, 1980; Gupta and Rab, 1994;Haroon and Pittman, 1997; Ananth *et al*.,2017;Myimt *et al*., 2019). Further, since the species exhibits a preference towards the utilization of submerged algae as food, the faecal matter containing semi-digested cellulose serves as an excellent food for the omnivorous fish like common carp in the system. The species is also utilized by the farmer as an inter crop along with carp culture. The reason being, within three to four months, the species under study attains the marketable size (300 g), provides an opportunity to the farmers for intermittent income generation through periodic harvesting and marketing of the produce (Mohanta *et al*., 2008; Chaudhary *et al*., 2008; Abdul Halim *et al*., 2018). The present study was carried out with an aim to assess the growth performance of silver barb, *Puntius gonionotus* with major carps under polyculture system.

MATERIALS AND METHODS

Design of Experiment

The present investigation was carried out in cement cisterns of $5 \times 3 \times 1.5$m dimensions located in the instructional farm of College of Fisheries (OUAT), Berhampur, Odisha for a period of 150days commencing from November, 2017 to May, 2018.The fingerlings comprising of Indian major carps, exotic carps and the silver barb, *Puntius gonionotus* were collected from the instructional farm of College of Fisheries having almost uniform size and weight, good and healthy seeds devoid of any disease and parasites were collected for the experimental purpose. The stocking density adopted was 10,000 fingerlings/ha. The treatments were T_0 (catla, rohu, mrigal and common carp stocked at a ratio of 3:4:1:2), T_1 (catla, rohu, mrigal, common carp and silver barb at a ratio of 3:3:1:2:1), T_2 (catla, rohu, mrigal, common carp and silver barb at a ratio of 3:2:1:2:2), T_3 (catla, rohu, mrigal, common carp, and silver barb at a ratio of 3:1:1:2:3). The stocking sizes of the fingerlings of catla, rohu, mrigal, common carp and silver barb were 8.94 ± 1.00g, 10.86 ± 0.52g, 7.27 ± 0.21g, 10.06 ± 0.50g and 8.43 ± 0.33g respectively. Each treatment was replicated thrice following standard statistical procedure complete randomized design (Gagoi *et al*., 2018).

Water quality monitoring

The water quality parameters in the cement cisterns were

maintained at an optimum level as required for fish. The water quality parameters such as dissolved oxygen, temperature, pH, carbon dioxide, alkalinity, ammonia, nitrate, nitrite and total dissolved solids were analysed periodically using APHA (2005).

Growth parameters

Fortnight sampling of the fish biomass was carried out to assess the increment in weight and survival in order to reschedule the feeding rate and feed quantity. The growth parameter indices of fish species under different treatments in terms of weight gain, daily weight gain, specific growth rate, percentage weight gain and survival percentage were calculated following the formula of Rahman *et al*. (2012) and Sveier *et al*.(2000).

Statistical analysis

The statistical tools "Completely randomised design" (CRD) was used to know the significant difference among the treatment means (Gagoi *et al*., 2018).

RESULTS AND DISCUSSION

The study was conducted from last week of November, 2017 to first week of May, 2018 for a period of150 days. The growth parameters like final weight, weight gain, specific growth rate and survival (%) are given in Table 1. Among all the species catla showed highest final weight gain in all the treatments. Catla showed final weight gain of 83.84 ± 0.64 g, 85.47 ± 1.16 g, 80.14 ± 14.01 g, and 93.14 ± 1.52 g in T_0 T_1, T_2 and T_3 respectively and it was highest in $T_3$and lowest in T_2. The final weight gain by rohu was highest in T_0 (62.27 ± 1.01 g) followed by T_1 (60.98 ± 1.52 g), T_3 (55.38 ± 1.01 g) and T_2 (46.57 ± 1.26 g). Growth of rohu was drastically affected due to presence of silver barb because both are column feeder. In case of mrigal the final weight gain was similar in T_2 and T_3 *i.e.* 65.38 ± 0.75 g and 66.19 ± 0.93 g respectively. In T_0 and T_1 final weight gain by common carp was 46.22 ± 0.77 g and 58.51 ± 0.54 g respectively. Mrigal showed final weight gain of 40.44 ± 0.25 g, 50.73 ± 1.42 g, 65.38 ± 0.75 g and 66.19 ± 0.93 g in T_0, T_1, T_2 and T_3 respectively. Mrigal accounted highest final weight gain in T_3 followed by T_2, T_1 and T_0. So it can be concluded that presence of silver barb does not affect growth performance of major carps except rohu and weight gain increases in presence of silver barb than in the absence of the later one.The highest weight gain percentage for silver barb in treatment T_3 (1021.8 ± 34.63%) followed by T_2 (574.02 ± 14.78%) and T_1 (422.98 ± 13.47%) indicating that silver barb performed well in T_3 when present in more number in carp polyculture system. Weight gain percentage of catla in treatment T_0, T_1, T_2, T_3 were 836.2 ± 15.28%, 780.17 ± 3.01%, 846.38 ± 4.02% and 853.20 ± 36.90% respectively and reveals presence of silver barb does not affected the weight gain of catla. In case of rohu weight gain percentage in treatment T_0, T_1, T_2 and T_3 was 478.26 ± 18.61%, 519.49 ± 12.59%, 392.88 ± 12.72%, and 551.77 ± 16.92% respectively. Rohu showed lower weight gain percentage in treatment T_2 and highest in T_3, concludes that though silver barb and rohu both are column feeder but silver barb can be incorporated in polyculture. In case of common carp better weight gain percentage was observed in polyculture with silver barb than in the absence of silver barb. The percentage weight gain by common carp in treatment T_0, T_1, T_2, T_3 was 346.44 ± 16.46%, 503.85 ± 16.04%, 770.27 ± 137.85% 603.36 ± 1.83% respectively indicating in presence of more number of silver barb has positive impact on percentage weight gain of common carp. Similarly mrigal registered weight gain percentage in treatment T_0, T_1, T_2, and T_3 was 427.81 ± 26.94%, 473.92 ± 49.70%, 782.44 ± 6.95%, 527.02 ± 4.01% respectively, indicating that presence of silver barb does not affected performance of mrigal.

The specific growth rate for silver barb under treatment T_1, T_2 and T_3 recorded to be 1.10 ± 0.02%, 1.27 ± 0.01% and 1.31 ± 0.23% respectively. Catla showed specific growth rate in T_0, T_1, T_2, T_3 was 1.49 ± 0.01%, 1.48 ± 0.04%, 1.50 ± 0.05% and 1.50 ± 0.02% indicates better performance in polyculture with silver barb. In rohu, specific growth rate observed in treatment T_0, T_1, T_2 and T_3 was 1.17 ± 0.02%, 1.21 ± 0.01%, 1.06 ± 0.01%, 1.25 ± 0.02% respectively. Lower specific growth rate was observed in treatment T_2 and highest in T_3. In case of mrigal specific growth rate observed was 1.11 ± 0.03%,

Table1: Growth parameter indices

Treatments	Species	Final weight (g)	Weight gain (%)	Daily weight gain(g)	Specific growth Rate (%)	Survival (%)
T0	Catla	83.84 ± 0.64	836.2 ± 15.28	0.50 ± 0.005	1.49 ± 0.01	80.95 ± 6.74
(3:4:1:2)	Rohu	62.27 ± 1.01	478.26 ± 18.61	0.35 ± 0.016	1.17 ± 0.02	80.00 ± 0.00
	Mrigal	40.44 ± 0.25	427.81 ± 26.94	0.22 ± 0.000	1.11 ± 0.03	88.89 ± 15.72
	Common carp	46.22 ± 0.77	346.44 ± 16.46	0.24 ± 0.008	1.00 ± 0.02	80.00 ± 0.00
T1	Catla	85.47 ± 1.16	780.17 ± 3.01	0.51 ± 0.005	1.48 ± 0.04	90.47 ± 6.74
(3:3:1:2:1)	Rohu	60.98 ± 1.52	519.49 ± 12.59	0.34 ± 0.008	1.21 ± 0.01	85.71 ± 0.00
	Mrigal	50.73 ± 1.42	473.92 ± 49.70	0.28 ± 0.008	1.16 ± 0.06	100.00 ± 0.00
	Common carp	58.51 ± 0.54	503.85 ± 16.04	0.33 ± 0.005	1.20 ± 0.02	80.00 ± 0.00
	Silver barb	43.34 ± 0.73	422.98 ± 13.47	0.23 ± 0.005	1.10 ± 0.02	88.89 ± 15.72
T2	Catla	80.14 ± 14.01	846.38 ± 4.02	0.54 ± 0.005	1.50 ± 0.005	76.19 ± 6.73
(3:2:1:2:2)	Rohu	46.57 ± 1.26	392.88 ± 12.72	0.25 ± 0.009	1.06 ± 0.01	80.00 ± 0.00
	Mrigal	65.38 ± 0.75	782.44 ± 6.95	0.39 ± 0.005	1.45 ± 0.01	88.89 ± 15.72
	Common carp	71.14 ± 1.68	770.27 ± 137.85	0.42 ± 0.016	1.43 ± 0.11	80.00 ± 0.00
	Silver barb	55.65 ± 1.16	574.02 ± 14.78	0.32 ± 0.009	1.27 ± 0.01	80.00 ± 0.00
T3	Catla	93.14 ± 1.52	853.2 ± 36.90	0.56 ± 0.012	1.5 ± 0.02	100.00 ± 0.00
(3:1:1:2:3)	Rohu	55.38 ± 1.01	551.77 ± 16.92	0.31 ± 0.005	1.25 ± 0.02	88.89 ± 15.72
	Mrigal	66.19 ± 0.93	527.02 ± 4.01	0.37 ± 0.005	1.23 ± 0.00	100.00 ± 0.00
	Common carp	74.79 ± 1.33	603.36 ± 1.83	0.43 ± 0.008	1.3 ± 0.00	100.00 ± 0.00
	Silver barb	88.41 ± 0.68	1021.8 ± 34.63	0.54 ± 0.005	1.31 ± 0.23	95.23 ± 6.74

1.16 ± 0.06%, 1.45 ± 0.01%, 1.23 ± 0.00% in treatment T_0, T_1, T_2 and T_3 respectively. Similarly specific growth rate of common carp observed was 1.00 ± 0.2%, 1.20 ± 0.02%, 1.43 ± 0.11%, 1.30 ± 0.00% in T_0, T_1, T_2 and T_3 respectively indicates good performance by common carp in polyculture with other carps.

The survival (%) of silver barb in treatment T_1, T_2 and T_3 were recorded to be 88.89 ± 15.72%, 80% and 95.23 ± 6.74% respectively. The highest survival rate (95.23%) observed in treatment T_3 indicating better compatibility with the catla, rohu,mrigal and common carp. Survival percentage of catla in treatment T0,T1,T2 and T3 observed was 80.95% ± 6.74%, 90.47 ± 6.74%, 76.19 ± 6.73% and 100 ± 00% respectively.

In all the treatments survival of catla is more except treatment T2indicating moderate compatibility. In case of rohu, survival (%) in treatment T_0, T_1, T_2 and T_3 was 80%, 85.71%, 80% and 88.89 ± 15.72% respectively indicating moderate compatibility. The survival (%) of mrigal in treatment T_0, T_1, T_2 and T_3 was 88.89 ± 15.72%, 100%, 88.89 ± 15.72% and 100% respectively. Mrigal showed highest survival in treatment T_3 (100%). Survival (%) showed by common carp was 80%, 80%, 80% and 100% in treatment T_0, T_1, T_2 and T_3 respectively suggesting moderate to good survival.

The present investigation reveals the weight gain of common carp was higher in T_3 than other treatments, which is attributed due to omnivorous feeding habit of common carp. It also reveals that five species combination with silver barb yield higher production than four species combination without silver barb. The study conducted on impact of silver barb in the polyculture of carps like *Labeo rohita, Catla catla* and *Cyprinus carpio* indicates significantly ($p < 0.05$) higher yield in four species polyculture system containing silver barb. The presence of silver barb decreased the growth of Indian major carps while increased that of common carp (Haque *et al*., 1998). Similarly Wahab *et al*. (2001) reveals higher fish production was obtained when there is medium stocking density of silver barb with carp *(Labeo rohita, Catla catla, Cyprinus carpio*) under polyculture system. Rahman *et al*. (2006) attempted to study the growth performance of Thai sharpunti with four major carps like rohu, catla and silver carp confirms the present study. Higher production was observed in T_3 due to higher number of silver barb. In this experiment, treatment T_3, consisting of a species ratio of catla, rohu, silver barb, mrigal, common carp, in a ratio of 3:1:3:1:2 in which more number of silver barbs were present gives higher production followed by T_2 and T_1. There is no significant difference between T_1 and T_0 with respect to their weight gain ($P > 0.05$). The highest weight gain and gross biomass is observed in T_3 by all the species indicates silver barb can be cultured with major carps. Similarly in the present study silver barb showed 95.23 ± 6.74% in T_3. All the species showed higher survival in T_3 (catla, rohu, silver barb, mrigal, common carp, at a ratio of 3:1:3:1:2) than T_0 (catla, rohu, mrigal, common carp at a ratio of 3:4:1:2).

An investigation carried out on compatibility of *Puntius gonionotus* with Indian major carps like *Catla catla, Labeo rohita* and *Cirrhinus mrigala* shows incorporation of silver barb into the polyculture system neither affected the survival of any carp irrespective of species combination nor yielded significant changes in biomass production among treatments, except for the one without catla, where it was significantly low (Jena *et al*., 2007). In the present study, incorporation of silver barb into the carp polyculture system does not affect the survival of other species. All the species showed greater survival in T_3.The survival rate of catla, rohu, mrigal, common carp, and silver barb in T_3(catla, rohu, silver barb, mrigal, common carp at a ratio of 3:1:3:1:2) were 100%, 88.89 ± 15.72%, 100%, 100% and 95.23% ± 6.74% respectively. In the present study a decline in the growth of rohu was reported with more number of silver barbs but did not affected the growth performance of catla. Catla showed higher weight gain and survival in presence of more number of silver barbs in T_3. In case of common carp also weight gain and survival was not affected due to presence of silver barb.

Common carp also showed higher survival and weight gain in presence of silver barb. Wahab *et al*. (1998) investigated on food competition of silver barb with major carps like catla, rohu and common carp which indicates a strong food competition between silver barb with other three major carps. Food items of silver barb were similar to carps. In natural condition, strong food competitions of *P. gonionotus* exist with catla and rohu and to a lesser extend with common carp. Azim *et al*. (2004) reveals that additional yield of 300kg/ha was obtained when silver barb stocked with catla, rohu, mrigal and common carp which was 25% higher than the net yield from three species without silver barb. Survival of different species did not vary between treatments. The individual weight gain of catla and rohu were slightly lower but weight gain of common carp increased significantly higher in ponds with silver barb ($p < 0.01$). In this present investigation presence of silver barb resulted in higher weight gain of all the species in treatment T_3 than polyculture without silver barb (T_0). Common carp showed higher weight gain in treatment T_3 where more no of silver barb was present. In case of rohu, growth was affected by silver barb but weight gain of rohu in treatment T_3 than T_2 and T_1 but less than T_0. Das and Mishra. (2016) reveals on multispecies farming of carps (catla, rohu, mrigal) with minor carps and barbs (*P. gonionotus, L. Fimbriatus* and *P. sarana*) increase production in seasonal ponds.T_4 formed ideal density with 28.8 and 76% higher yield compared to T_1 with only IMC and T_5 with only minor carp and barbs. All multiple species treatments having minor carps and barbs group as major component yielded higher fish biomass than those of IMC group. In all treatment silver barb showed higher survival 71.6%-78.9%. In this present study silver barb showed higher survival in all the treatment and polyulture of silver barb with major carps gives higher weight gain. Weight gain of all the species higher in T_3, where stocking density of silver barb was higher than T_0 (without silver barb).

The present investigation showed that the production increases when there is more number of silver barb and growth performance of silver barb contribute to higher production. From the present set of experiment, it is concluded that, a combination of catla, rohu, mrigal, common carp, silver barb in a ratio 3:1:1:2:3 gives best result.

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