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Carp Seabass Polyculture Concept is an Eco-Friendly Farming Technology in Freshwater Aquaculture

H G Solanki and N C Ujjania*

Department of Aquaculture, College of Fisheries Science
Navsari Agricultural University, Navsari 396 450 (Gujarat)

ABSTRACT

In this study, the carps were cultured with Asian seabass (*Lates calcarifer*) to access the feasibility, growth, survival and production of fishes in freshwater condition for two consequent years. Carps (*Catla catla, Labeo rohita, Cirrhinus mrigala* and *Ctenopharyngodon idella*) were cultured along with seabass in experiment pond whereas only carps were reared in control pond. The result showed that the water and sediment quality were optimum in both the ponds as per fish growth and survival. The work revealed that average growth of carps in terms of length, weight, biomass and production was significantly high ($P<0.01$) in experiment pond during the subsequent years of the study. Satisfactory results and the positive impact of introducing seabass in carp polyculture may be attributed to seabass stocking after the carps have attained appropriate size. The stocking of seabass seeds was done after getting the proper size of carps that help protect these carps from predation and chasing, availability of primary food components for consumption than the supplementary feed and consumption of weed fish by seabass minimized competition for food, oxygen and space for carps. Based on these findings, it was concluded that such practices would be a milestone for fish farming in freshwater.

Key Words*:* Carps, seabass, survival rate, growth, polyculture.

INTRODUCTION

Aquaculture is discrete from capture fisheries because of production, employment and economic values (Belton and Thilsted, 2014). Therefore, stagnation in capture fisheries and the rise in fish culture practice is shifted as the primary source of fish (Beveridge *et al,* 2013) which fullfil the demand for the growing population, urbanization and economy (Merino *et al,* 2012; Beveridge *et al,* 2013; Tacon and Metian, 2013; Waite *et al,* 2014). The culture of carp is an ancient activity, using different feeding habits of fishes in freshwater (Salehi, 2004) while sea bass (*Lates calcarifer*) can be cultured in specified culture systems using either marine water, brackish water or freshwater (Harpaza *et al,* 2005). The polyculture system of sea bass has been reported with shrimp, mullet and milkfish (Rauangpanit *et al,* 1984) and tilapia (Singh and Shirgur, 1994; Monwar *et al,* 2013). Seabass is a predatory fish and cannibalistic in case of variations in size or lack of feed sufficiency during the culture (Singh, 2000; Mathew, 2009). The study on polyculture of carps and seabass is minimal (Singh *et al,* 2001). Therefore, the present study was conducted to evaluate seabass's effect on carps' growth and survival in a polyculture system.

MATERIALS AND METHODS

The present study was conducted attwo different locations namely Danti pond (experiment pond) and SWMRU pond (control pond) situated at the research station of Navsari Agricultural University, Navsari (Gujarat) during the year 2008-09 and 2009-10. For fishes culture, dried ponds of 0.3 ha size were separately prepared (water filling, liming @ 100 kg/ha, manuring with raw cattle dung @ 1 toN/ha, *etc.*) to follow the prescribed method (Coche *et al,* 1996). The carps' seeds were procured

Corresponding Author's Email: ncujjania@vnsgu.ac.in

*Department of Aquatic Biology, Veer Narmad South Gujarat University, Surat 395007 (Gujarat). Email: ncujjania@vnsgu.ac.in

Table 1. Important water and soil quality parameter of the ponds during polyculture of carps and seabass

Parameters	Control pond		Experiment pond	
	2008-09	2009-10	2008-09	2009-10
Water quality parameters				
pH	8.13±0.07	8.36±0.03	8.05±0.09	8.16±0.05
Total Alkalinity (ppm)	179.73±10.46	177.58±9.732	215.66±19.01	213.57±17.90
Total Ammonical N (ppm)	0.12±0.04	0.07±0.01	0.22±0.05	0.15±0.05
NO_2-N (ppm)	0.02±0.01	0.07±0.01	0.12±0.03	0.13±0.03
NO_3-N (ppm)	0.190.06	0.07±0.01	0.14±0.04	0.10±0.01
Soil quality parameters				
pH	8.48	8.12	8.12	8.48
Electrical Conduction (dSm^{-1})	0.49	1.06	1.06	1.26
Organic C (%)	0.11	0.15	0.15	0.28
Available P($kgha^{-1}$)	37	155.31	155.31	203.57
Avail K ($kgha^{-1}$)	250.5	675.48	675.48	789.31
Available N($kgha^{-1}$)	77.52	612.5	612.5	798.69

from a local vendor while seeds of seabass were procured from Fish Seed Production Unit, CIBA (Chennai). The control pond was stocked with 2000 carp yearlings (*Catla catla, Labeo rohita, Cirrhinus mrigala and Ctenopharyngodon idella*; 3:3:2:2 ratio). In experiment pond, bottom feeder and slow-growing carp (mrigal) were partially replaced by seabass (*Lates calcarifer*) and stocked with 2000 carp yearlings and sea bass in the ratio of 3:3:1.5:2:0.5. The stocking of carps was done in one month advance, and later on, sea bass was stocked assuming that in this duration carps will grow up to sufficient size to escape from predation and sea bass will feed upon the available weed fishes in the pond. Supplementary feed (Crude protein 18.16 ± 0.21%; crude lipid 2.29 ± 0.289%; crude fiber 9.96 ± 0.763% and Ash 19.19 ± 0.777%) were also provided in both the ponds with perforated hanging bags @ 3% fish bodyweight. The fishes' culture duration was eight months, and at the end of the crop, the achieved biomass,growth (total length in cm and weight in g) of the individual specimen of cultured fishes was measured randomly.

Water quality parameters, including pH, total alkalinity, total ammonical nitrogen (TAN), nitrite-nitrogen (NO_2) and nitrate-nitrogen (NO_3), were analyzed to follow the standard method (APHA, 2005). Pond soil samples were analyzed for pH, electrical conductivity (EC), organic carbon (OC), available nitrogen, phosphorus and potassium (Jackson, 1973).

The statistical tool *t*-test validated the variation in the variables, *e.g*. total length, weight, biomass and total production of ponds by SPSS 16.0.

RESULTS AND DISCUSSION

Asian seabass is euryhaline commercially important fish, and in the current study, it was cultured with carps in fresh water. Quality of pond water and sediments were analyzed during the culture period and it was observed that these were optimum and suitable for fish culture in both the ponds (Table 1). These findings were supported by Singh *et al* (2001) and Monwar *et al* (2013) in polyculture system of Asian sea bass with other fishes.

Table 2. Culture and production of carps and seabass during 2008-09

Components	Control pond*				Experiment pond*				
Area (ha)	0.3				0.3				
Culture duration (days)	245				245				
Fish species	**C. catla**	**L. rohita**	**C. mrigala**	**C. idella**	**C. catla**	**L. rohita**	**C. mrigala**	**C. idella**	**L. calcarifer**
Fish seed stocked (No.)	600.00	600.00	400.00	400.00	600.00	600.00	300.00	400.00	100.00
Fish seed survived (No.)	492.00	534.00	296.00	100.00	462.00	528.00	144.00	76.00	95.00
Fish seed survived* (%)	82.00	89.00	74.00	25.00	77.00	88.00	48.00	19.00	95.00
Mean length* (mm) ± SE	390.55 ± 3.97	421.17 ± 8.42	330.78 ± 2.60	397.11 ± 7.32	486.00 ± 12.65	420.50 ± 7.83	446.89 ± 17.31	485.11 ± 17.45	400.18 ± 3.57
Mean weight* (g) ± SE	950.09 ± 34.59	968.42 ± 51.24	704.33 ± 13.24	870.33 ± 63.98	1813.00 ± 121.25	969.67 ± 54.71	1259.00 ± 98.62	1836.22 ± 188.99	836.91 ± 21.89
Biomass (kg)*	467.44	517.13	208.48	87.03	837.61	511.98	181.30	139.55	79.51
Total biomass (kg)	1280.10				1749.95				
Increment in biomass (%)	36.70								
Yield ($Kgha^{-1}$)	4266.57				5832.58				

*The variations in the variables at 1% level of significance

In the present study, the survival rate for catla (82-84%), rohu (83-89%), mrigal (67-74%) and grass carp (18-25%) was noted in control pond whereas it was for catla (77-86%), for rohu (79-88%), mrigal (48-51%), grass carp (19-20%) and for sea bass (95-89%) in experiment pond during the year 2008-09 and 2009-10 respectively (Table 2 & 3). These results showed that the survival rate of carps was comparatively high in the control pond.

Growth of catla, rohu, mrigal and grass carp in terms of length 390.55± 3.97, 421.17 ± 8.42, 330.78 ± 2.60 and 397.11 ± 7.32 cm and weight was 950.09 ± 34.59, 968.42 ± 51.24, 704.33± 13.24 and 870.33 ± 63.98g for the respective fish in control pond during 2008-09 (Table 2). Whereas, length 388.91 ± 4.88, 426.58 ± 9.79, 351.56 ± 10.14 and 425.11 ± 9.05 cm and weight of 952.73 ± 46.70, 994.75 ± 55.66, 797.56 ± 47.64 and 1116.33 ± 81.74 g were noted in respective fish in control pond during 2009-10 (Table 3). In experiment pond,the length and weight of catla (486.00 ± 12.65 cm and 1813.00 ± 121.25 g), rohu (420.50 ± 7.83 cm and 969.67 ± 54.71), mrigal (446.89 ± 17.31 cm and 1259.00 ± 98.62 g), grass carp (485.11 ± 17.45 cm and 1836.22 ± 188.99 g) and sea bass (400.18 ± 3.57 cm and 836.91 ± 21.89 g) were recorded during the year 2008-09 (Table 2) while during 2009-10, these were observed for catla 487.73 ± 14.03 cm and 1803.00 ± 143.77 g, rohu 431.42 ± 9.40 cm and 996.63 ± 55.94 g, mrigal 435.11 ± 16.46 cm and 1225.89 ± 84.26 g, grass carp 496.89 ± 9.41 cm and 1933.22 ± 99.43 g and seabass 388.91 ± 4.31 cm and 865.00 ± 25.47 g (Table 3).

At the end of crop harvested biomass of individual species was comparatively high in experiment pond. In control pondbiomass was

Table 3. Culture and production of carps and seabass during 2009-10

Components	Control pond						Experiment pond		
Area (ha)	0.3						0.3		
Culture duration (days)	245						245		
Fish species	C.catla	L.rohita	C.mrigala	C.idella	C.catla	L.rohita	C.mrigala	C.idella	L.calcarifer
Fish seed stocked (No.)	600.00	600.00	400.00	400.00	600.00	600.00	300.00	400.00	100.00
Fish seed survived (No.)	504.00	498.00	268.00	72.00	516.00	474.00	153.00	80.00	89.00
Fish seed survived* (%)	84.00	83.00	67.00	18.00	86.00	79.00	51.00	20.00	89.00
Mean length (mm)* ± SE	388.91± 4.88	426.58 ± 9.79	351.56± 10.14	425.11 ± 9.05	487.73± 14.03	431.42± 9.40	435.11 ± 16.46	496.89 ± 9.41	388.91 ± 4.31
Mean weight (g)* ± SE	952.73± 46.70	994.75 ± 55.66	797.56± 47.64	1116.33 ± 81.74	1803.00 ± 143.77	996.63± 55.94	1225.89± 84.26	1933.22 ± 99.43	865.00 ± 25.47
Biomass (kg)*	480.17	495.39	213.74	80.38	930.35	472.40	187.56	154.66	76.99
Total biomass (kg)	1269.68				1821.95				
Increment in biomass (%)	43.50								
Yield (Kgha^{-1})	4231.84				6072.56				

*The variations in the variables at 1% level of significance

noted 467.44, 517.13, 208.48 and 87.03 kg during 2008-09 and 480.17, 495.39, 213.74 and 80.38 kg during 2009-10 for catla, rohu, mrigal and grass carp,respectively whereas, in experiment pond it was 837.61, 511.98, 181.30, 139.55 and 79.51 kg during 2008-09 and 930.35, 472.40, 187.56, 154.66 and 76.99 kg during 2009-10for catla, rohu, mrigal, grass carp and sea bass respectively (Table 2 & 3).In the experiment pond, total fish production was 1749.95 kg, which was 36.70% more than total fish production of 1280.10 kg in the control pond during 2008-09. In comparison, 43.50% increment in total fish production (1821.95 kg) was noted in experiment pond compared to 1269.68 kg total fish production of control pond during 2009-10 (Table 2 , 3).

The statistical tool t-test verified the variations in the variables including fish survival, length, weight, biomass and total fish production. The result depicts that variations in these variables are significantly varied at a 1% level of significance, indicating that significant increment in growth (length and weight), survival and total fish production were observed in simultaneous study years. These results spectacles the positive impact of seabass in carp polyculture system that may be attributed to the consumption of weed fishes (*Oreochromis, Puntius, Ambasis etc.*) by sea bass and ultimately minimized the competition of feed, space and dissolved oxygen for carps in experiment pond.

Singh *et al* (2001) conducted a similar study, and their findings were sounded uneconomical. However, the pond conditions were almost the same, the production1.5-1.8 t/ha and survival of catla (28.8-87%), rohu (7.5-50.7%) and mrigal (70%) was meagre compared to the present study. The stocking of high sea bass and tilapia numbers seems unscientific as the high sea bass numbers might have preyed upon the carp seeds. The high tilapia numbers might have affected the average size of catla 1.2 kg, rohu 1.1 kg and mrigal 0.82 kg at harvest, significantly less compared to the present study. The average weight of harvested sea bass was reported 670g in their research study, which was also low than the present study (837-865 g). ICAR (2010) reported that sea bass attained 450 to 950 g after 270 DOC in tilapia poly farming with sea bass at Kakdwip, India and similar findings were also reported in poly farming of seabass and tilapia by Hossain *et al* (1997) and Monwar *et al* (2013). The higher growth and survival (89-95%) obtained in the present study reveals that the stocking density of seabass (5%) for such polyculture systems are ideal compared to the research conducted by Singh *et al* (2001). Kasim and James (1986), Hossain *et al* (1997) and Monwar *et al* (2013) also suggested undertaking such kinds of research on prospects of seabass culture.

CONCLUSION

Carp seabass polyculture concept is an eco-friendly farming technology in freshwater aquaculture. The novel technology of introducing predatory fish would be a milestone in fish farming. The implications of such research are to bring the vast underutilized aquatic freshwater resources under fish culture. Thus, harnessing a profitable and generating employment opportunities to the small and marginal farmers. It is concluded that the seabass introduction has a positive impact in carp polyculture systems. The stocking of seabass after appropriate size of carps has attained, prevents the predation and chasing, availability of primary food components for the carp fishes, supplementary feeding and consumption of weed fish by seabass minimizing the competition for food, oxygen and space for the growing carp fishes.

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