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Effect of Dedhuwa (*Esomus danricus*), Mara (*Amblypharyngodon mola*) and Pothi (*Puntius sophore*) on Carp Production in Chitwan, Nepal

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Abstract
In order to assess the effect of adding Dedhuwa (*Esomus danricus*), Mara (*Amblyparyngodon mola*) and Pothi (*Puntius sophore*) on Carp production, an experiment was carried out in farmers' pond in Chitwan. The experiment included four treatments in triplicates: T_1, (Carp: Silver carp, *Hypophthalmychthys molitrix,* Bighead carp, *Aristichthys nobilis*, Rohu, *Labeo rohita* and Mrigal, *Cirrhinus mrigala*), T_2 (Carp+Dedhuwa), T_3 (Carp+Mara), and T_4 (Carp+Pothi). Fish were fed on dough of rice bran and mustard oil cake (1:1) at the rate of 3% of body weight. Results showed that Dedhuwa, Mara and Pothi did not differ significantly ($P>0.05$) in terms of production. Production of Silver carp and Bighead carp was found significantly higher ($P<0.05$) in T_3 and T_4 than control indicating no niche overlapping among these fish. Based on total production and profit T_4 appeared to be best.

***Key words*:** Dedhuwa, Pothi, Mara, Carp polyculture

Introduction

Small indigenous fish species (SIS) are highly valuable source of macro and micronutrients that play an important role to provide essential nutrients for the people. Vitamins and minerals are found to be much more in small fish than in large fish such as Carp. Dedhuwa (*Esomus danricus* Hamilton-Buchanan),Mara (*Amblypharyngodon mola* Hamilton-Buchanan) and Pothi (*Puntius sophore* Hamilton-Buchanan) are rich in iron, vitamin-A and calcium, respectively. Dedhuwa contains 12 mg Iron which is three times higher than in Silver carp (*Hypophthamichthys molitrix* Hamilton-Buchanan). Similarly, vitamin-A content in Mara is 2,680 RAE which is 90 times higher than in Silver carp whereas Pothi contains 784 mg calcium in 100 g raw, cleaned parts while Silver carp contains 36 mg calcium (Roos *et al*., 2006). The bones of SIS are very rich in calcium. Likewise, the eyes, head, organs and viscera of some SIS, such as Mola are rich in vitamins and minerals, especially vitamin A, iron and zinc. Since SIS are eaten whole, without loss of nutrients from cleaning or as plate waste, contribution of SIS on micro-nutrients intake is higher than large Carp. These nutrients are found to be highly boiavailable in SIS. Studies in poor, rural households in Bangladesh and Cambodia showed that a small production of the vitamin A-rich fish, Mola in household ponds can meet the annual vitamin A recommendation of 2 million Bangladeshi children and a traditional, daily meal with the iron-rich small fish, trey changwa plieng (*Esomus longimanus* Hamilton-Buchanan) can meet 45% of the daily median iron requirement of Cambodian women (Roos *et al.*, 2007). Moreover, SIS is self recruiting fish and are therefore, can be harvested weekly and biweekly, favouring household consumption.

Preliminary research on polyculture of Carp, SIS such as Dedhuwa and Pothi, and Prawn in Chitwan showed that there is a potential of such polyculture system in terai (Yadav, 2011). Incorporating Dedhuwa and Pothi in Carp ponds indeed increased nutrients intake and income generation among farmers. Therefore, there is a need of studies with other high nutrient containing SIS such as Mara in polyculture. The present experiment is therefore to assess the effect of incorporating Dedhuwa, Mara and Pothi on Carp production in Carp polyculture ponds in Chitwan, Nepal.

Materials and methods

The experiment was conducted at Majhui, Khaireni Village Development Committee-3 of Chitwan district for 270 days. The experiment was conducted in 15 newly constructed ponds of approximately 100 m^2 (75 m^2-133 m^2). The experiment was conducted in completely randomized design (CRD). There were four treatments and each with three replications. Treatments included T_1, Carp only (Silver carp, Bighead carp, Rohu and Mrigal), T_2 (Carp+Dedhuwa), T_3 (Carp+Mara), and T_4 (Carp+Pothi). The stocking density of Carp and SIS were 100 (Silver carp 40, Bighead carp 15, Rohu 25, and Mrigal 20) and 300 per 100 m^2 respectively. The mean stocking size of Silver carp, Bighead carp, Rohu, Mrigal, Dedhuwa, Mara and Pothi were 2.72±0.25 g, 7.15±2.04 g, 34.84±2.11 g, 6.10±0.87 g, 0.99±0.01g, 1.39±0.01 g, and 1.94±0.04 g, respectively. Water fertility was maintained by applying cow dung, urea and Di-Ammonium Phosphate (DAP) regularly at the rate of 0.4 g N/m^2/day and 0.1 g P/m^2/day (Shrestha and Pandit, 2007). Fish were fed on dough of rice bran and mustard oil cake (1:1) at the rate of 3% of body weight.

Composite water samples representing the entire pond water column were taken for analysis. Physical water quality parameters (DO, pH, temperature, transparency and water depth) were measured weekly at 7.00-9.00 am *in situ* where as chemical water quality parameters (total alkalinity, soluble reactive phosphorous, total ammonium nitrogen and chlorophyll- *a*) were analyzed monthly.

At least 20% fishes were netted monthly for sampling. Dedhuwa, Mara and Pothi were regularly harvested after three months of its stocking because these are self recruiting species. Final harvesting of all Carp and SIS was done after complete draining of each pond. During harvest, all fishes were counted and weighed separately to assess survival rate and production.

Experimental data were analyzed by using one-way ANOVA using SPSS, 16.0. Mean differences were compared using the DMRT after ANOVA. Differences were considered significant at an alpha level of 0.05 ($p<0.05$). All means were given with ±1 standard error (S.E.).

Results

Water quality parameters did not vary among treatments ($P>0.05$, Tab. 1).

Final total weight and total weight gain of Silver carp was significantly higher ($P<0.05$, Tabs. 2, 3) in T_3 and T_4 than T_1 but was not significantly different than T_2 ($P>0.05$). Initial mean weight of Bighead carp was significantly higher ($P<0.05$) in T_1

than T_2, T_3 and T_4. Final mean weight of Bighead carp was significantly higher ($P<0.05$) in T_4 than T_2 while it was not significantly different ($P>0.05$) from that of T_1 and T_3. Total weight gain of Bighead carp was significantly higher ($P<0.05$) in T_3 and T_4 than T_1. Final mean weight, survival, daily weight gain and total weight gain of Rohu and Mrigal did not differ significantly ($P>0.05$) among treatments. Total weight gain of Dedhuwa, Mara and Pothi were 2.56, 0.98, 4.04 kg/100 m^2 in T_2, T_3 and T_4, respectively.

Net yield of Carp and combined total net fish yield was significantly higher ($P<0.05$, Tab. 4) in T_4 than T_1 while it was not significantly different ($P>0.05$) from that of T_2 and T_3. Contributions of Carp to total production in T_2, T_3 and T_4 were 89.7, 96.0 and 87.0% while that of SIS was 10.3, 4 and 13%, respectively. Apparent food conversion ratio did not vary significantly ($P<0.05$) among treatments.

Variable costs involved in fish production were not significantly different ($P>0.05$, Tab. 5) among treatments. Total gross return was higher in T_4 (NRs. 6,915±501) and lower in T_1 (NRs. 4,889±336) but was not significantly different ($P>0.05$) from that of T_2 and T_3. Gross margin was higher in T_4 (NRs. 574,130±106,530/ha/yr) than rest treatments.

Discussion

All the water quality parameters were within the suitable range for Carp. Water remained muddy brown instead of green during rainy season due to dike run off as ponds were newly constructed and dikes were uncovered. In addition, canal water used to top the pond was also muddy brown. The non-algal turbidity is caused by suspended clay particles (Boyd, 1990) due to erosion of newly constructed pond dikes, run off from the dike and use of muddy canal water during rainy season.

The production of Dedhuwa, Mara, and Pothi did not differ significantly ($p>0.05$) among treatments. However, their effect on growth and production of Carp was apparent. Total weight gain of Silver carp was significantly higher ($P<0.05$) in T_3 and T_4 than other treatments. This might be due to no niche overlapping with Mara and Pothi. Mara and Pothi are omnivore while Silver carp is a phytoplankton feeder (Wahab and Kadir, 2009). Silver carp is a surface feeder while Pothi is a bottom feeder. So, different feeding habits and habitat reduced interspecific competition between Silver carp and both SIS. Despite larger stocking size ($P<0.05$) in T_1, final total weight gain of Bighead carp was found significantly higher ($P<0.05$) in T_3 and T_4 than T_2 indicating that Mara and Pothi had positive effect on its growth and production. Perhaps no food competition occurred between Bighead carp and Mara and Pothi because both Mara and Pothi are omnivore (Wahab and Kadir, 2009). Growth rates of Silver carp, Bighead carp, Rohu and Mrigal was not significantly different ($p>0.05$) among treatments indicating SIS independent growth. The growth rate was found highest in Rohu (1.21±0.12 g/f/d) followed by Mrigal (1.17±0.16 g/f/d), Silver carp (1.09±0.08 g/f/d) and Bighead carp (0.87±0.27 g/f/d).

Net Carp yield and total net fish yield was significantly higher ($P<0.05$) in T_4 than T_1, which can be attributed to positive effect of Pothi on Carp leading to better growth and production of Carp in the treatment. The net Carp yield in the present experiment was higher than as reported by Miah *et al.*

Table 1. Summary of water quality parameters in different treatments during experimental period (Mean±S.E.)

Parameters	Treatment			
	T_1	T_2	T_3	T_4
Temperature (°C)	28.9±0.2 (23.8-31.1)	28.8±0.5 (22.8-31.7)	28.9±0.4 (23.5-32.4)	29.2±0.1 (24.0-32.2)
Dissolved Oxygen (mg/L)	6.7±0.4 (3.5-9.3)	6.1±0.7 (3.9-8.0)	6.1±0.7 (3.0-8.4)	7.0±0.1 (4.4-9.3)
pH	8.2±0.0 (7.9-8.9)	8.2±0.2 (7.9-8.8)	8.2±0.2 (7.8-8.9)	8.2±0.2 (7.7-8.7)
Secchi disk depth (cm)	27.1±1.7 (19.2-33.0)	24.1±1.4 (20.7-26.7	28.6±0.7 (22.3-29)	26.6±0.4 (19.3-26.3)
Total alkalinity (mg/L Ca CO_3)	104.8±5.3 (89.9-156.0)	106.4±2.7 (86.4-125.6)	107.7±5.6 (90.3-121.4)	112.7±4.8 (88.9-121.9)
Chlorophyll-*a* (mg/m^3)	17.8±.3 (7.3-26.97)	15.12±3.21 (7.1-28.9)	18.48±1.82 (7.6-31.9)	18.8±1.87 (6.7-29.3)
Total ammonium nitrogen (mg/L)	0.040±0.002 (0.006-0.072)	0.041±0.002 (0.019-0.075)	0.048±0.003 (0.024-0.079)	0.042±0.025 (0.029-0.067)
Soluble reactive phosphorus (mg/L)	0.024±0.005 (0.013-0.034)	0.025±0.007 (0.001-0.053)	0.027±0.006 (0.015-0.084)	0.028±0.004 (0.009-0.093)

Mean values with different superscript letters in the same row are significantly different ($P<0.05$).

Table 2. Growth performance of Carp in different treatments (Mean±S.E.).

Parameters	Treatments			
	T_1	T_2	T_3	T_4
Silver carp				
Initial mean weight (g/fish)	3.46±1.33	2.70±0.08	2.52±0.05	2.60±0.01
Initial total weight (kg/100 m^2)	0.14±0.05	0.10±0.00	0.10±0.00	0.10±0.00
Final mean weight (g/fish)	296.35±6.05	266.89 ±14.06	311.14 ±4.46	309.09±16.60
Final total weight (kg/100 m^2)	7.78±0.94^{b}	9.15±0.03^{ab}	11.15±0.28^{a}	11.28± 0.82^{a}
Survival (%)	65.6±8.6	91.2±1.9	85.7±3.9	89.6±2.5
Daily weight gain (g/f/d)	1.08±0.02	0.97±0.04	1.14±0.01	1.13±0.06
Total weight gain (kg/100 m^2)	7.64±0.90^{b}	9.05±0.03^{ab}	11.05±0.28^{a}	11.18 ±.826^{a}
Bighead carp				
Initial mean weight (g/fish)	20.51±10.10^{a}	3.43±0.44^{b}	3.13±0.34^{b}	3.99±0.33^{b}
Initial total weight (kg/100 m^2)	0.52±0.25	0.08±0.01	0.07±0.01	0.09±0.01
Final mean weight (g/fish)	283.86±15.02^{ab}	189.20±22.34^{b}	289.00±14.37^{ab}	326.60±67.62^{a}
Final total weight (kg/100 m^2)	3.13 ±0.11^{ab}	2.41±0.27^{b}	3.93±0.26^{a}	4.33±0.53^{a}
Survival (%)	73.5±3.7	88.4±8.6	84.9±8.6	90.6±2.3
Daily weight gain (g/f/d)	0.81±0.07	0.68±0.08	1.06±0.05	1.19±0.24
Total weight gain (kg/100 m^2)	2.60±0.25^{b}	2.32±0.27^{b}	3.86±0.26^{a}	4.24±0.53^{a}
Rohu				
Initial mean weight (g/fish)	27.56±2.78	36.48±2.42	28.50±3.77	41.26±5.50
Initial total weight (kg/100 m^2)	0.42±0.03	0.56±0.02	0.42±0.05	0.62±0.08
Final mean weight (g/fish)	427.73±45.73	347.65±28.74	361.42±48.79	371.39±8.03
Final total weight (kg/100 m^2)	8.27±0.14	7.78±0.79	7.11±0.78	8.16±0.52
Survival (%)	77.3±15.7	92.4±0.1	87.9±3.4	78.7±8.9
Daily weight gain (g/f/d)	1.47±0.16	1.15 ± 0.09	1.23 ± 0.16	1.22±0.02
Total weight gain (kg/100 m^2)	7.84± 0.14	7.32±0.76	6.69±0.75	7.54±0.44
Mrigal				
Initial mean weight (g/fish)	8.08±0.48	7.51±3.81	4.29±0.87	6.57±2.30

Contd....

Table 2-Contd....

Initial total weight (kg/100 m^2)	0.17±0.00	0.15±0.07	0.08±0.00	0.13±0.05
Final mean weight (g/fish)	278.92±45.73	340.71±36.52	352.13±74.96	437.36±49.19
Final total weight (kg/100 m^2)	5.26 ±0. 75	6.47±0.52	6.39±1.44	7.78±1.30
Survival (%)	94.3±2.7	88.9±4.1	95.0±3.3	90.7±4.8
Daily weight gain (g/f/d)	1.00 ± 0.11	1.23 ± 0.14	1.29 ± 0.27	1.59±0.17
Total weight gain (kg/100 m^2)	5.09±0.75	6.33 ±0.60	6.30±1.54	7.66 ±1.27

Mean values with different superscript letters in the same row are significantly different (P<0.05).

Table 3. Growth performance of Dedhuwa, Mara and Pothi in different treatments (Mean±S.E.).

Parameters	Treatments			
	T_1	T_2	T_3	T_4
Dedhuwa				
Initial mean weight (g/fish)	-	0.98±0.00	-	-
Initial total weight (kg/100 m^2)	-	0.43±0.00	-	-
Final total weight (kg/100 m^2)	-	2.98±1.78	-	-
Total wt. gain (kg/100 m^2)	-	2.56±1.80	-	-
Mara				
Initial mean weight (g/fish)	-	-	1.39±0.00	-
Initial total weight (kg/100 m^2)	-	-	0.29±0.00	-
Final total weight (kg/100 m^2)	-	-	1.27±0.13	-
Total wt. gain (kg/100 $m^{2)}$	-	-	0.98±011	-
Pothi				
Initial mean weight (g/fish)	-	-	-	1.94±0.36
Initial total weight (kg/100 m^2)	-	-	-	0.58±0.01
Final total weight (kg/100 m^2)	-	-	-	4.62±0.91
Total wt. gain (kg/100 m^2)	-	-	-	4.04±0.92

Mean values with different superscript letters in the same row are significantly different (P<0.05).

Table 4. Extrapolated net yield of Carp, SIS and combined total net fish yield (t/ha/yr) and AFCR (Mean±S.E.)

Parameters	Treatments			
	T_1	T_2	T_3	T_4
Carp (t/ha/yr)	3.13±0.20^b	3.38±0.21^{ab}	3.77±0.29^{ab}	4.14±0.29^a
Dedhuwa (t/ha/yr)	-	0.39±0.27	-	-
Mara (t/ha/yr)	-	-	0.15±0.11	-
Pothi (t/ha/yr)	-	-	-	0.61±0.14
Total (t/ha/yr)	3.13±0.20^b	3.77±0.51^{ab}	3.92±0.31^{ab}	4.75±0.38^a
AFCR	3.2±0.11	2.6±0.38	2.6±0.02	2.5±0.04

Mean values with different superscript letters in the same row are significantly different (P<0.05).

Table 5. Economic analysis of different treatments based on 100 m^2 pond in Nepalese currency (NRs) during experimental period

Variables	Treatments			
	T_1	T_2	T_3	T_4
Gross Return				
Carp	4,889±336^b	5,186 ±308^{ab}	5,720±444^{ab}	6,314±454^a
Dedhuwa	-	387± 232	-	-
Mara	-	-	165.79± 31.37	-
Pothi	-	-	-	601 ±118
Total Gross Return	4,889±336^b	5,573±679^{ab}	5,885±463^{ab}	6,915±501^a

Contd....

Table 5-Contd....

Variable Cost				
Lime	50	50	50	50
Feed	1,402±145	1,269±309	1,472±269	1,657± 252
Urea	531	531	531	531
DAP	180	180	180	180
Carp fingerlings	100	100	100	100
SIS	-	150	150	150
Total Variable Cost	2,263±145	2,280±309	2,483±269	2,668±252
Gross Margin (100 m^2)	2,626±199[b]	3,293 ±387[b]	3,402 ±196[b]	4,247 ±283[a]
Gross Margin (in'000) (NRs/h/yr)	354.24 ±52.12[b]	445.25 ±214.90[b]	459.90 ±113.09[b]	574.13 ±106.53[a]

Mean values with different superscript letters in the same row are significantly different ($P<0.05$).

(1992), Shahabuddin *et al.* (1994), Mazid *et al.* (1997), Abbas *et al*. (2010), Rehman *et al.* (2006) and Yadav (2011) from Carp polyculture system. The net Carp yield in the present experiment was lower than those reported by Wahab *et al.* (1995) of 2,225 kg/ha in 120 days (equivalent to 6,767kg/ha/yr), Jena *et al*. (2002) of 5,843.75 kg/ha and Lakshmanan *et al*. (1971) of 2,229 to 4,209 kg/ha/yr.

The overall result showed that SIS did not have adverse effect on growth and production of Carp. Production of Carp was better in SIS added ponds. Adding SIS in appropriate density enhanced Carp production. Production of Carp was higher in SIS treatments. This can be attributed to partial harvesting system of SIS which regular thinned the population of SIS and maintained appropriate density in ponds. Moreover, SIS might be compatible to Carp as reported by Wahab *et al.* (2003), Alim *et al.* (2005), Kadir *et al.* (2006) and Yadav (2011). Though all treatments were profitable but gross margin was highest in Pothi added treatment due to higher total production. Based on production and profit, Carp-Pothi polyculture treatment appears to be best among the treatments. Since adding SIS to Carp polyculture ponds increased the Carp production and profit, there is a need of such studies with other nutrient rich SIS so that more rural poor will be benefited.

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