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Efficacy of Mixture of Cattle Urine and Dung as a Fertilizer on the Growth and Survival of Carps

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Abstract

An on-farm experiment was conducted in 0.15 ha earthen ponds for a period of nine months from August 2014 to April 2015 to evaluate the efficacy of mixture of cattle urine and dung as a source of nutrients for plankton production in the polyculture of Indian and exotic carps. The ponds were stocked @ 6000 ha^{-1} with catla, rohu, mrigal, grass carp and common craps in the ratio of 4:2:1:1:2 respectively. Mixture of 30 liter of cattle urine and 6 kg of dung was provided daily to treatment pond. The control pond was not fertilised with any manure but the fishes were provided with a mixture (1:1) of rice bran and groundnut oil cake @ 3% of body weight. The treatment pond received no supplementary feed. The growth trial conducted in 2014-15 was repeated in 2015-16. The production obtained in treatment pond was 5198 kg and 5468 kg ha^{-1} yr^{-1} for the two consecutive years against 3257 kg and 3485 kg ha^{-1} yr^{-1} in control pond. The total input value of NPK provided into the treatment pond through the mixture of cattle urine and dung during the culture period was estimated to be 83.43, 10.70 and 68.52 kg respectively.

Keywords: Polyculture; Livestock; Creatinine; Cattle urine; Agricultural

Introduction

Manuring and supplementary feeding play vital role in various types of fish farming practices. The feed and fertilizer cost constitutes about 40-60% of total operational cost and this could be reduced considerably by integrating fish farming with livestock farming which ultimately reduces the cost of production. Integrated fish farming with livestock involves two production technologies to function together on parallel footing. This helps in enhancing the resource utilization and reduced investment through diversification of crops. The system has been successfully demonstrated in China, Malaysia, Thailand and several other countries. Attempts have been made in the recent past in India to combine small livestock raising with fish culture and standardize the number of animals required per unit of water area so as to effect adequate manuring for obtaining substantial fish yields without using inorganic fertilizers and supplementary feeding [1-4]. The results of such integration have been indeed very encouraging. The cattle and buffalo population in India is estimated to be around 299.6 million (19th Livestock Census, 2012, Ministry of Agriculture, Govt. of India). The annual production of wet dung and urine from cattle and buffalo works out to 1228 and 800 MT respectively [5]. A good proportion of wet dung and urine are utilized for manurial purpose. Literature on the use of cattle urine along with dung as a fertilizer in carp culture is scanty. The present study was conducted to evaluate the growth rate, survival and gross production of different carp species used in poly culture.

Material and Methods

The present study was conducted in two earthen ponds (0.15 ha each) at Zonal Agricultural Research Station, University of Agricultural and Horticultural Sciences, Navile, Shivamogga, Karnataka for a period of 9 months from August 2014 to April 2015. A cattle shed was established near the pond embankment to maintain the dairy of the Station. Necessary drainage from cattle shed to fish pond was provided for smooth flow of cattle shed waste. Initially the ponds were cleaned, dried and limed at 400 kg ha^{-1}. Water form an adjacent perennial canal was pumped into ponds and water level was maintained between 1.5 and 1.6 m.

Fingerlings of catla, rohu, mrigal, grass carp and common carp were stocked in the ponds at a stocking density of 6000 ha^{-1} in the ratio of 4:2:1:1:2 respectively. No extra fertilization and supplementary feeding was done for treatment ponds throughout the culture period. Urine excreted by 10 Holstein Friesian (HF) cows was collected and mixed with 6 kg of dung in the collection pits by stirring with sticks and was discharged directly into the treatment pond every morning. The control pond received only supplementary feed consisting of mixture of groundnut oil cake and rice bran (at 1:1 ratio) at the rate of 3% of body weight of fish. Monthly sampling was done to assess the growth rate of fish in the control pond and feeding quantity was adjusted. Selected physico-chemical parameters of water from the experimental ponds were analyzed at monthly intervals by following standard procedures [6]. The weight of plankton was determined every month by filtering 100 liters of water from each pond through a plankton net of 15 size and drying the filtrate in a hot-air oven at 80°C, till a constant weight was obtained. Concentration of major nutrients in the urine and cow dung was estimated as per the recommendation of Satpathy and Radheshyam [7]. Nitrogen was estimated by alkaline potassium permanganate method [8] whereas the phosphorous was estimated by chlorostannous reduced molybdophosphoric acid blue colour method [9]. Potassium was estimated using flame photometric method [9]. Harvesting of fishes was done after 9 months of culture, growth and survival recorded. The experiment was repeated from August 2015 to April 2016.

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Results and Discussion

The physico-chemical parameters of water recorded in the treatment and control ponds, respectively, were in the following range. Water temperature 24.80-31.40 °C and 24.80-30.60 °C; pH 6.91-8.39 and 6.16-7.65; dissolved oxygen (DO) 4.42-6.39 $mg1^{-1}$ and 3.58-6.25 $mg1^{-1}$; free carbon dioxide 0-1.80 $mg1^{-1}$ and traces; total alkalinity 41.60-102 $mg1^{-1}$ and 35-59 $mg1^{-1}$ and Secchi disc visibility 33-46 cm and 53-63 cm (Table 1). Generally, cyprinids are capable of tolerating low oxygen levels of 3 mg l^{-1}. The DO values recorded in the present study in both the ponds were above this level, indicating the ideal condition for the carp culture. According to Dennis Rouse [10], Secchi visibility in the range between 30-60 cm is generally adequate for good fish production and value above 60 cm encourages saprophyte growth and less plankton. The lower Secchi disc visibility (33-46 cm) in Treatment pond compared to that in Control pond (53-63 cm) is attributable to the presence of higher planktonic biomass in the former due to higher nutrient availability. Rouse D [10] further opined that when Secchi disc visibility decreases below 30 cm, there will be an increase in the frequency of dissolved oxygen problem. The values recorded in the present study indicate good growth of plankton production in the treatment ponds. The values recorded for Control pond is attributable to the manuring effect of unconsumed food and fish faecal matter. The total alkalinity values generally were higher in the Treatment ponds (41.60-102 mgl^{-1}) compared to Control ponds (35-59 mgl^{-1}). A productive pond is expected to have a total alkalinity range of 75-100 ppm. Total alkalinity increases due to organic fertilization and application of feeds to ponds [11]. This is due to bacterially generated CO_2 from manure decomposition dissolving calcium and magnesium carbonate in pond water into calcium and magnesium bicarbonate. Corresponding with higher alkalinity, Treatment pond recorded higher pH (6.91-8.39) compared to Control pond (6.16-7.65). The higher values obtained in the treatment ponds indicates its conduciveness for fish production. Ponds treated with manure mixture showed some carbon dioxide concentrations (0-1.80 mgl^{-1}), attributable to the organic load. Dissolved oxygen was generally higher in treatment ponds compared to Control ponds. This can be attributed to the higher level of plankton recorded in the treatment ponds which produce oxygen in the day time.

Both the wet and dry weight of plankton was higher in treatment ponds compared to control ponds as recorded on both the years (Table 2). The relationship between provision of manure/feed and plankton biomass observed in the present study can be related to the nutrient input. Rahman MM et al. [12] reported that plankton availability was positively correlated with bio-available nitrogen and phosphorus. Edmondson [13] reported that the production of rotifers, which are the preferred food for fish, is related to the production density of edible phytoplankton. Further he opined that the nitrogen level was high in cattle liquid manured ponds followed by cow dung manured ponds and the exchangeable cation Ca was high in cattle liquid manure. Francis et al. [14] studied rotifer diversity in fish ponds manured with different domestic animal waste and found highest plankton diversity in cattle liquid manure fertilized pond. Fertilizing the ponds with fresh, soft animal excreta which has higher carbon component increased the photosynthetic activity [15]. Newell [16] and Schroeder [17] opined that detritus provided on the livestock excreta at the pond bottom, would have functioned as substrate for micro-organisms as well as food for zooplankton.

Fish production obtained in the treatment ponds were 3,898.60 kg and 4,101.26 kg compared to 2,443.27 and 2,641.13 kg ha^{-1} 9 $months^{-1}$ in control ponds in two consecutive years respectively (Table 3). Based on the data obtained from the present study, it is estimated that 10 cows are adequate to supply major nutrients for culture ponds. The

Year	Parameter	Ponds	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April	May
2014-15	Temperature	T	26.9	25.6	25.8	24.8	26	27.8	29.2	29.2	30.6	31.4
		C	26.9	25.6	25.8	25	26.2	28	29	29.2	29.8	30.6
	pH	T	7.22	6.95	6.91	7.12	7.41	7.23	7.09	7.23	7.45	7.18
		C	6.16	7.14	6.63	7.31	7.28	7.39	7.1	6.95	7.35	7.31
	DO (mg 1^{-1})	T	5.66	4.42	5.83	5.56	6.13	6.03	5.08	5.15	6.21	6.26
		C	5.93	3.58	4.51	3.81	4.3	6.04	5.13	4.92	4.85	4.52
	Free carbon dioxide (mg 1^{-1})	T	Tr	1.37	0.65	0.12	0.73	1.59	0.26	Tr	0.8	1.03
		C	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr
	Total alkalinity	T	48	64	59	60	73	68	88	65	83	98
	(mg 1^{-1})	C	35	53	44	49	55	45	52	46	52	50
	Secchi disc visibility (cm)	T	46	36	44	40	37	42	39	30	34	33
		C	60	60	56	58	60	53	58	60	62	64
2015-16	Temperature	T	25.8	25.2	25.2	24.8	25.2	24.8	29	29.6	29.8	30.2
		C	25.8	25	25.2	24.8	25.5	24.5	29.4	29.5	30	30.1
	pH	T	7.39	7.9	7.18	7.3	7.42	7.41	7.82	8.39	7.63	7.48
		C	7.65	7.38	7.43	6.92	7.39	7.25	7.41	7.28	7.02	7.14
	DO (mg 1^{-1})	T	6.26	5.18	6.32	5.8	5.65	6.34	6.08	6.39	5.97	6.33
		C	5.95	5.2	6.18	5.9	4.92	4.45	5.95	6.25	5.83	6.08
	Free carbon dioxide (mg 1^{-1})	T	Tr	Tr	1.45	1.8	0.62	0.8	0.85	0.93	1.06	1.27
		C	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr
	Total alkalinity (mg 1^{-1})	T	41.6	46	70	61	55	69	80	74	86	102
		C	40	48	42	59	46	42	54	49	41	53
	Secchi disc visibility (cm)	T	42	40	33	41	38	35	36	38	35	45
		C	62	59	58	61	60	59	57	60	63	61

T - Treatment pond; C - Control pond; Tr– Traces

Table 1: Water quality parameters in the experimental ponds.

Year	Particulars	January	February	March	April	May	June	July	August	September	October	November	December
2014-15	**Wet weight (mg)**												
	Treatment	119.3 ± 2.0	275.2	290	184.5	144 ± 6 4.8	170.9	131.7± 1.2	125	220	185.6 ± 3.2	168	98.6
			3	15.5	4.1		5.1		2.7	5.3		1.4	1.2
	Control	54.6	93	84.3	75	41	76.2	47.1	45.7	44.8	30.1	22.4	18.3
		2.4	1.8	3.1	1.3	2	3	0.6	0.5	0.12	0.5	0.4	0.2
	Dry weight (mg)												
	Treatment	25.7	24.4 ± 0.07	40.8	35.2 ± 0.19	45.2	43.5 ± 0.08	44.8	16.8	29.2	41.5 ± 0.43	39.2	43.7
		0.04		0.75		0.31		0.9	0.42	0.53		0.4	0.72
	Control	5.2	7.1	8.7	7.9 ± 1.23	6.20.18	5.4	7.8	3.2	9.6	7.1	5.8	6.3
		0.14	0.18	1.42			0.22	0.52	0.13	1.21	0.82	0.18	0.22
2015-16	**Wet weight (mg)**												
	Treatment	230	295	270	310	230 ± 2.71	205	156	140	270	220	189	105
		1.8	6.2	10.1	2.2		4.3	2.6	3.6	4.1	3.9	1.8	2.7
	Control	50	84	88.3	71	52	70	55	38.6	52.1	40.6	32.3	26.4
		1.3	2.6	4.1	1.9	1.7	3.1	1.8	1.9	0.18	3.2	0.8	1.1
	Dry weight (mg)												
	Treatment	26.2	29.3	44.6	31.8	28.4 ± 0.23	24.9	38.5	32.16	27.8	31.4	22.7	28.6
		0.03	0.05	0.9	0.3		1.82	0.35	0.5	0.25	1.06	2.2	0.36
	Control	4.6	6.8	5.6	8.1	6.5	7.9	5.3	3.8	7.3	8	6.8	5.8
		0.12	0.23	0.08	1.05	0.23	1.05	0.22	0.18	0.18	0.16	0.09	0.06

Table 2: Variation in wet and dry weight of plankton (per 100 litres of water) in the experimental ponds.

Year	Particulars	Ponds	Catla 4	Rohu 2	Mrigal 1	Grass carp 1	Common carp 2	
2014-15	Number stocked	T	360	180	90	90	180	**Production** Treatment: 584.79 kg 0.15 ha-1 Control : 366.49kg 0.15ha-1 **Gross Production** Treatment: 3898.6 kg ha-1 9 months-1 Control: 2443.27 kg ha-1 9 months-1
		C	360	180	90	90	180	
	Number harvested	T	308	145	76	72	168	
		C	296	150	78	70	159	
	Survival (%)	T	85.56	80.55	84.44	80	93.3	
		C	82.22	83.33	86.67	77.78	88.33	
	Initial av. weight (g)	T	3.05	3.17	2.95	2.83	3.14	
		C	2.98	3.21	3.01	3.03	3.14	
	Final av. Weight (g)	T	913	625	710	750	625	
		C	575	450	370	485	415	
	Total weight of fish harvested (kg)	T	281.2	90.63	53.96	54	105	
		C	170.2	67.5	28.86	33.95	65.98	
2015-16	Number stocked	T	360	180	90	90	180	**Production** Treatment: 615.19 kg 0.15 ha-1 Control: 396.17 kg 0.15ha-1 **Gross Production** Treatment : 4101.26 kg ha-1 9 months-1 Control : 2641.13 kg ha-1 9 months-1
		C	360	180	90	90	180	
	Number harvested	T	312	154	78	76	162	
		C	295	158	76	79	160	
	Survival (%)	T	86.67	85.5	86.67	84.44	90	
		C	81.94	87.78	84.44	87.78	88.89	
	Initial av. weight (g)	T	2.94	3.15	2.63	2.86	3.19	
		C	3.01	3.06	2.87	2.97	3.1	
	Final av. Weight (g)	T	980	600	630	685	715	
		C	600	475	345	500	490	
	Total weight of fish harvested (kg)	T	305.76	92.4	49.14	52.06	115.83	
		C	117	75.05	26.22	39.5	78.4	

T: Treatment pond; C: Control pond

Table 3: Details of stocking and harvesting of different species in the experimental ponds.

total major nutrient input for treatment ponds was estimated to be 83.43 kg nitrogen, 10.70 kg phosphorus and 68.52 kg potassium. The composition of urine, however, depends on the type of animal, age, condition of animal, nature of food eaten etc. Jena et al. [18] obtained a gross production of 2741 kg 11 months^{-1} by stocking of Indian and Exotic carps at 6000 Nos. ha^{-1} with supplementary feeding. Gupta recorded 2.58 t ha^{-1} yr^{-1} using cattle manure alone while providing no supplementary feeding. The experiment conducted by Santhakumar [11] and Athithan et al. [19] registered production as high as 5.94 t ha^{-1} yr^{-1} and 5.96 t ha^{-1} yr^{-1} respectively, using cattle urine alone at stocking density of 7500 nos. ha^{-1}. In the present study, the productions achieved in treatment pond were 584. 79 kg and 615.19 kg whereas that in the control ponds were only 366.49 kg and 396.17 kg 0.15 ha^{-1} 9 months^{-1} for two consecutive years. The average production worked out to be 3999.93 kg and 2542.2 kg ha^{-1} 9 months^{-1} in the treatment and control ponds, respectively. The solid and liquid excrements differ much in composition, for, while the former contain principally phosphoric acid, lime, magnesia, and silica and comparatively little nitrogen, the urine contains alkaline salts (including salts of potash) and nitrogenous organic matters. The farm yard manure contains phyto-hormones of plant growth regulators namely creatinine and indole acetic acid [20], which could have augmented plankton population in the present treatment pond and resulted in higher production. Sabir et al. [21] opined that cow dung and urine together seems to be good for plankton production as it is readily available and is not lost through leaching and volatilization.

The study indicates that when cattle are reared in the farm in close proximity with aquaculture ponds, it is easy and inexpensive to utilize their waste materials for fertilizing the ponds. The cattle urine, mixtures of cattle shed washings and manures can be disposed at hand resulting in saving energy, labour and money. As water will be no longer available for aquaculture in an unlimited manner, such efforts on water budgeting will ensure higher water productivity through integrated fish culture.

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