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Note

Nursery rearing of rohu *Labeo rohita* (Hamilton, 1822) using water lettuce (*Pistia stratiotes*) compost

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ABSTRACT

Efficacy of water lettuce (*Pistia stratiotes*) compost in pond fertilisation and nursery rearing of the Indian major carp, *Labeo rohita* (Hamilton, 1822) was assessed at doses of 0.5, 1.0 and 1.5 kg m^{-3} with an aim of eco-friendly management of this weed. Half of the compost prepared by anaerobic digestion was applied 7 days before stocking the spawn of rohu and the rest half was applied after 15 days of stocking. The stocking density of spawn was 100 nos. m^{-3} and duration of the study was 30 days. No feed was supplemented during the entire nursery rearing period. The basic water and soil quality parameters of the ponds were analysed on 0, 15 and 30th day of stocking which showed a slight increase in pH, total alkalinity and ammonia ($p \leq 0.05$) and a decrease in dissolved oxygen of water with increase in compost doses. Plankton density was highest when compost application was @ 1.0 kg m^{-3} and it was lowest when compost application was @ 1.5 kg m^{-3}. Soil pH ($p \geq 0.05$), organic carbon, available nitrogen and phosphorus ($p \leq 0.05$) were increased with increase in compost doses. The growth and survival of fish, fish production and profit were highest ($p \leq 0.05$) when the compost was applied at a dose of 1 kg m^{-3}. From the results of the study, it is concluded that water lettuce can be used as a compost for pond fertilisation and rohu seed production.

Keywords: Compost, Fish growth and survival, Indian major carp, Nursery rearing, Plankton density, Pond fertilisation

Pistia stratiotes, popularly known as 'water lettuce', or 'water cabbage' and locally known as '*Jalkumbhi*' is a problematic aquatic weed (Holm *et al*., 1977) in almost all types of freshwater bodies of tropical and temperate regions (Sushilkumar, 2011). A good number of reports are available on eco-friendly management of this weed by converting it into high-quality organic manure for soil amendment for agriculture (Singh, 1962), feeding livestock as fodder, preparation of green manure and extraction of bio-active compounds for medicinal purpose. So far there is no report on its efficacy as a manure in pond fertilisation. *P. stratiotes* can be used for the preparation of high-quality compost for pond fertilisation. Water hyacinth (*Eichhornia crassipes*), a problematic weed of similar type, was successfully converted into high-quality manure for nursery pond fertilisation by Sahu *et al.* (2002). Another benefit of the use of this type of compost is that, it supplies microbial protein-rich small fractions of the plants which can directly or indirectly form the food of small fishes (Ansa and Jiya, 2002). The problem due to floating weeds like *P. stratiotes* and the investment in feed and fertilisers are the two common issues that co-exist in Indian aquaculture. In this regard, *P. stratiotes* can be converted into high-quality manure to reduce the dependency of feed and fertilisers in aquaculture (Boyd, 1974; Swift, 1993) at least for nursery rearing. This will also help in the eco-friendly management of problems caused by aquatic weeds (Kang'ombe *et al*., 2006). Keeping this in consideration, the present study was undertaken to evaluate the efficacy of water lettuce compost in the nursery rearing of rohu *Labeo rohita* (Hamilton, 1822).

The study was carried out in the fish ponds of ICAR Research Complex for NEH Region, Tripura. Nine ponds of almost uniform shape, size (300 m^2), depth (1.0 m) and basin conformation were used for the trial. For preparation of compost, *P. stratiotes* plants were collected from ICAR farm and sun dried for three days. The dry matter content in the plant was estimated as 6.3%. Then the plants were turned into compost following anaerobic digestion technique (Sahu *et al*., 2002). The nitrogen content of the compost was estimated to be 1.5%, phosphorus 1.2%, potassium 2.6%, calcium 2.4%, organic carbon 22.5%, magnesium 0.5%, copper 0.05%, zinc 0.02%, iron 0.07% and manganese 0.15%. The C/N value calculated was 15.4 and pH 7.5. The doses of compost tested were 0.5 kg m^{-3} (T1), 1.0 kg m^{-3} (T2) and 1.5 kg m^{-3} (T3).

The ponds were prepared by following the same methodology described by Debnath *et al.* (2015). Liming was done @ 25 g m^{-3}. Half of the compost was applied 7 days before the stocking and the rest after 15 days of stocking. The stocking density of fish spawn (0.5 cm and 0.02 g) was 100 nos. m^{-3}. No supplementary feeding was done throughout the experimental period of 30 days. Water and soil quality parameters of the ponds were analysed on 0, 15 and 30 day post-fertilisation (dpf). Water temperature (°C) was measured using a digital thermometer, dissolved oxygen (ppm) by the Winkler's method, pH by a digital pH meter, total alkalinity, ammonia and phosphate by a portable photometer (Spectroquant Nova 60, Merck). Soil samples were analysed for pH, available nitrogen (N), available phosphorous (P) and organic carbon (OC) following the methods described by Debnath *et al*. (2015). Plankton populations were determined from each pond by filtering water (50 l each) through phytoplankton and zooplankton nets. At the end of 30 day trial, the fry were harvested and their growth attributes were measured by random sampling (Chakraborty *et al*., 2010). Data were analysed statistically using SPSS 21.0 (IBM Corp., Newyork) software and the results were expressed as mean±S.D. The level of significance was drawn at 5% ($p \leq 0.05$). Economic feasibility was assessed by a simple cost-benefit analysis.

Results of the experiment proved that the compost made from *P. stratiotes* was effective for pond fertilisation and fry production of *L. rohita*. Though the plant was less in dry matter content (6.3%), it was useful in production of high-quality compost as reported by Little (1979).

The water quality parameters were improved with the increase in dose of compost (Table 1). Water temperature showed slight variations among the treatments; however, it remained within the acceptable range for fish rearing (Boyd, 1990). The pH increased ($p \geq 0.05$) with increase of dose of compost. The dissolved oxygen level was highest in T1 and lowest in T3. Phosphate, total alkalinity and ammonia levels increased ($p \leq 0.05$) with increase of dose of compost.

The plankton level increased from T1 to T2 with the increase in dose of compost except with T3 where plankton level was reduced. This could be due to the reduction in dissolved oxygen level and increase in ammonia level with the increased dose of organic fertiliser (Debnath *et al*., 2015). Initially plankton production was good with T1, but from 15 dpf it could not sustain the production (Fig. 1) which could be due to the insufficiency of nutrients from the lower dose compost application than the optimum. Plankton groups recorded were found same for all the treatments; phytoplankton represented 5 groups (Chlorophyceae, Cyanophyceae, Bacillariophyceae, Euglenophyceae, Dinophyceae) and 28 genera (*Carteria, Physocystium, Oscillatoria, Spirulina*, *Arthrospira, Pleudorina, Phacotus, Platymonas, Chlamydomonas, Chlorogonium, Pyramimonas, Gonium, Cyclotella, Surirella, Melosira, Pandorina, Eudorina, Volvox, Dysmorphococcus*, *Trachelomonas, Peridinum, Microcystis, Anabaena, Raphidiopsis*, *Synura, Dinobryon*, *Euglena* and *Ceratium*) and zooplankton represented 2 groups (Crustacea, Rotifera) and 12 genera (*Cyclops*, *Moina*, *Daphnia*, *Bosmina*, *Mesocyclops*, *Ceriodaphnia, Brachionus*, *Asplanchna*, *Polyarthra, Dipahanosoma, Diaptomus* and *Keratella*). This could be due to blending effect of diverse groups of nutrients produced from the compost application (Sahu *et al.*, 2002). Phytoplankton dominated over zooplankton

Table 1. Water quality parameters of the ponds treated with compost made from *P. stratiotes*

Parameters	Day-post fertilisation (dpf)	T1 (Compost 0.5 kg m^{-3})	T2 (Compost 1.0 kg m^{-3})	T3 (Compost 1.5 kg m^{-3})
Temperature (°C)	0	27.6±0.1[a]	27.6±0.1[a]	27.6±0.1[a]
	15	27.6±0.1[a]	27.5±0.1[a]	27.5±0.1[a]
	30	27.6±0.1[a]	27.5±0.1[a]	27.6±0.1[a]
pH	0	7.2±0.1[a]	7.3±0.1[a]	7.4±0.1[a]
	15	7.3±0.1[a]	7.4±0.1[a]	7.4±0.1[a]
	30	7.3±0.1[a]	7.4±0.1[a]	7.5±0.1[a]
Dissolved oxygen (ppm)	0	5.8±0.1[a]	5.2±0.1[b]	4.1±0.2[c]
	15	5.7±0.1[a]	5.1±0.1[b]	4.2±0.1[c]
	30	5.6±0.1[a]	5.0±0.1[b]	4.1±0.1[c]
Phosphate (ppm)	0	0.04±0.01[a]	0.08±0.01[b]	0.11±0.01[c]
	15	0.02±0.01[a]	0.06±0.01[b]	0.12±0.01[c]
	30	0.01±0.01[a]	0.04±0.02[b]	0.08±0.01[c]
Total alkalinity (ppm)	0	44.6±1.2[a]	68.6±1.3[b]	83.3±1.2[c]
	15	52.3±1.8[a]	72.2±1.27[b]	88.6±1.2[c]
	30	54.2±1.6[a]	66.3±2.3[b]	77.2±1.8[c]
Ammonia (ppm)	0	0.4±0.01[a]	0.8±0.01[b]	1.2±0.01[c]
	15	0.5±0.01[a]	0.9±0.01[b]	1.8±0.01[c]
	30	0.3±0.01[a]	0.8±0.01[b]	1.6±0.02[c]

Data expressed as : Mean±S.D of 3 ponds for each trial. Values for each parameter in rows with different superscripts signify statistical difference ($p \leq 0.05$).

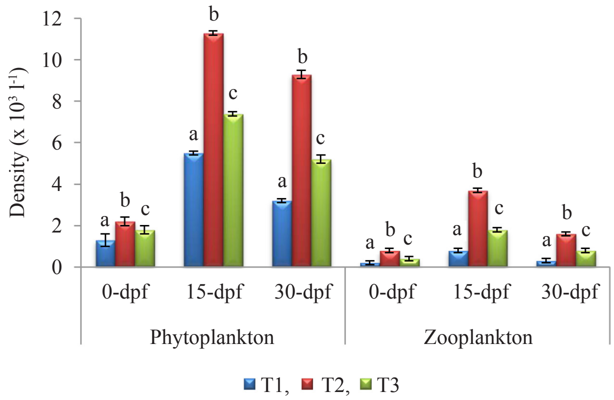

Fig. 1. Plankton density in ponds treated with compost. Bars having same superscript in same dpf indicates no significant difference (T1, T2 and T3 - compost fertiliser @ 0.5 kg m^{-3}, @ 1 kg m^{-3}) and @ 1 kg m^{-3} respectively; dpf - Days post-fertilisation). Means with different superscript letters are significantly different ($p<0.05$)

in all ponds throughout the study which indicated that the ponds remained productive throughout the study period. This could further be attributed to the higher affinity of rohu towards zooplankton during its early phase of life, as a result, there was a dominance in phytoplankton (Khan and Siddiqui, 1973).

Soil pH ($p\geq0.05$), OC, available N and available P ($p\leq0.05$) levels increased with increased dose of the compost (Table 2) which could be attributed to the higher mineralisation capacity of the compost produced out of *P. stratiotes* (Kaviraj *et al*., 1998).

Both length and weight of the fry increased with increase in dose of compost from T1 to T2 except in T3 ($p\geq0.05$) (Table 3). The specific growth rate and survival of fish decreased ($p\geq0.05$) when compost dose was lower (0.5 kg m^{-3}) or higher (1.5 kg m^{-3}) than the optimum (1 kg m^{-3}). This could be due to the low nutrient availability in T1 and increased ammonia load and decreased oxygen level in T3 with the increased dose of compost (Chakraborty *et al.,* 2010). Overall, fish (fry) production was highest in T2, as a result, the profit was also highest ($p\leq0.05$) with T2 (Table 4).

Nursery rearing of rohu in ponds treated with compost of *P. stratiotes* yielded highest survival, production and return. From this experiment, it is also concluded that the problem of *P. stratiotes* can be managed by converting the biomass into high-quality manure for improving the pond fertility. However, to maintain the optimum water quality parameters and plankton production, the dose of the compost needs to be restricted to 1.0 kg m^{-3} for one month in two split doses of equal quantity for 15 days interval. Higher doses of compost increases ammonia load in the pond water and can hamper the growth and survival of fry of rohu. Further study is recommended to assess how compost of *P. stratiotes* affect the fish production and the productivity in grow-out ponds.

Table 2. Soil quality parameters of the ponds under different treatments of compost made from *P. stratiotes*

Parameters	Day-post fertilisation (dpf)	T1 (Compost 0.5 kg m^{-3})	T2 (Compost 1.0 kg m^{-3})	T3 (Compost 1.5 kg m^{-3})
pH	0	6.3±0.1^{a}	6.4±0.1^{a}	6.5±0.1^{a}
	15	6.3±0.1^{a}	6.5±0.1^{a}	6.6±0.2^{a}
	30	6.3±0.1^{a}	6.5±0.1^{a}	6.7±0.1^{a}
Organic carbon (%)	0	0.2±0.1^{a}	0.5±0.1^{b}	0.7±0.1^{c}
	15	0.3±0.1^{a}	0.6±0.1^{b}	0.8±0.1^{b}
	30	0.3±0.1^{a}	0.6±0.1^{b}	0.9±0.1^{b}
Available N (mg%)	0	2.3±1.2^{a}	5.5±1.3^{b}	8.3±1.1^{c}
	15	3.3±0.2^{a}	6.8±0.4^{b}	9.6±0.3^{c}
	30	2.6±0.5^{a}	6.0±0.5^{b}	8.1±0.6^{c}
Available P (mg%)	0	0.3±0.1^{a}	0.8±0.2^{b}	1.2±0.1^{c}
	15	0.4±0.1^{a}	0.9±0.1^{b}	1.4±0.1^{c}
	30	0.5±0.10^{a}	0.8±0.1^{b}	1.2±0.1^{c}

Data expressed as : Mean±S.D of 3 ponds for each trial. Values for each parameter in rows with different superscripts signify statistical difference ($p\leq0.05$).

Table 3. Growth attributes of *L. rohita* in different treatments of compost made from *P. stratiotes*

Parameters	T1 (Compost 0.5 kg m^{-3})	T2 (Compost 1.0 kg m^{-3})	T3 (Compost 1.5 kg m^{-3})
Final length (cm)	4.6±0.2^{b}	4.8±0.3^{a}	4.7±0.4^{a}
Final weight (g)	1.3±0.1^{c}	1.7±0.1^{a}	1.6±0.1^{b}
Specific growth rate (%/day)	11.3±0.1^{b}	11.7±0.1^{a}	11.6±0.1^{a}
Survival (%)	16±2^{c}	31.3±3.^{a}	28.3±2.5^{b}
Fish production (Nos. ha^{-1})	160000±73786^{c}	313333.3±30550^{a}	283333.3±25166^{b}

Data expressed as : Mean±S.D of 3 ponds for each trial. Values for each parameter in rows with different superscripts signify statistical difference ($p\leq0.05$),

Table 4. The economics of nursery rearing of *L. rohita* estimated for a hectare of pond in one month trial with *P. stratiotes* compost

Items	Cost of items and benefits (₹)		
	T1 (Compost 0.5 kg m^{-3})	T2 (Compost 1.0 kg m^{-3})	T3 (Compost 1.5 kg m^{-3})
A. Costs (₹)			
Pond lease (₹ 20000 ha^{-1} $year^{-1}$)	1600	1600	1600
Pond clearance	1500	1500	1500
Lime	3750	3750	3750
Compost from *P. stratiotes*[*]	15000	30000	45000
Spawn	10000	10000	10000
Labour	3500	3500	3500
Miscellaneous	1000	1000	1000
Total	36350	51350	66350
B. Gross benefits			
Fish (fry)[**]	40000	78333	70833
C. Net benefits	3650	26983	4483

[*]₹ 3 per kg; [**] ₹0.25 per piece

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