

EFFECTS OF FERTILIZATION RATES ON GROWTH PERFORMANCE OF RED TILAPIA AT DIFFERENT SALINITIES

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INTRODUCTION

- Many tilapia species are euryhaline and can grow in saline water:
Oreochromis mossambicus, *O. niloticus*, *O. aureus*, *O. spilurus*, red tilapias
- Tilapia culture in saline water: intensive
- Interest in semi-intensive culture in brackishwater ponds: integrated with shrimp, monoculture
- Fertilization for semi-intensive culture in saline ponds: milk fish, marine shrimp, etc.
- Difference in chemical constituents between seawater and freshwater

Constituent		Sea water		River water	
		Concentration (mg/l)	Rank	Concentration (mg/l)	Rank
<i>Major ions^b</i>					
Chloride	(Cl ⁻)	19,340	1	8	5
Sodium	(Na ⁺)	10,770	2	6	6
Sulfate	(SO ₄ ²⁻)	2,712	3	11	4
Magnesium	(Mg ²⁺)	1,294	4	4	7
Calcium	(Ca ²⁺)	412	5	15	2
Potassium	(K ⁺)	399	6	2	8
Bicarbonate	(HCO ₃ ⁻)	140	7	58	1
Bromide	(Br ⁻)	65	8	-	-
Strontium	(Sr ⁺)	9	9	-	-
<i>Trace elements mg/l</i>					
Boron	(B)	4,500	1	10	15
Silicon	(Si)	(5,000)	2	13,100	3
Fluoride	(F)	1,400	3	100	12
Nitrogen	(N)	(250)	4	230	11
Phosphorus	(P)	(35)	5	20	13
Molybdenum	(Mo)	11	6	1	18
Zinc	(Zn)	5	7	20	14
Iron	(Fe)	3	8	670	9
Copper	(Cu)	3	9	7	17
Manganese	(Mn)	2	10	7	16
Nickle	(Ni)	2	11	0.3	19
Aluminum	(Al)	1	12	(400) ^b	10

Objectives

- To determine appropriate fertilization rates
- To observe effect of salinity on tilapia production in fertilized ponds

Experimental design and facility set-up

- Experiment venue: Asian Institute of Technology (AIT), Thailand,
- Time duration: 5 months
- Experiments design: RCB; 2x3 factorial; 3 replications
Fertilization rate (week): 28 kg N and 7 kg P ha⁻¹ ; and 14 kg N and 7 kg P ha⁻¹
Salinity (ppt): 10, 20, and 30 (dilute 150 ppt brine)
- Treatment: six combinations and a control with 28 kg N and 7 kg P ha⁻¹ in freshwater
- Culture facility: twenty-one 4 m³ (2x2.5 x0.8 m) cement tanks with 10-cm soil on the bottom.

Experimental inputs

- Fish: Sex-reversed all-male Thai red tilapia (20.2-23.7 g size); acclimated to respective salinity at 5-ppt increments over two days
- Stocking density: 25 fish/tank
- Fertilization: weekly, applied sodium bicarbonate at 250 kg/ha in the third week.
- Maintained stable salinity and water level by topping up with freshwater
- Continuous aeration with diffuser air stones

Measurements

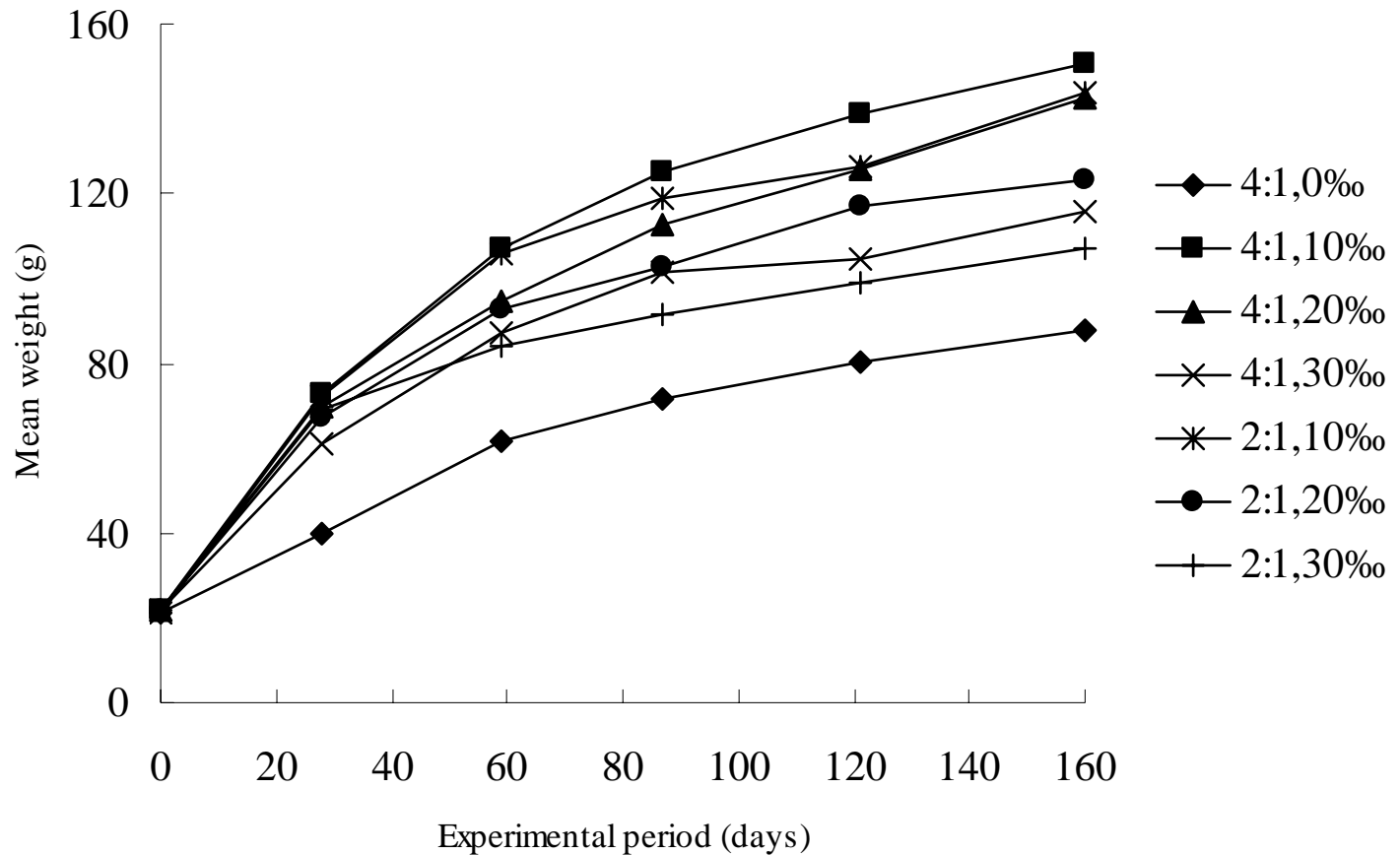
- *Fish*: individual weight and length of 50% stocked population biweekly; all fish were harvested in 160 days. Results were expressed in daily weight gain (g fish/d), yield (kg/pond)
- *Water quality*: analyzed biweekly at 0900 h for:
 - Bi-weekly*: pH, alkalinity, total ammonium nitrogen (TAN), nitrite nitrogen, nitrate nitrogen, total Kjeldahl nitrogen (TKN), soluble reactive phosphorus (SRP), total phosphorus (TP), chlorophyll *a*, total suspended solids (TSS), and total volatile solids (TVS), Secchi disk visibility, temperature(C) and dissolved oxygen (DO)
 - Diel (monthly)*: temperature, DO and pH at 0600, 1000, 1400, 1600, 1800, and 0600 h

RESULTS

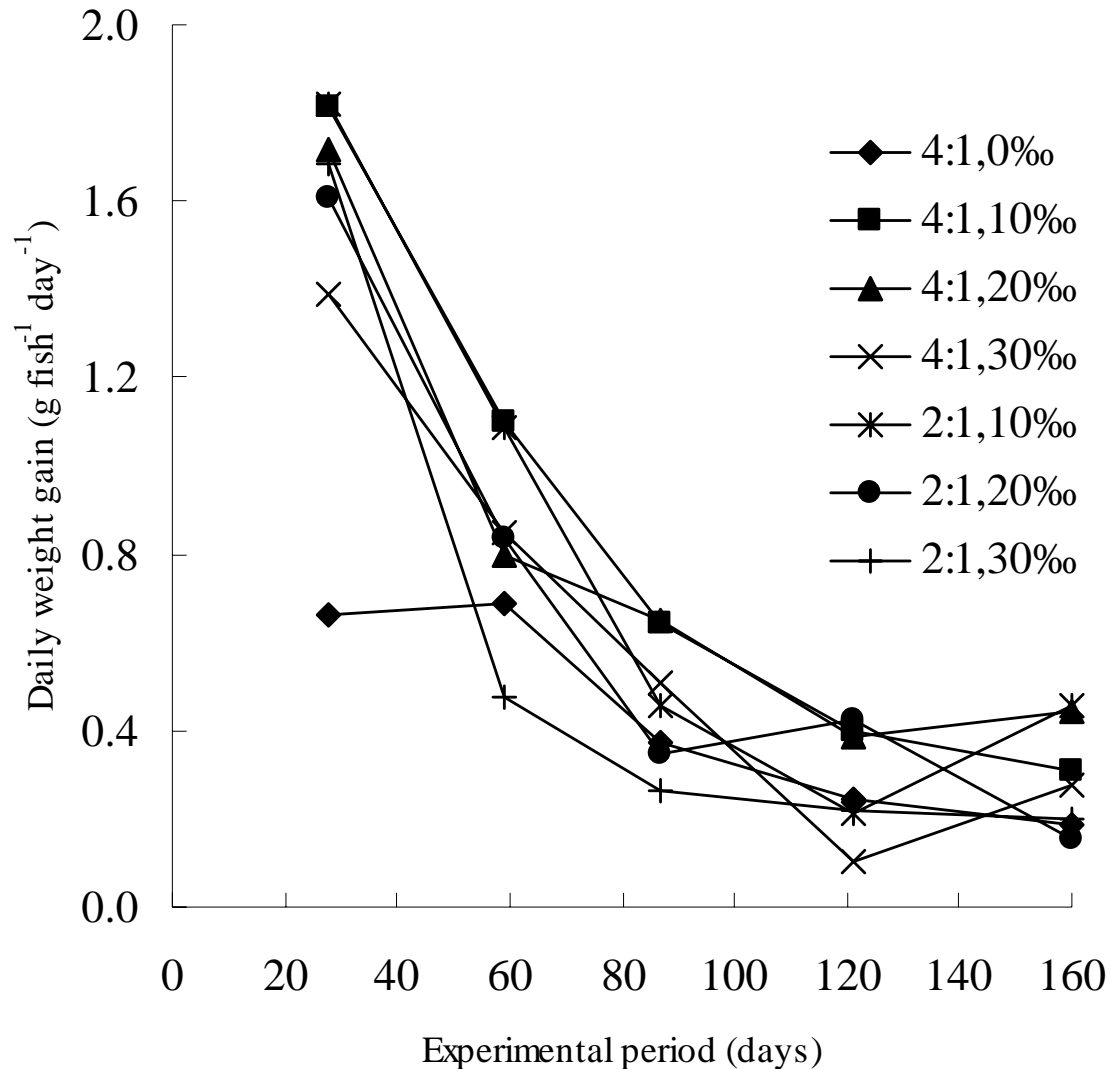
Fish Growth Performance

Parameters	Salinity and Fertilization Rate						
	N:P=4:1				N:P=2:1		
	0‰	10‰	20‰	30‰	10‰	20‰	30‰
Stocking							
Density (fish m ⁻²)	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Total number (fish tank ⁻¹)	12	12	12	12	12	12	12
Mean weight (g fish ⁻¹)	21.4±0.3	22.0±0.4	21.6±0.3	21.9±0.9	21.5±0.6	22.0±0.2	22.1±1.0
Total weight (kg tank ⁻¹)	0.26±0.00	0.26±0.00	0.26±0.00	0.26±0.01	0.26±0.01	0.26±0.00	0.26±0.01
Harvest							
Total number (fish tank ⁻¹)	12±0	12±0	12±0	12±0	12±0	12±0	12±0
Mean weight (g fish ⁻¹)	87.5±11.7 ^a	150.5±9.2 ^c	142.8±17.0 ^{bc}	115.6±11.0 ^{abc}	144.0±14.3 ^{bc}	123.1±6.1 ^{abc}	106.8±10.0 ^{ab}
Total weight (kg tank ⁻¹)	1.05±0.14 ^a	1.81±0.11 ^c	1.71±0.20 ^{bc}	1.39±0.13 ^{abc}	1.73±0.17 ^{bc}	1.48±0.07 ^{abc}	1.28±0.12 ^{ab}
Survival Rate (%)	100	100	100	100	100	100	100
Daily weight gain (g fish ⁻¹ d ⁻¹)	0.41±0.07 ^a	0.80±0.06 ^c	0.76±0.11 ^{bc}	0.59±0.06 ^{abc}	0.77±0.09 ^{bc}	0.63±0.04 ^{abc}	0.53±0.07 ^{ab}
Total weight gain (kg tank ⁻¹)	0.79±0.14 ^a	1.54±0.11 ^c	1.45±0.21 ^{bc}	1.12±0.12 ^{abc}	1.47±0.17 ^{bc}	1.21±0.07 ^{abc}	1.02±0.13 ^{ab}
Net yield (t ha ⁻¹ year ⁻¹)	3.62±0.64 ^a	7.04±0.48 ^c	6.64±0.95 ^{bc}	5.13±0.56 ^{abc}	6.71±0.76 ^{bc}	5.53±0.33 ^{abc}	4.64±0.58 ^{ab}
Gross yield (t ha ⁻¹ year ⁻¹)	4.79±0.64 ^a	8.24±0.50 ^c	7.82±0.93 ^{bc}	6.33±0.60 ^{abc}	7.88±0.78 ^{bc}	6.74±0.34 ^{abc}	5.85±0.54 ^{ab}

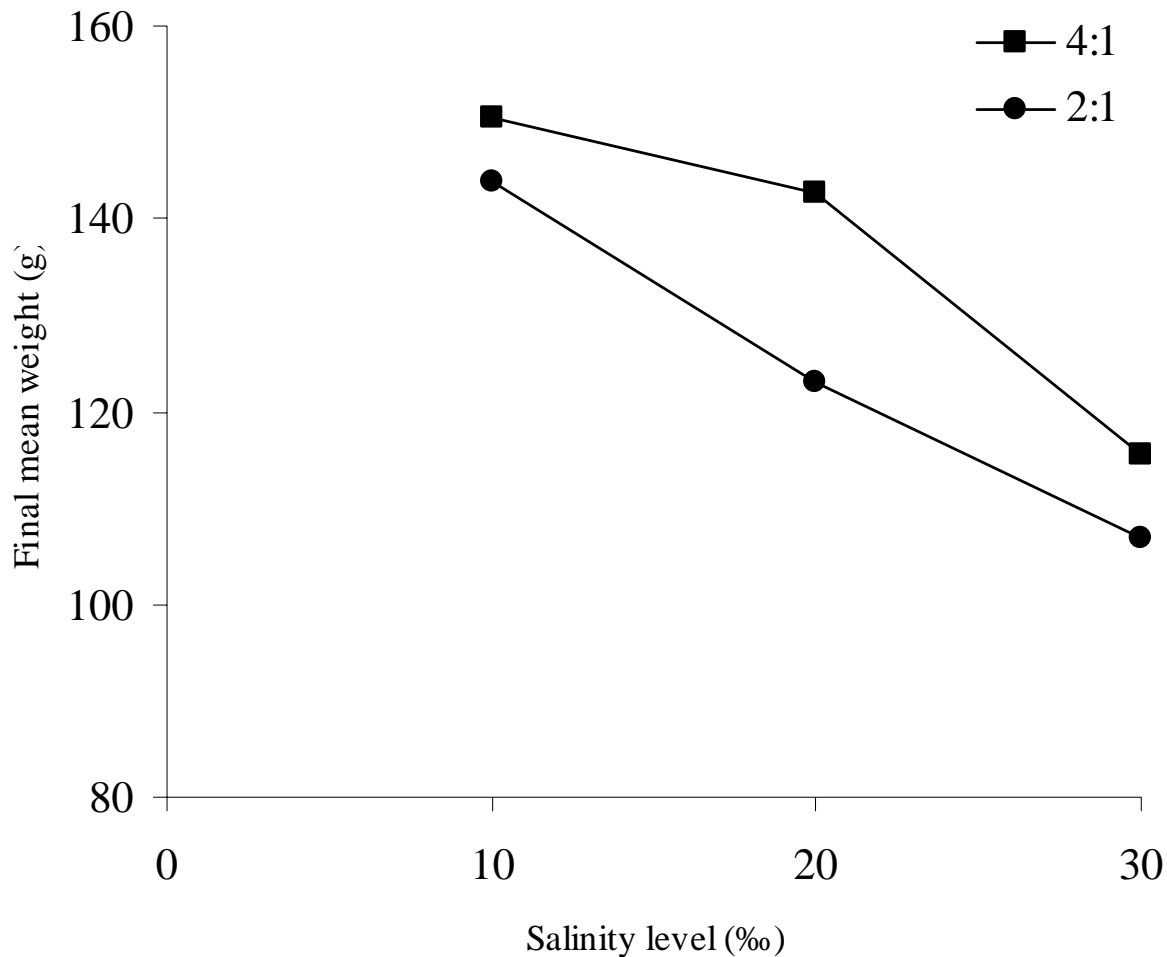
Harvested Fish Mean Weight



Daily Weight Gain



Final mean weight at different salinity levels under two fertilization rates



Water quality

Mean (+ SE) values of water quality parameters measured throughout the experiment.

Parameters	Salinity and Fertilization Rate						
	N:P=4:1				N:P=2:1		
	0‰	10‰	20‰	30‰	10‰	20‰	30‰
DO at dawn (mg L ⁻¹)	5.40±0.26	5.74±0.17	5.04±0.19	4.77±0.16	5.63±0.20	5.07±0.20	5.00±0.17
Temperature (C)	28.2-32.7	28.1-32.7	28.2-32.7	28.2-32.7	28.2-32.7	28.3-32.7	28.1-32.7
pH	7.1-11.1	6.4-10.2	6.3-10.0	6.1-9.6	5.7-11.0	6.7-10.2	6.4-9.8
Alkalinity (mg L ⁻¹)	46.5±1.4 ^a	27.6±2.9 ^b	29.7±1.6 ^b	22.9±1.2 ^b	29.3±2.7 ^b	27.8±2.9 ^b	27.8±6.8 ^b
TAN (mg L ⁻¹)	0.02±0.00 ^a	0.05±0.00 ^a	0.05±0.00 ^a	0.09±0.01 ^b	0.04±0.01 ^a	0.04±0.01 ^a	0.05±0.02 ^a
Nitrite-N (mg L ⁻¹)	0.38±0.03 ^{abc}	0.44±0.01 ^c	0.42±0.02 ^{bc}	0.39±0.04 ^{abc}	0.35±0.03 ^{ab}	0.31±0.02 ^a	0.31±0.04 ^a
TP (mg L ⁻¹)	0.83±0.13	0.52±0.07	0.56±0.02	0.41±0.07	0.47±0.05	0.53±0.09	0.61±0.17
SRP (mg L ⁻¹)	0.56±0.16	0.30±0.07	0.35±0.03	0.20±0.06	0.26±0.05	0.30±0.08	0.44±0.19
Chlorophyll <i>a</i> (mg m ⁻³)	62±15.0	53±3.4	57±7.5	72±1.4	58±3.7	68±9.0	69±7.1

Conclusions

- Thai red tilapia grew best at 10 ppt brackishwater than freshwater and higher salinity in present experimental conditions
- There is no significant difference in fish growth between two fertilization rate at all salinity levels; no conclusive recommendation on optimal fertilization rate can be made for saline water ponds
- The fish growth rate is sub-optimal compared to *O. niloticus* in freshwater open pond at the same fertilization rate
- The phytoplankton production is considerable lower than that in the freshwater ponds at the same fertilization rates
- There is no obvious water quality problems, except wide pH fluctuation, which perhaps due to low alkalinity
- Precaution needs to be taken to extrapolate results from small tank experiments to real production ponds
- Further research is needed based on large earthen brackishwater ponds

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