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***Research Article** (Open Access)*

SEASONAL VARIATION IN THE WATER QUALITY PARAMETERS OF *PENAEUS VANNAMEI* PONDS CULTURED WITH HATCHERY AND NURSERY REARED POST LARVAE AT YAZALI, GUNTUR DISTRICT, ANDHRA PRADESH

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ABSTRACT
Regular monitoring of water quality parameters are most important in shrimp farming because it determines the quality of the pond water. Hence, the present study was conducted to estimate the water quality parameters of *P. vannamei* both in ponds cultured with hatchery reared and nursery reared post larvae during the year 2019. The ponds selected for this study are located in Guntur District of Andhra Pradesh. It is evident from the results of the summer crop of 2019 at Yazali, in the ponds stocked with hatchery reared post larvae, total vibrio counts of water varied from $0.18\times10^2\pm0.07$ to $1.37\times10^2\pm0.19$ cfu/ml, whereas in the ponds stocked with nursery reared post larvae, total vibrio counts of pond water varied from $0.32\times10^2\pm0.11$ to $0.44\times10^2\pm0.14$ cfu/ml respectively. Similarly in the winter crop of 2019 at Yazali, in the pond stocked with hatchery reared post larvae, total vibrio counts of pond water varied from $0.12\text{x}10^2\pm0.03$ to $1.24\times10^2\pm0.19$ cfu/ml, whereas in the ponds stocked with nursery reared post larvae, total vibrio counts of pond water varied from $0.14\text{x}10^2\pm0.12$ to $0.49\times10^2\pm0.14$ cfu/ml respectively.

***Keywords:** TVC, Water Quality, Temperature, Dissolved Oxygen*

INTRODUCTION
According to the studies of (Ma *et al.,* 2013; Sahrijanna and Sahabuddin, 2014) the quality of water in pond environment is crucial factor which determine the optimum output. Due to the improper pesticide managements in agriculture crops could result in contamination of water bodies. When pesticide reaches the aquatic environment, it might present for several days or weeks, depending upon its solubility, morphological and physiological changes; produce several undesirable effects and mortality in the organisms (Lalitha Vinnakota and Venkata Rathnamma, 2021). Regular monitoring of dissolved oxygen is at most important in shrimp farming because it is prominent abiotic factor which determine the quality of the pond water (Kuligiewicz *et al.*, 2015). Van Wyk and Scarpa (1999) stated that pacific white shrimp cannot regulate their body temperature according to environmental temperature. Hence the fluctuation in temperatures in the pond environment alter the metabolic activities of the shrimp eventually leads to impair major metabolic processes which includes feed consumption, excretion of ammonia, consumption of oxygen and growth rate of the shrimp. Van Wyk and Scarpa (1999) reported that a salinity range of 1 ppt to 40 ppt favors the production of *P. vannamei*. Usually shrimps can able to tolerate pH ranges of 7.0 to 9.0. pH is less than 6.5 and greater than 10 is not ideal for the shrimps and these ranges can hamper the processes of gill lamellae and leads to growth reduction. Keeping in view of the above reasons in the present study a comparative study was conducted to estimate the water quality parameters in ponds cultured with hatchery reared and nursery reared post larvae.

MATERIALS AND METHODS
The present work is carried out in commercial shrimp farms located at Yazali, Guntur District, Andhra Pradesh, India, during the year 2019 (15.9411°N 80.5466°E). Modified extensive shrimp

farms were selected for this research work. The comparative data was collected from the ponds cultured with hatchery reared and nursery reared post larvae for two different crops i.e. summer and winter crops. The major water quality parameters in this study were examined by using standard methods employed in (APHA, 1995). The water quality parameters were studied from the day 1 to 120 days of culture period. Sampling was done for every 15 days intervals from the ponds cultured with hatchery reared post larvae and nursery reared post larvae. Salinity, pH and temperatures of the water were recorded at study sites by using standard mercury grade thermometer, pH pen, and digital salino meter respectively. For microbial analysis the standard method mentioned in Dalmin *et al.*, (2001) was used. Vibrio counts were recorded according to the method of Dalmin *et al.,* (2001) and the TVC counts were expressed in colony forming units/ml (cfu/ml).

RESULTS

It is evident from the results of water quality parameters in the year of 2019 at Yazali, ponds stocked with hatchery reared post larvae, and the salinity of pond water was ranged from 10.32±1.5 to 12.83±2.2 ppt in the summer crop and 6.69±1.3 to 10.35±1.3 ppt in the winter crops respectively.

Table 1. Salinity (ppt) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Days of culture	Hatchery reared		Nursery reared	
	Summer	Winter	Summer	Winter
1 day	10.32±1.5[a]	7.40±2.2[a]	10.12±1.5[a]	9.25±1.1[a]
15days	11.54±1.2[a]	7.44±1.4[a]	10.23±1.6[a]	9.54±1.2[a]
30days	10.71±1.3[a]	6.69±1.3[a]	11.25±1.7[a]	9.67±1.3[a]
45days	11.49±2.4[a]	7.49±1.9[a]	12.26±1.8[a]	10.98±1.2[a]
60days	11.84±1.2[a]	8.55±1.4[a]	11.18±1.4[a]	10.84±1.1[a]
75days	12.63±2.1[a]	10.14±2.6[a]	12.27±1.9[a]	10.76±1.2[a]
90days	11.59±1.3[a]	10.35±1.3[a]	12.15±1.5[a]	11.11±1.1[a]
105days	12.76±2.5[a]	9.48±1.5[a]	12.24±1.6[a]	11.42±1.2[a]
120days	12.83±2.2[a]	9.60±2.8[a]	12.16±1.5[a]	11.22±1.4[a]

Identical alphabetical superscripts along column indicate there is no significant difference ($p > 0.05$).

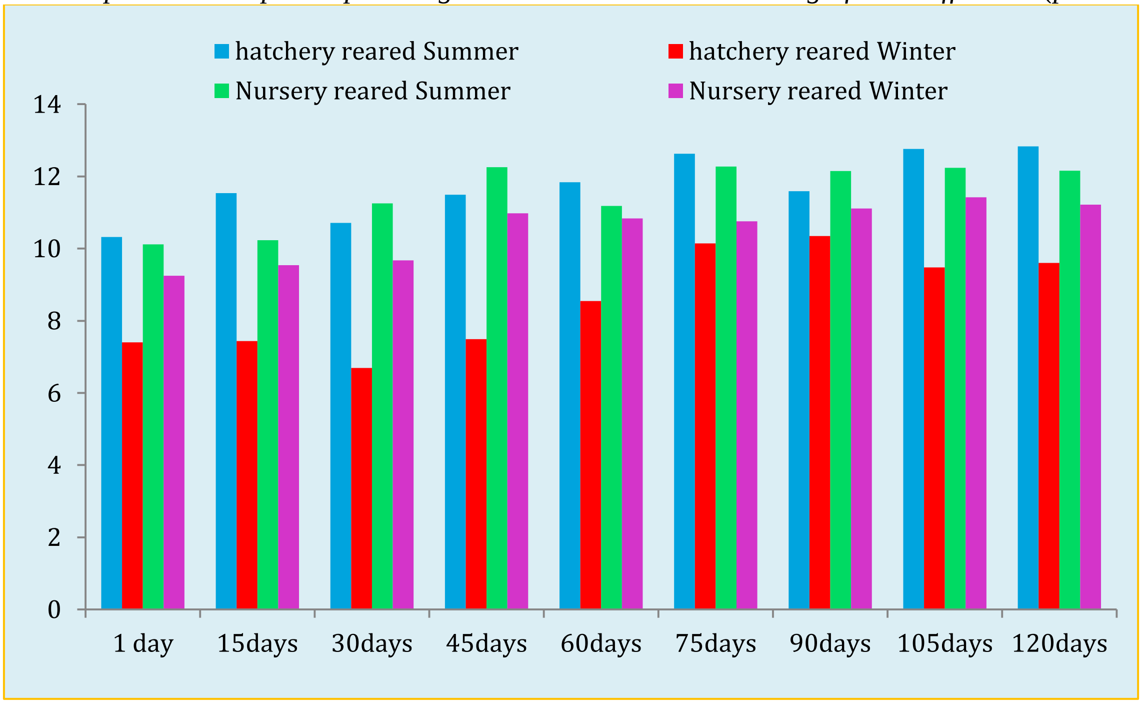

Figure 1. Salinity (ppt) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Whereas in the pond water stocked with nursery reared post larvae it was ranged from 10.12±1.5 to 12.27±1.9 ppt in the summer crop, and 9.25±1.1 to 11.42±1.2 ppt in the winter crops respectively and the values are represented in **Table 1 and Figure 1.** Similarly pH of the pond water stocked with hatchery reared post larvae in both summer and winter seasons varied from 7.52±1.5 to 8.65±2.3 and 7.29±1.9 to 8.45±2.5 respectively. Whereas in the ponds nursery reared post larvae, it was ranged from 7.50±1.5 to 7.89±1.1 and 7.49±1.8 to 8.21±1.3 respectively (**Table 2 and Figure 2**).

Table 2. pH of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Days of culture	Hatchery reared		Nursery reared	
	Summer	Winter	Summer	Winter
1 day	7.52±1.5[a]	7.71±1.3[a]	7.63±1.2[a]	7.58±1.2[a]
15days	8.34±1.2[a]	7.89±1.4[a]	7.72±1.4[a]	7.77±1.4[a]
30days	7.67±1.8[a]	8.45±2.5[a]	7.84±1.3[a]	7.55±1.7[a]
45days	8.41±1.3[a]	8.23±1.7[a]	7.61±1.2[a]	7.49±1.8[a]
60days	7.59±2.1[a]	7.29±1.9[a]	7.50±1.5[a]	7.96±1.5[a]
75days	8.36±1.5[a]	8.16±1.3[a]	7.75±1.4[a]	8.03±1.6[a]
90days	8.65±2.3[a]	7.75±2.0[a]	7.86±1.2[a]	7.92±1.2[a]
105days	7.89±1.2[a]	8.25±1.8[a]	7.58±1.3[a]	8.21±1.3[a]
120days	8.54±1.5[a]	7.89±1.4[a]	7.89±1.1[a]	8.14±1.1[a]

Identical alphabetical superscripts along column indicate there is no significant difference ($p > 0.05$).

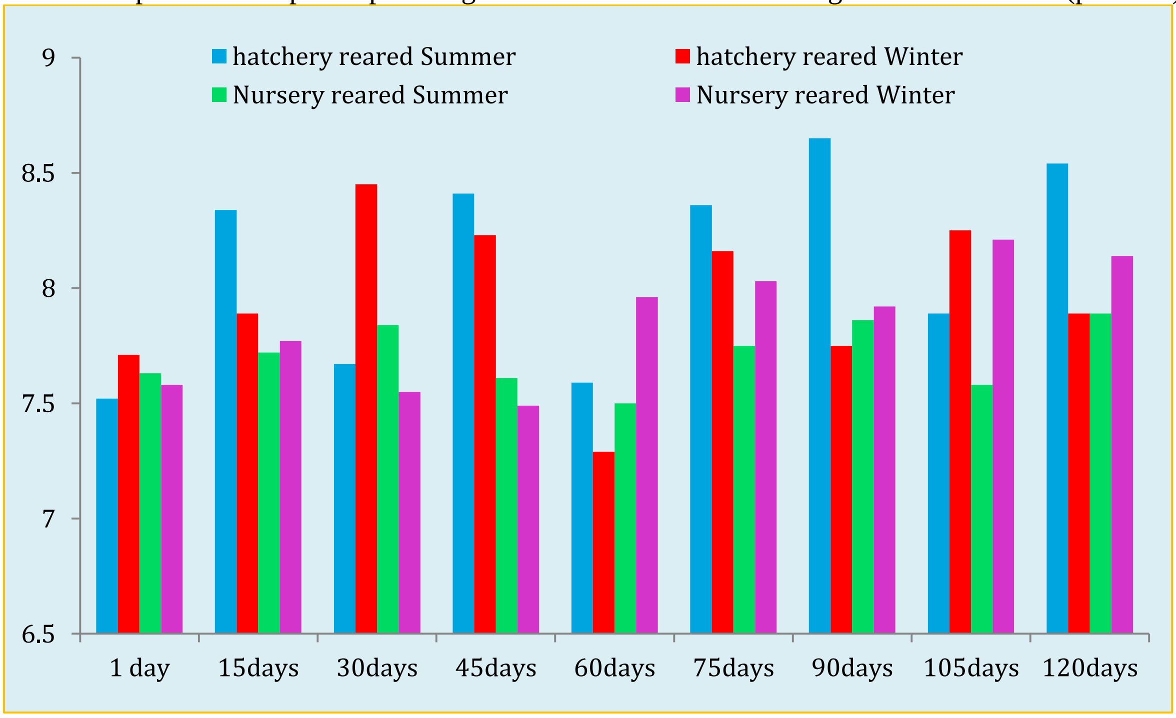

Figure 2. pH of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Water temperature in the ponds varied from 27.53±1.4ºC to 29.52±1.2^{0}C and 26.43±1.4 ºC to 28.83±1.6 ºC in both summer and winter seasons in the ponds of hatchery reared post larvae**.** Similarly in the ponds of nursery reared post larvae, it was ranged from 25.33±1.6ºC to 30.44±1.4ºC and 25.34±1.6 to 29.44±1.7ºC respectively (**Table 3 and Figure 3**). Water dissolved oxygen values varied from 4.37±1.2 to 5.65±2.1 mg/l and 4.30±1.3 to 6.89±1.3 mg/l in summer and winter seasons in the ponds of hatchery reared post larvae**.** Similarly in the ponds of nursery reared post larvae, 4.12±1.1 to 5.25±1.7 and 4.12±1.5 to 5.67±1.4 recorded as lowest and highest values respectively (**Table 4 and Figure 4**). The ponds stocked with hatchery reared post larvae, total ammonia content values were ranged from 0.01±0.001to 0.18±0.002 and 0.01±0.003 to 0.13±0.002 in summer and winter seasons, whereas in the nursery reared ponds, it was varied from 0.02±0.001 to 0.11±0.006 and 0.01±0.005 to 0.05±0.001 respectively (**Table 5 and Figure 5**).

Table 3. Temperature (ºC) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Days of culture	Hatchery reared		Nursery reared	
	Summer	Winter	Summer	Winter
1 day	29.36±1.5[a]	26.43±1.4[a]	28.20±1.5[ab]	28.12±1.5[a]
15days	28.43±1.3[a]	26.57±1.3[a]	28.32±1.7[ab]	27.22±1.4[a]
30days	28.61±1.2[a]	27.72±1.0[a]	29.11±1.8[ab]	29.44±1.7[a]
45days	29.52±1.2[a]	28.45±1.7[a]	30.44±1.4[b]	26.56±1.8[a]
60days	27.68±1.5[a]	28.83±1.6[a]	25.33±1.6[a]	28.89±1.2[a]
75days	28.95±1.2[a]	27.34±1.4[a]	27.25±1.5[ab]	26.98±1.1[a]
90days	27.53±1.4[a]	27.12±1.3[a]	30.19±1.3[b]	28.67±1.3[a]
105days	28.81±1.2[a]	28.64±1.4[a]	29.56±1.1[b]	25.34±1.6[a]
120days	29.48±1.7[a]	28.79±1.8[a]	29.33±1.2[ab]	29.25±1.4[a]

Identical alphabetical superscripts along column indicate there is no significant difference (p > 0.05).

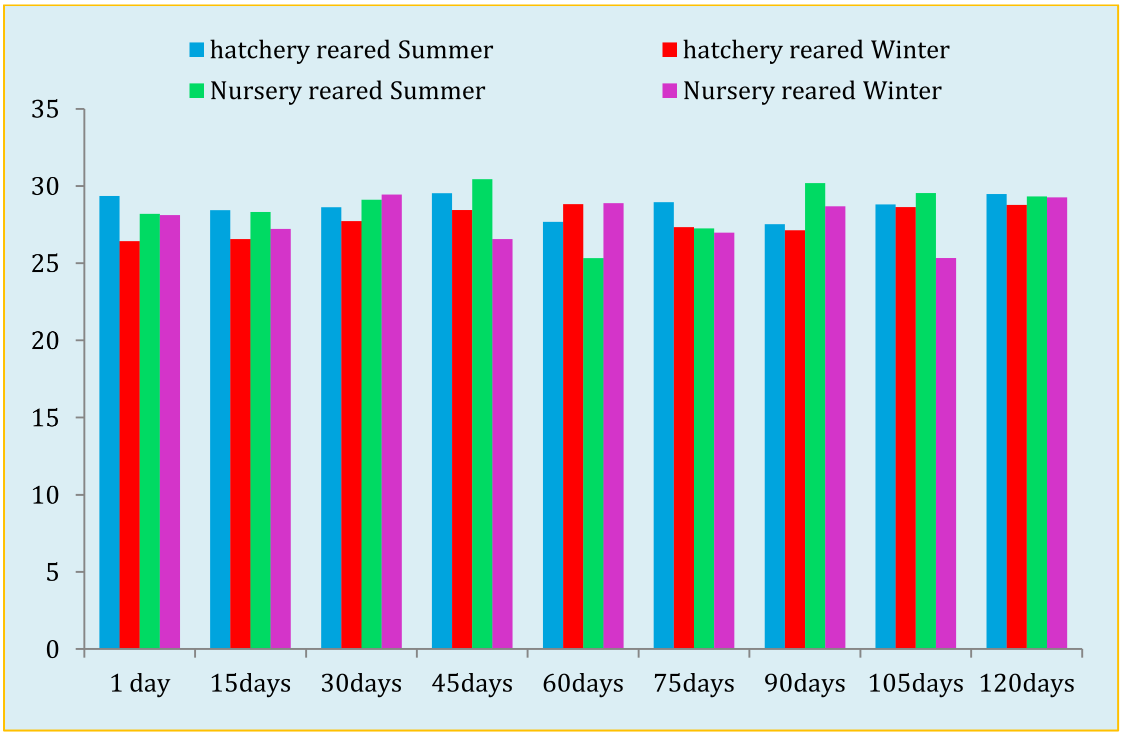

Figure 3. Temperature (ºC) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Similarly Hardness of the pond water stocked with hatchery reared post larvae in both summer and winter seasons varied from 1508±54.2mg/l to 1721±34.2 mg/l and 1223±22.2 mg/l to 1653±31.8 mg/l respectively. Whereas in the ponds nursery reared post larvae, it was ranged from 1323±48 mg/l to 1495±38 mg/l and 1448±71 mg/l to 1594±47 mg/l respectively (**Table 6 and Figure 6**). Alkalinity of the pond water studied in both hatchery and nursery reared ponds stocked with *P. vanammei* post larvae in both summer and winter seasons. In hatchery reared pond, it varied from 158±31.2mg/l to 186±24.2 mg/l in summer and 122±25.2 mg/l to 200±47.2 mg/l in winter season. Whereas in the ponds nursery reared post larvae, it was ranged from 122±28 mg/l to 190±25 mg/l and 178±34 mg/l to 197±45 mg/l in both summer and winter season respectively (**Table 7 and Figure 7**).

The total vibrio count (TVC) of the pond water recorded in both hatchery and nursery reared ponds stocked with *P. vanammei* post larvae in two selected seasons i.e. summer and winter. In hatchery reared pond, TVC ranged from $0.18\times10^{2}\pm0.07$ cfu/ml to $1.37\times10^{2}\pm0.19$ cfu/ml and $0.12\times10^{2}\pm0.03$ cfu/ml to $1.24\times10^{2}\pm0.19$ cfu/ml were recorded in both summer and winter season. Whereas in the ponds nursery reared post larvae, it was ranged from $0.28\times10^{2}\pm0.13$ cfu/ml to $0.44\times10^{2}\pm0.14$ cfu/ml and $0.14\times10^{2}\pm0.04$ cfu/ml to $0.49\times10^{2}\pm0.14$ cfu/ml recorded as lowest and highest values in both summer and winter crops respectively (**Table 8 and Figure 8**).

Table 4. Dissolved oxygen (mg/l) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Days of culture	Hatchery reared		Nursery reared	
	Summer	Winter	Summer	Winter
1 day	4.45±1.3[a]	4.30±1.3[a]	4.12±1.1[a]	4.12±1.5[a]
15days	4.37±1.2[a]	6.24±1.7[a]	4.15±1.2[a]	5.21±1.3[a]
30days	5.53±1.5[a]	6.41±1.4[a]	4.13±1.4[a]	5.42±1.2[a]
45days	4.71±1.3[a]	5.33±1.5[a]	5.12±1.5[a]	4.59±1.1[a]
60days	4.64±1.2[a]	5.45±1.6[a]	5.15±1.8[a]	5.67±1.4[a]
75days	4.83±1.5[a]	6.57±1.4[a]	5.25±1.7[a]	4.38±1.5[a]
90days	5.65±2.1[a]	6.89±1.3[a]	5.15±1.1[a]	5.27±1.6[a]
105days	4.59±1.5[a]	5.61±1.0[a]	4.32±1.2[a]	4.55±1.8[a]
120days	4.96±1.2[a]	6.56±1.1[a]	4.88±1.0[a]	4.44±1.7[a]

Identical alphabetical superscripts along column indicate there is no significant difference ($p > 0.05$).

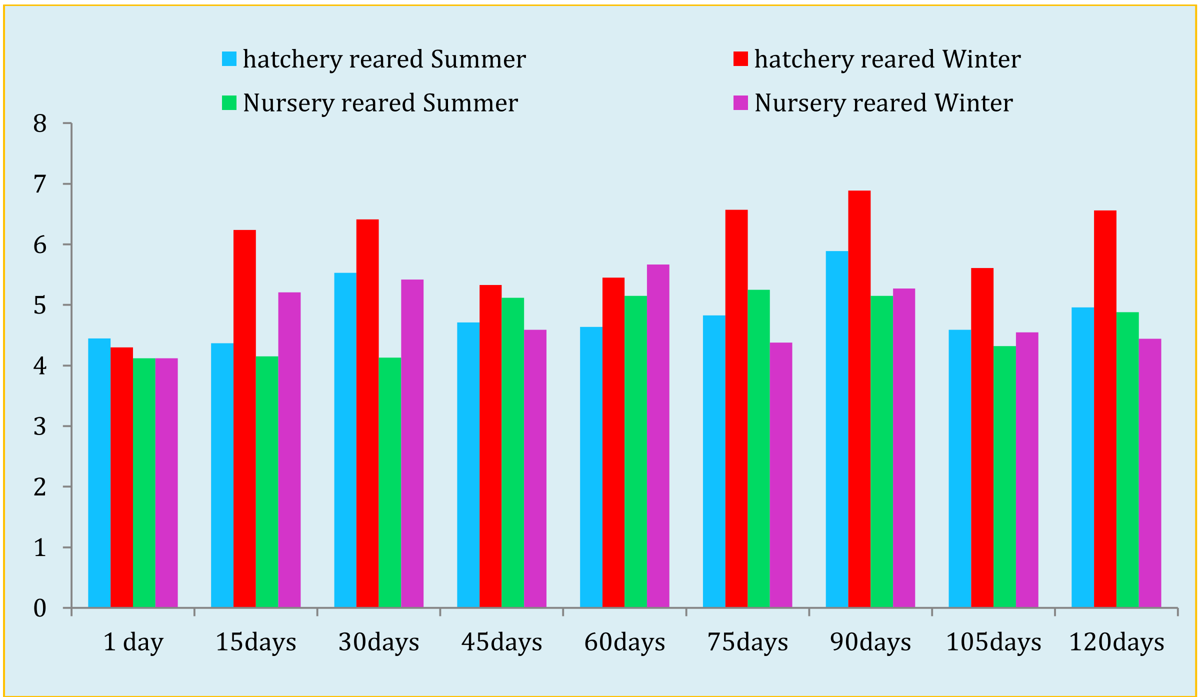

Figure 4. Dissolved oxygen (mg/l) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Table 5. Total Ammonia (ppm) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Days of culture	Hatchery reared		Nursery reared	
	Summer	Winter	Summer	Winter
1 day	0.01±0.001[a]	0.01±0.003[a]	0.08±0.002[f]	0.02±0.002[ab]
15days	0.03±0.001[c]	0.02±0.001[b]	0.05±0.004[cd]	0.04±0.004[cd]
30days	0.02±0.001[b]	0.03±0.003[c]	0.07±0.005[ef]	0.02±0.003[ab]
45days	0.04±0.002[d]	0.04±0.004[d]	0.04±0.006[bc]	0.03±0.002[bc]
60days	0.06±0.001[e]	0.04±0.002[d]	0.06±0.008[de]	0.05±0.001[d]
75days	0.10±0.002[f]	0.03±0.003[c]	0.11±0.006[g]	0.01±0.005[a]
90days	0.11±0.003[g]	0.09±0.001[e]	0.03±0.005[ab]	0.02±0.002[ab]
105days	0.13±0.001[h]	0.11±0.004[f]	0.02±0.001[a]	0.04±0.013[cd]
120days	0.18±0.002[i]	0.13±0.002[g]	0.05±0.003[cd]	0.03±0.004[bc]

Identical alphabetical superscripts along column indicate there is no significant difference (p > 0.05).

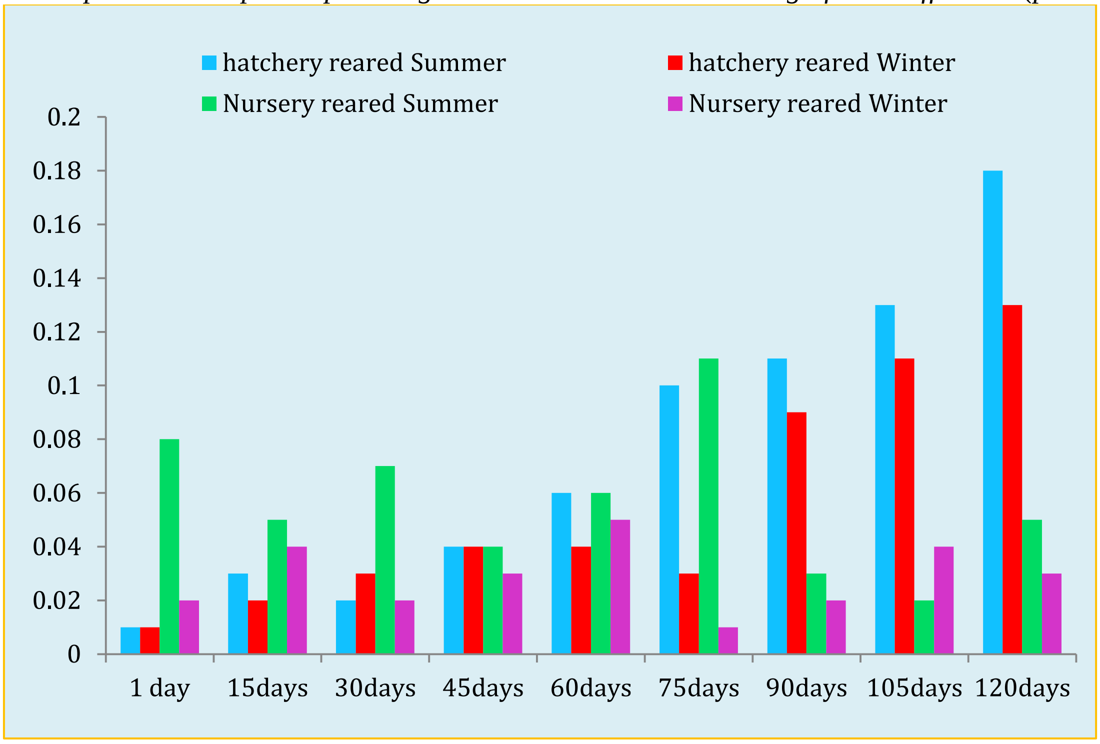

Figure 5. Total Ammonia (ppm) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Table 6. Hardness (mg/l) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Days of culture	Hatchery reared		Nursery reared	
	Summer	Winter	Summer	Winter
1 day	1721±34.2[c]	1510±21.5[cde]	1495±38[c]	1452±26[a]
15days	1621±52.5[abc]	1578±45.3[ef]	1462±29[c]	1475±43[a]
30days	1698±51.3[c]	1653±31.8[f]	1442±16[bc]	1489±52[a]
45days	1684±47.5[bc]	1545±57.4[def]	1425±45[bc]	1448±71[a]
60days	1662±53.2[bc]	1415±33.4[bc]	1402±27[abc]	1457±84[a]
75days	1598±67.5[abc]	1325±48.6[ab]	1345±34[ab]	1585±55[a]
90days	1556±45.3[ab]	1223±22.2[a]	1323±48[a]	1594±47[a]
105days	1521±21.5[a]	1445±50.5[cd]	1458±25[c]	1561±58[a]
120days	1508±54.2[a]	1258±27.4[a]	1489±36[c]	1452±45[a]

Identical alphabetical superscripts along column indicate there is no significant difference (p > 0.05).

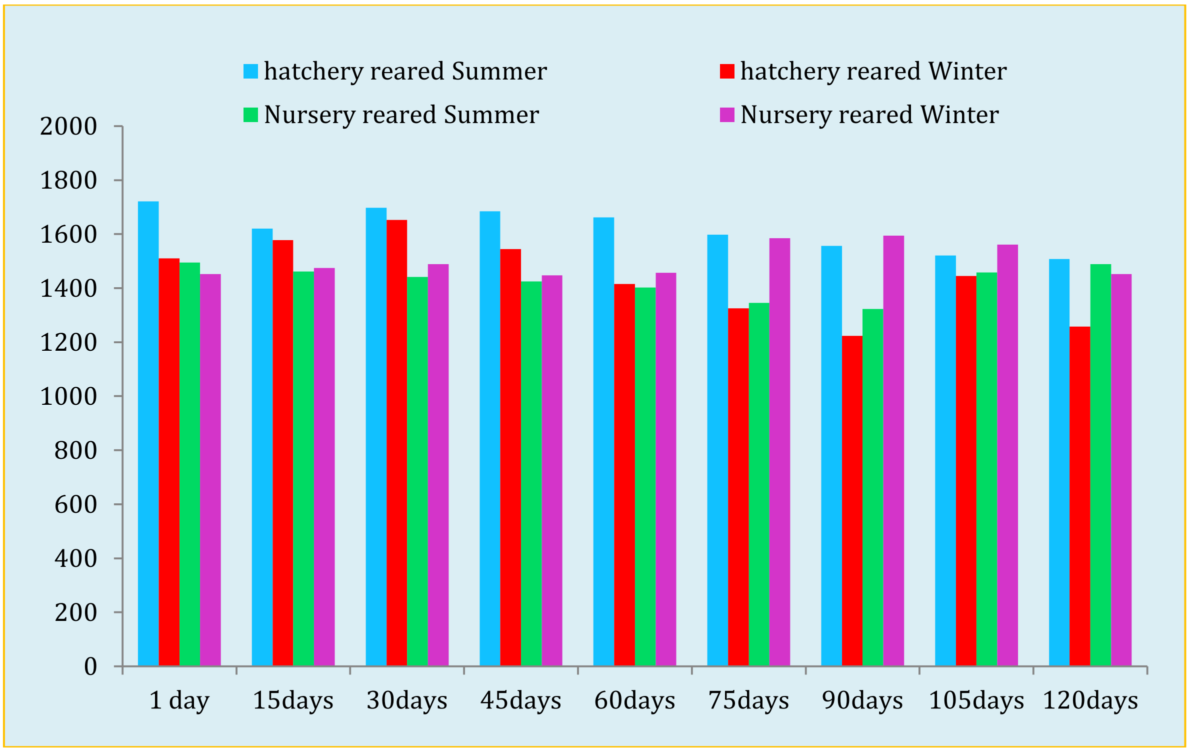

Figure 6. Hardness (mg/l) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

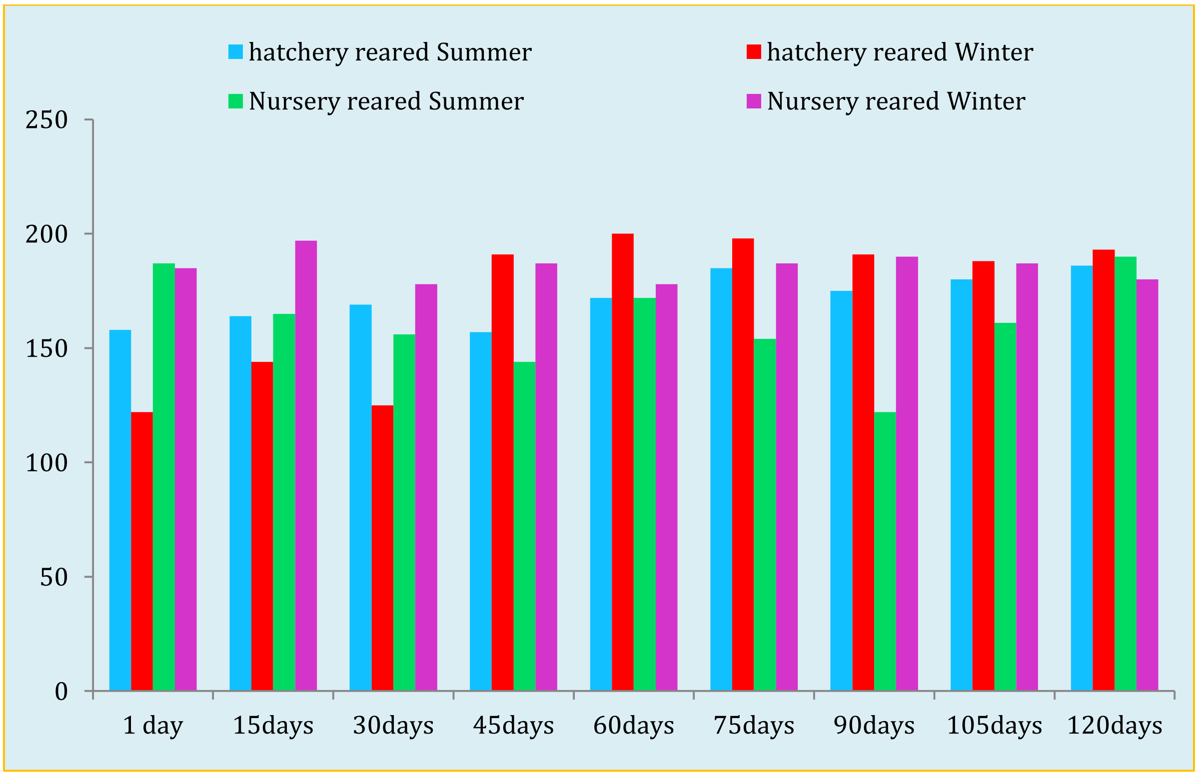

Figure 7. Alkalinity (mg/l) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Table 7. Alkalinity (mg/l) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Days of culture	Hatchery reared		Nursery reared	
	Summer	Winter	Summer	Winter
1 day	158 ± 31.2^{a}	122 ± 25.2^{a}	187 ± 22^{a}	185 ± 24^{a}
15days	164 ± 25.5^{a}	144 ± 38.4^{a}	165 ± 12^{a}	197 ± 45^{a}
30days	169 ± 34.2^{a}	125 ± 56.6^{a}	156 ± 21^{a}	178 ± 52^{a}
45days	157 ± 49.1^{a}	191 ± 73.4^{a}	144 ± 32^{a}	187 ± 23^{a}
60days	172 ± 54.5^{a}	200 ± 47.2^{a}	172 ± 24^{a}	178 ± 34^{a}
75days	185 ± 27.3^{a}	198 ± 38.3^{a}	154 ± 19^{a}	187 ± 52^{a}
90days	175 ± 61.5^{a}	191 ± 73.1^{a}	122 ± 28^{a}	190 ± 44^{a}
105days	180 ± 43.1^{a}	188 ± 43.5^{a}	161 ± 47^{a}	187 ± 12^{a}
120days	186 ± 24.2^{a}	193 ± 65.2^{a}	190 ± 25^{a}	180 ± 24^{a}

Identical alphabetical superscripts along column indicate there is no significant difference ($p > 0.05$).

Table 8. TVC (cfu/ml) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

Days of culture	Hatchery reared		Nursery reared	
	Summer	Winter	Summer	Winter
1 day	$0.18\times10^{2}\pm0.07^{a}$	$0.12\times10^{2}\pm0.03^{a}$	$0.35\times10^{2}\pm0.12^{a}$	$0.14\times10^{2}\pm0.12^{a}$
15days	$0.31\times10^{2}\pm0.10^{a}$	$0.21\times10^{2}\pm0.12^{ab}$	$0.44\times10^{2}\pm0.13^{a}$	$0.25\times10^{2}\pm0.6^{e}$
30days	$0.42\times10^{2}\pm0.15^{ab}$	$0.30\times10^{2}\pm0.13^{abc}$	$0.36\times10^{2}\pm0.7^{a}$	$0.14\times10^{2}\pm0.12^{a}$
45days	$0.54\times10^{2}\pm0.12^{abc}$	$0.53\times10^{2}\pm0.12^{bcd}$	$0.44\times10^{2}\pm0.14^{a}$	$0.28\times10^{2}\pm0.11^{f}$
60days	$0.76\times10^{2}\pm0.14^{bc}$	$0.60\times10^{2}\pm0.14^{cd}$	$0.32\times10^{2}\pm0.11^{a}$	$0.24\times10^{2}\pm0.5^{d}$
75days	$0.93\times10^{2}\pm0.16^{cd}$	$0.81\times10^{2}\pm0.13^{d}$	$0.32\times10^{2}\pm0.12^{a}$	$0.15\times10^{2}\pm0.13^{b}$
90days	$1.19\times10^{2}\pm0.15^{de}$	$1.22\times10^{2}\pm0.10^{e}$	$0.28\times10^{2}\pm0.13^{a}$	$0.49\times10^{2}\pm0.14^{g}$
105days	$1.24\times10^{2}\pm0.11^{de}$	$1.20\times10^{2}\pm0.14^{e}$	$0.43\times10^{2}\pm0.11^{a}$	$0.14\times10^{2}\pm0.04^{a}$
120days	$1.37\times10^{2}\pm0.19^{e}$	$1.24\times10^{2}\pm0.19^{e}$	$0.39\times10^{2}\pm0.12^{a}$	$0.19\times10^{2}\pm0.10^{c}$

Identical alphabetical superscripts along column indicate there is no significant difference ($p > 0.05$).

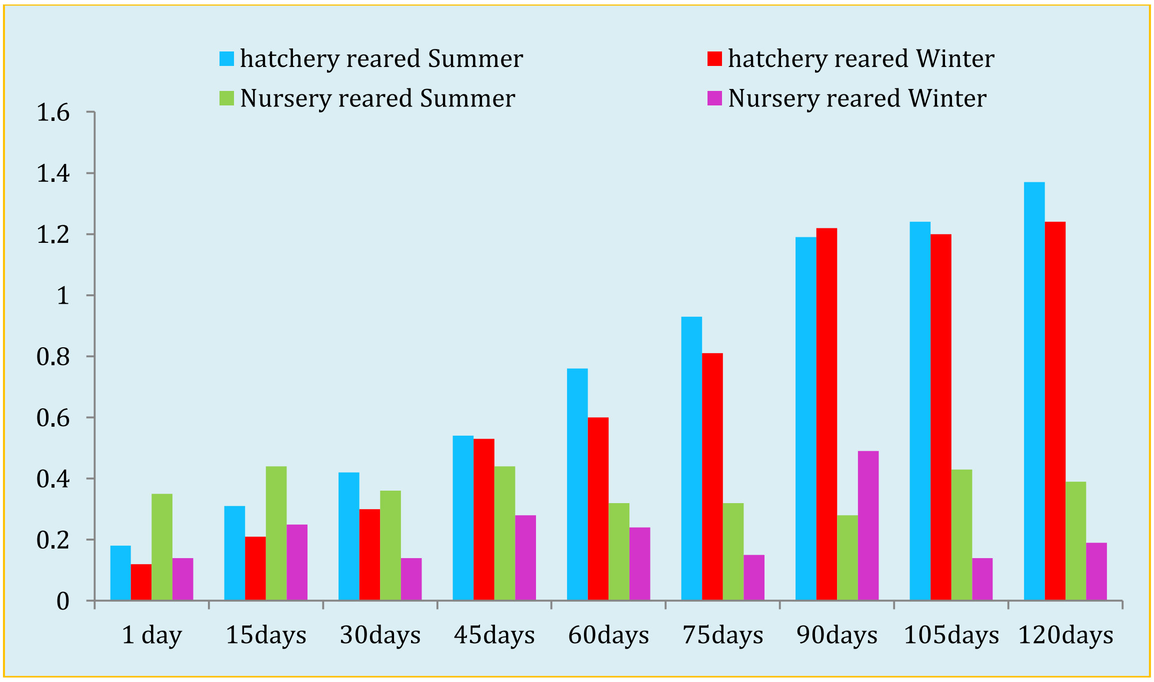

Figure 8. TVC (cfu/ml) of the pond water in both summer and winter seasons at Yazali during the year 2019 (PL Source: Hatchery reared and Nursery Reared).

DISCUSSION

Mazid (2009) recorded the salinity of 5-30 ppt is an ideal range for the successful outcome of shrimp culture operations. Samocha *et al.,* (1998) tested 2-45 ppt is an ideal range for the *P. vannmei* culture. Gunalan *et al.,* (2010) recorded 10-35 ppt is an ideal range for *P. monodon* culture operations. Similarly in the present study the salinity values were fluctuated between 6 to 13 ppt in the culture operation of *P. vannamei.* Zafar *et al.,* (2015) recorded the temperature values for dry season varied from 30 to 34^0C and for wet season temperature values ranged from 31 to 34^0C. According to the findings of (Mazid, 2009; DoF, 2009), the temperature ranges of 25 to 30^0C is an ideal range for the cultured shrimps and prawns to get maximum production. Similar pattern of temperature ranges were recorded in the present study. Das and Saksena (2001) reported that farmed shrimp shows best growth in a temperature range of 24°C to 32°C. Several finfish and shellfish can tolerate water temperature upto a maximum of 33°C (Santhanam and Ramadhas, 2001).

According to Direkbusarakom and Danayadol (1998) in *Penaeus monodon* disease incidence and mortality was observed due to low dissolved oxygen and weak immune response of the organism. Rather and Jetuni (2012) recorded the dissolved oxygen levels were greater than 6 ppm in shrimp and prawn cultured ponds. These values were very similar to the investigations of the present study. Similar trends of observations were reported by (Lazur, 2007; DoF, 2009). Venkateswarlu *et al.,* (2019) reported that pH values were ranged from 7.67±1.5 to 7.88±1.4. Magallon Barajas *et al.,* (2006) have reported that, to overcome ammonia toxicity, organisms in mariculture must be cultured in water with a pH ranged from 7 to 8. These values were very similar to the investigations of the present study. Similar trends of observations were reported by (Ramakrishnareddy, 2000; Ramanathan *et al.,* 2005). Alkalinity in the pond should be maintained at greater than 100 ppm for good production. Sea water has an average alkalinity of 116 ppm as $CaCO_3$. Maintaining of a total alkalinity of 100-200 ppm favors to less fluctuations in pH and good productivity as reported by Ponnuchamy (1997). In the present study the alkalinity values were fluctuated between 120 to 200 ppm.

According to Maclean *et al.,* (1994) and Sharmila *et al.,* (1996) environmental factors will not influence the distribution of bacterial loads in the pond ecosystem since there were no significant changes in the environmental parameters, however turbidity and organic matter play an important role in culture ponds. The optimum pathogenic bacterial counts of culture ponds was less than 1000 cfu/ml. Similar trends of observations were recorded in the present investigation.

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