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Growth Performance of Common Carp (*Cyprinus carpio*) in Earthen Ponds in Basrah Province, Iraq by Using Different Stocking Densities

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Abstract: The present study aims to assess the growth of common carp in different stocking densities depending on the natural food in earthen ponds. The study was conducted in the Agricultural Research Station at Al-Hartha (College of Agriculture, University of Basrah). Fishes were obtained from Marine Science Centre fish farm in 18.7.2018. After acclimatization for two weeks, fishes were stocked in earthen ponds in three treatments, each was replicated twice at different stocking densities of 0.7 (T1), 1.4 (T2) and 2.1 (T3) fish/m^2. No supplemental food was supplied to fishes and natural food was the only food source. Water temperature ranged between 14 ^oC in January to 29 ^oC in August, while water salinity ranged from 2.6 to 11.2 ‰ at the same months. The first treatment with 0.7 fish/m^2 showed significantly (P<0.05) higher final weight (42.10 g) at the end of experiment compared to the other two treatments (31.63 and 21.30 g) T2 and T3, respectively. Weight gain, daily growth rate and specific growth rate were decreased significantly (P< 0.0.5) with increased stocking density. However, yield was increased with increasing in stocking density and significant differences (P< 0.0.5) occurred between the lower density and the other two densities. The results indicate that shortly (one month) after fish stocking, a significant difference in weight gain was observed between low, moderate and high stocking densities. This may point out that natural food source became a restricted growth factor for common carp in earthen ponds. It was also concluded that this was the time for starting with supplementary feeding if the stocking density increased above 0.7 fish/m^2.

Keywords: Natural food, *Cyprinus carpio*, Earthen ponds**,** Stocking density, Basrah

Introduction

Recent country reviews of FAO (Hasan et al., 2007) support that the characteristics of pond fish culture make it very suitable to produce fishes in an inexpensive integrated way.

Common carp (*Cyprinus carpio*) is the most common cyprinid species that generates a significant part of inland freshwater fish production. It was introduced to inland waters such as lakes, dams and streams in different regions (Vilizzi et al., 2015) and is the third most important farmed freshwater species in the world, besides it is the most important in Eastern Europe (Ljubojević et al., 2016). The total world production of common carps was 4.557 million tons in 2016, contributing to 8% of total major species produced in world aquaculture (FAO, 2018).

Common carp is very much favored for cultivation in ponds in Asia, Near East and Far East, alone or in combination with other fishes, because of its excellent growth rate, omnivorous habit, breeding in confined waters (unlike the Indian and Chinese major carps), hardy nature and easy adaptation to artificial feeds. Consequently, this fish was introduced into many countries throughout the world, including Europe, Australia and North America (Khan et al., 2016). Gyalog et al. (2017) revealed that carp farming had a key role in the Blue Revolution at a global level.

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Fish stocking density is a key factor in determining the management of fish pond and so, the production (Hassan & Mahmoud, 2011). One of the important factors related to fish culture productivity is stocking density (Roy et al., 2018). Obviously, with increasing stocking density, competition for food also increases. The optimum stocking densities of different fish species should be determined in order to improve fish performance and economic profitability of the aquaculture system.

Under culture condition, fish growth depends on many factors; stocking rate and available natural food were the most two factors (Badilles et al., 1996). Data on the optimum stocking density of common carps are highly variable (Musa et al., 2010).

Okoye & Mohammed (1985) worked on monoculture of carps, used stocking density of 0.5 and 1 fish/m^2 with an initial average weight of 7.07 g and 6.13 g, respectively, and obtained after 100 days an average weight gain of 98.57 g and 29.03 g respectively, while Ita (1989) recommended a standard stocking density of 0.3 to 0.6 fish/m^2 for common carps. Al-Daham et al. (1991) studied the stocking density of common carps in earthen brackish water ponds and found that 0.17 fish/m^2 provided superior results in respect to growth and food conversion rate. Mehta et al. (2016) stated that the production level of existing practice of the farmers may be enhanced up to 1.5 times with proper stocking density i.e. 3 fish/m^3.

The production of common carps per hectare in Iraq is much lower than other countries of the world. The reason of this fact is correlated with the absence of correct understanding of the scientific basis of fish culture and management practices. Pond and cage fish culture is the main aquaculture system in Iraq, contributing to the majority of production. The Arab Organization for Agricultural Development estimated the annual production of common carp hatcheries in Iraq in 2015 at about 22 millions, but no data available for recent years (AOAD, 2018). Iraq production from aquaculture sector estimated as 24 thousand tons in 2014, but a future goal in 2020 is to increase it up to 90 thousand tons (AOAD, 2016). Common carps represent 63.5% of cultured fish species in Basrah province (Jassim et al., 2013).

The present study aims to evaluate the growth of the common carp stocked in different stocking densities depending on natural food in earthen ponds.

Materials and Methods

Study Site

The research was conducted at the Agricultural Research Station at Al-Hartha (College of Agriculture, University of Basrah), which is located in Al-Hartha district, about 16 km northeastern part of Basrah province (30^o 65’ 64.6"N, 47^o 74’ 79.5"E) (Figure 1). The fish farm consisted of four large ponds (2500 m^2) and 14 small ponds (600 m^2) (Figure 2). Inlet water is supplied with electrical pump, while outlets are made by gravity. The water source was from Shatt Al-Arab river.

The organic fertilizers (buffalo manure) was applied to each pond with the rate of 0.4 kg/m^2 one week prior to fish stocking. Three large ponds were selected for the experiment where each pond was divided by a net wall to represent six ponds needed for the three stocking densities.

Experimental Design

The common carps were obtained from Marine Science Centre fish farm at 18.7.2018, and transported to the study site by small truck. After acclimatization for two weeks, the fishes were stocked in earthen ponds with three treatments, each was replicated twice at different stocking densities of 0.7 (T1), 1.4 (T2) and 2.1 (T3) fish/m^2. No supplemental food was supplied to the fishes and natural food was the only source.

During the experiment, which lasted for 125 days, from 31.8. 2018 to 2.1.2019, weights of representative fish samples from each pond were measured with sensitive electronic top loading scale. Throughout this period, five samples were collected to calculate the following equations:

Weight gain (WG, g) = FW-IW

Daily growth rate (DGR, g/day) = FW-IW/days

Specific growth rate (SGR, %/day) = 100 * [(Ln FW) - (Ln IW)]/days

Where: FW = final fish weight (g) and IW = initial fish weight (g).

Water Quality Parameters

Water temperature and salinity were measured during every fish sampling period from each pond.

Statistical analysis

Values of growth for all the treatments and replicates were subjected to Analysis of Variance (ANOVA) and all mean values were compared by using the LSD tests at 0.5% probability level by SPSS program Ver. 22.

Figure 1: Map of southern Iraq showing Al-Hartha district and the study site. (Modified from Fitzpatrick, 2004).

Figure 2: Location of study site showing earthen ponds. (Google earth).

Results

Water Quality Parameters

Water quality parameters were within the tolerance range for rearing common carps in extensive systems (Figure 3). The maximum value of water temperature (29 ºC) was recorded in August, while the minimum value (14 ºC) was in January. The maximum value of water salinity (11.2 ‰) was also recorded during August and the minimum value (2.6 ‰) was during January.

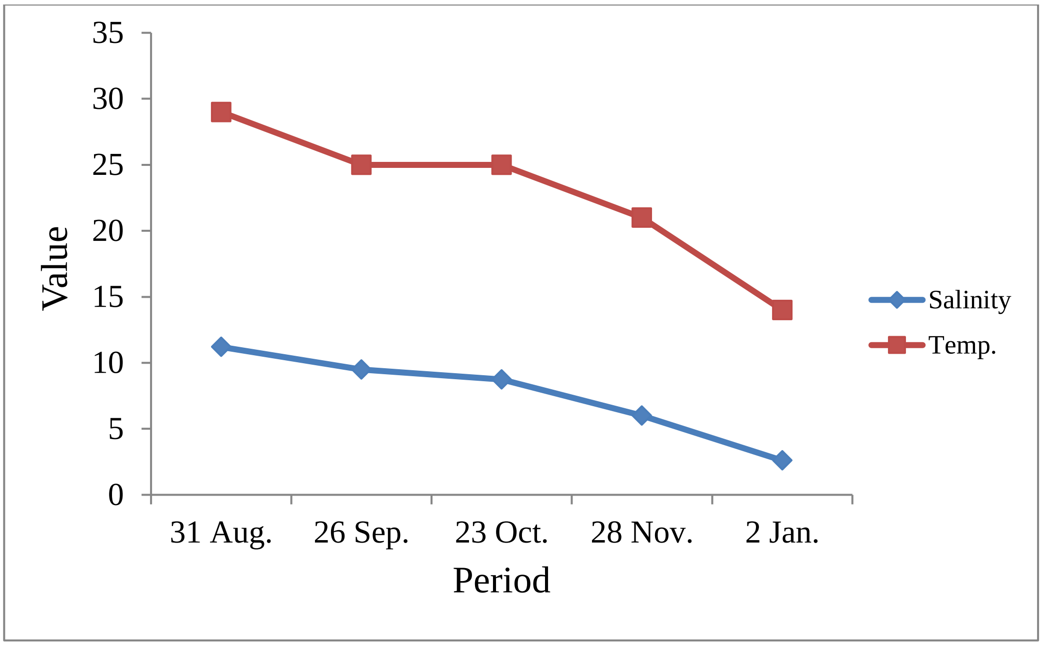

Figure 3: Water temperature (ºC) and salinity (‰) during the experiment period.

Growth Parameters

The mean weights of the common carps in the different treatments at different experimental periods were shown in Table 1. There was no significant difference (P>0.05) in initial weights, but in all subsequent periods, significant differences (P<0.05) were found between at least two treatments. The first treatment with 0.7 fish/m^2 showed significantly (P<0.05) higher final weight (42.10 g) at the end of the experiment compared to the other two treatments (31.63 and 21.30 g) T2 and T3, respectively.

Table 1: Weight of the common carps in different treatments during the experimental periods.

Date	Fish weight (g)		
	Ponds 1 & 2 0.7 fish/m^2 (T_1)	Ponds 3 & 4 1.4 fish/m^2 (T_2)	Ponds 5 & 6 2.1 fish/m^2 (T_3)
31.8.2018	$17.64^{a}\pm0.016$	$17.91^{a}\pm0.005$	$17.53^{a}\pm0.020$
26.9	$20.56^{ab}\pm0.191$	$25.71^{a}\pm3.507$	$17.94^{b}\pm0.113$
23.10	$22.55^{a}\pm0.608$	$26.40^{b}\pm1.386$	$19.25^{c}\pm0.283$
28.11	$30.07^{a}\pm0.142$	$33.52^{b}\pm0.707$	$22.25^{c}\pm0.191$
2.1.2019	$42.10^{a}\pm0.212$	$31.63^{b}\pm0.594$	$21.30^{c}\pm0.109$

Different letters in the same row are significantly different (P≤0.05).

Weight increments of fishes during the experimental periods (Table 2) were significantly (P<0.05) higher in T1, except for the first period (31.8- 26.9) as T2 showed higher value (7.80 g), while T2 and T3 revealed negative weight increments in the final period (28.11- 2.1).

Daily growth rate and specific growth rate showed the same trend as T1 was significantly (P<0.05) superior in the two parameters compared to the other two treatments in almost all periods (Table 2).

Table 2: Growth performance of fishes in different treatments during the experimental periods.

Period	Ponds 1 & 2 0.7 fish/m^2 (T_1)	Ponds 3 & 4 1.4 fish/m^2 (T_2)	Ponds 5 & 6 2.1 fish/m^2 (T_3)
	Weight increments (g)		
31.8- 26.9	$2.92^{a}\pm0.061$	$7.80^{b}\pm3.44$	$0.41^{a}\pm0.255$
26.9- 23.10	$2.00^{a}\pm0.417$	$0.69^{a}\pm2.121$	$1.31^{a}\pm0.170$
23.10- 28.11	$7.515^{a}\pm2.030$	$7.12^{a}\pm0.679$	$3.00_{b}\pm0.474$
28.11- 2.1	$12.04a^{\pm}2.510$	$-1.89^{b}\pm0.113$	$-0.95^{b}\pm0.021$
Period	Daily Growth rate (g/day)		
31.8- 26.9	$0.117^{ab}\pm0.002$	$0.312^{a}\pm0.137$	$0.017^{b}\pm0.011$
26.9- 23.10	$0.074^{a}\pm0.016$	$0.026^{a}\pm0.078$	$0.042^{a}\pm0.003$
23.10- 28.11	$0.209^{a}\pm0.057$	$0.198^{a}\pm0.019$	$0.083^{b}\pm0.013$
28.11- 2.1	$0.325^{a}\pm0.068$	$-0.051^{b}\pm0.003$	$-0.026^{b}\pm0.001$
Period	Specific growth rate (%/day)		
31.8- 26.9	$0.61^{ab}\pm0.007$	$1.43^{a}\pm0.530$	$0.07^{b}\pm0.028$
26.9- 23.10	$0.34^{a}\pm0.066$	$0.11^{a}\pm0.313$	$0.25^{a}\pm0.016$
23.10- 28.11	$0.80^{a}\pm0.206$	$0.60^{a}\pm0.001$	$0.42^{a}\pm0.206$
28.11- 2.1	$0.91^{a}\pm0.197$	$-0.16^{b}\pm0.006$	$-0.12^{b}\pm0.197$

Different letters in the same column are significantly different (P≤0.05).

Table 3 presents the final experimental results for the three stocking densities. The three parameters (weight gain, daily growth rate and specific growth rate) decreased significantly (P< 0.0.5) with increased stocking density. As expected, low density (0.7 fish/m^2) showed the highest values for the three parameters (24.46g, 0.18g/day and 0.66%/day, respectively). In all stocking densities, the survival rate were more than 90%.

Table 3: Average of weight increment, daily growth rate, specific growth rate, survival rate and yield of fishes during the experiment.

Treatment	Weight increment (g)	Daily growth rate (g/day)	Specific growth rate (%/day)	Survival rate (%)	Yield (kg/ha)
Ponds 1 & 2 0.7 fish/m^2 (T_1)	$24.46^a\pm0.962$	$0.18^a\pm0.007$	$0.66^a\pm0.016$	$95.37^a\pm3.563$	$281.06^a\pm4.006$
Ponds 3 & 4 1.4 fish/m^2 (T_2)	$13.72^b\pm0.523$	$0.12^b\pm0.009$	$0.50^b\pm0.005$	$96.84^a\pm5.644$	$433.14^b\pm9.141$
Ponds 5 & 6 2.1 fish/m^2 (T_3)	$3.77^c\pm0.070$	$0.03^c\pm0.001$	$0.16^c\pm0.005$	$95.85^a\pm4.791$	$422.93^b\pm27.253$

Different letters in the same column are significantly different (P≤0.05).

The three stocking densities exhibited different fish weight groups (Figure 4) as low density (T1) recorded a wide range, but more than 50% of fish weights were between 30 to 49 g, T2 between 20 to 39 g and T3 between 10 to 29 g. However, yield increased with increasing in stocking density and significant differences (P< 0.0.5) occurred between low density and the other two densities.

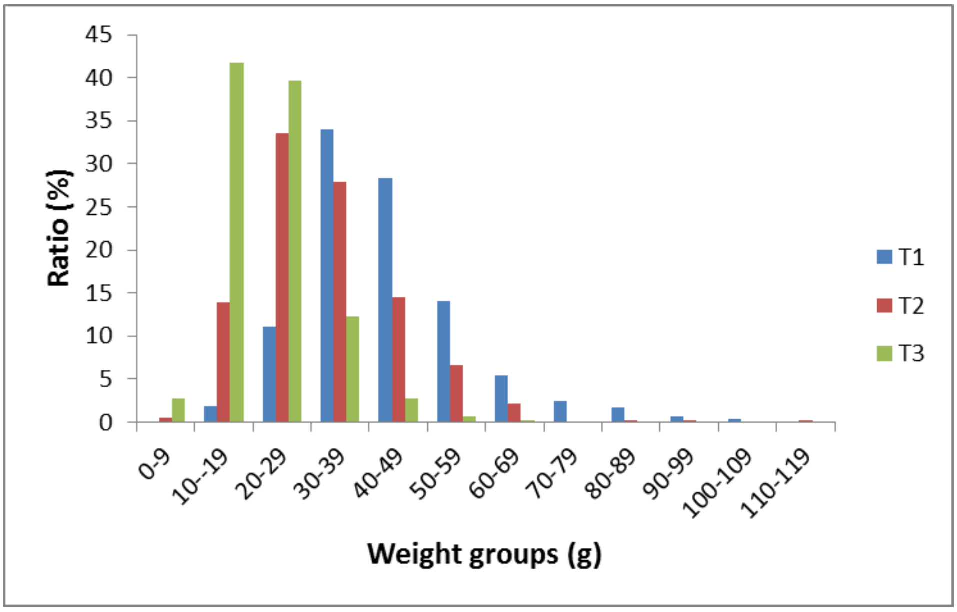

Figure 4: Ratio of weight groups in the three treatments in the earthen ponds.

Discussion

Aquaculture depends on the quality of water; the average value of the water temperature during the experimental period was 22.8 ^{o}C. At the beginning of January, the water temperature decreased significantly to a value of 14.0 ^{o}C. It was suggested that the desirable water temperature for carp culture in ponds should be from 20 to 30°C (Bhatnagar & Devi, 2013; Mocanu et al., 2015; Oprea et al., 2015) which was more or less similar in the present study. However, Al-Dubakel et al. (2018) recorded high mortality ratio of common carps during acute increasing of temperature in the same area. Salinity in the present study is considered high (mean = 7.6 ppt) for common carp culture. However, in its native range, common carps occur in coastal areas of the Caspian and Aral seas (Barus et al., 2001) as well as the estuaries of large Ukrainian and Russian rivers. Crivelli (1981) reported that the common carps occurred in brackish water marshes with salinities up to 14 ppt in southern France. In these salinities, even common carps could survive, but the growth is extremely affected. Common carp showed high appetitive behavior to food between 0 to 6 ppt salinities (Mangat & Hundal, 2014).

Currently, the main function of most fishponds is the production of fishes is based on utilization of the natural production potential of the pond ecosystem (Petrea et al., 2017). The results of low density (0.7 fish/m^2) in the present study conform to the recommendation of many studies which found that low density exhibited high weight gain (Musa et al., 2010; Hossain et al., 2014; Rumpa et al., 2016). The significant differences in weight gain after initial stocking, especially after one month, between low, moderate and high stocking densities may indicate that natural food supply became a restricted growth factor for common carps in earthen ponds. This was the time for using supplementary food if the stocking density was above 0.7 fish/m^2 regarding to water quality at the present study, especially salinity. Célestin et al. (2011) stated that in situation of low availability of food resources, the growth and the final average weight were much affected by high density treatment than the yield. Shafiullah et al. (2019) reported significantly higher ($p<0.05$) production in high density. Supplementary feed is required when the natural feed becomes scar, and the energy becomes limited not the protein (Nazish & Mateen, 2011). In comparison to current stocking densities observed in fish farms in Basrah province (1400-5800 fish/ha) as mentioned by Jassim et al. (2013), these densities are corresponding to the low density in the present study. However, unsuitable using of supplementary feeds practiced lead to unsuccessful and unsustainable fish culture operations in Basra, revealed low production and decreases in actual numbers of active fish farms.

A lower survival rate, most probably because of the higher stocking densities that were applied, found in the study of Petrea et al. (2017), was not recorded in the present study which was comparable with the findings of Hayat et al. (2018) and Shafiullah et al. (2019) where survival rate was not affected by stocking density.

Conclusions

The results of the present study have high applicability degree for aquaculture projects. The study concludes that 0.7 fish/m^2 is appropriate for common carp in earthen ponds. This low density utilizes the natural food, but in case of any further increase in stocking density, supplementary food must be applied, especially after one month of initial stocking.

Additional data collection and investigation are recommended to evaluate the impact of environmental and biotic factors on natural productivity, to a better understanding of its contribution in the whole fish culture production cycle.

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