JKAU: Mar. Sci., **Vol. 22**, No. 2, pp: 33-43 (2011 A.D. / 1432 A.H.)
DOI : 10.4197/Mar. 22-2.3

Growth Performance and Implication of a Thermal-Unit Growth Coefficient of Grass Carp *Ctenopharyngodon idella* and Silver Carp *Hypophthalmichthys Molitrix* Larvae Reared in Recirculation System

A.Y.Al-Dubakel[1]; A.A.Jabir[2] and **Q.H.Al-Hamadany[2]**
Department of Fisheries and Aquatic Resources, College of Agriculture, University of Basrah, Basrah, Iraq
Marine Science Center, Basrah University ,Iraq[2]
E-MAIL: [1]aaldubakel@yahoo.com ; [2]amirabdullah80@yahoo.com
qusayhamid@yahoo.com

Abstract. The present study evaluated the growth performance of two carp species *i.e*. grass carp *Ctenopharyngodon idella* and silver carp *Hypophthalmichthys molitrix* larvae reared in recirculation system and implication of a thermal unit growth coefficient (TGC) to quantify and predict its growth potential .The environmental factors of the water in the recirculation system was in the range of tolerance of both species where no mortality occurred. The result revealed that silver carp larvae growth performance was superior to grass carp larvae for all biotic indices as it reaches 0.802 g after 43days while its growth rate were 0.0301 g/day after 19 and 26 days from the start of experiment . TGC was 0.0578 for grass carp larvae and 0.0865 for silver carp larvae ,also the relation between observed and predicted growth of grass carp larvae was more matching than for silver carp larvae .It can be concluded that growth of grass and silver carp larvae in recirculation system were acceptable and the TGC values were fairly stable.

Keywords: Growth, carp, larvae, water recirculation, TGC.

Introduction

Limited resources of freshwater are today a serious problem in the world. Water consumption has shown exponential growth during the past few years (Lekang, 2007).Water quantity and quality beside suitable ground for fish culture consider the most critical problems facing fish culture projects especially for most economic species such as carp. The recirculation water systems solve these problems through reducing water and space demand compared to other systems. Recirculation or closed water systems continue to be used primarily for experimental work and for the rearing of larval organisms in commercial and research facilities, though increasingly, profitable commercial applications are being demonstrated (Stickney, 2000). The newly hatched larvae suffer from high mortality during nursery period that may be up to 70% after one month (Huisman, 1979); this may be due to variation in water temperature, unavailability of suitable food, predators, disease infections and its incomplete functional development (Lavens and Sorgeloos, 1996). The uses of recirculation system in larvae culture overcome these causes (Szlaminska *et al*., 1991). There have been many attempts to mathematically describe growth of fish using a large diversity of approaches and concepts (Iwama and Tauz, 1981; and Muller-Feuga, 1990). Ideally, growth models for fish and shrimp should offer possibility for comparing growth rates of animals of various sizes reared at various temperatures (Bureau *et al*, 2000).

Cho (1992) proposed the use of a thermal unit growth coefficient (TGC %) to predict the growth of a given species and stock of fish in relation to diet, husbandry, fish size, and temperature. Empirically derived growth patterns and rates for fish of a given species, diet, and rearing conditions are frequently used as the basis for calculating the daily ration of salmonids in aquaculture (Corey *et al.* 1983; Austreng *et al.* 1987; and Cho, 1992)however Jobling(2003) give cautionary note to use this model.

The aim of the present study was to evaluate the growth performance of two carp species *i.e*. grass carp *Ctenopharyngodon idella* and silver carp *Hypophthalmichthys molitrix* larvae reared in recirculation system and implication of a thermal unit growth coefficient (TGC%) to quantify and predict its growth potential.

Materials and methods

The newly hatched larvae (one week) were transported to the semi – closed recirculation system (Fig.1), it was comprised from four plastic tanks (1000 L,800L water) connected with biological filter and aeration for each tank .Water were circulated by automatic water pump (flow rate 9 L/min.).Tape water were used through the experiment after removal of chloride (salinity 1.2‰).The fish larvae were reared for 56 days, where the initial weight was 0.024 and 0.018 g for grass and silver carp respectively. Stocking rate was 300 larvae per tank .The larvae were fed fish and soybean meal besides *Artemia,* three meals per day for satiation for the first four weeks, then it was replaced with fine pellets (Table 1) with 10% B.W. /day to the end of the experiment.

Fig. 1. Semi – closed recirculation system used in the present study.

Table 1. Ingredients and protein content of the experimental diet used in the present study.

Ingredients	% (dry basis)	% Protein content	% Protein contribution
Fish meal	15	60	9
Wheat bran	30	9	0.9
Soybean meal	15	48	7.2
Yellowcorn meal	10	12	3.6
Rice bran	10	12	1.2
Wheat flour	20	10	2
Total	100		23.9

Fish were weighted periodically .Temperature, pH and dissolved oxygen were measured weekly. The following biological indices were calculated according to Jobling, (1993):

Weight increment = Final wt – Initial wt

Growth rate = Final wt – Initial wt/ Time

Specific growth rate (SGR) %/day = {ln Final wt – ln Initial wt/ Time}/100

Relative growth rate (RGR) %= Final wt – Initial wt/ Initial wt

In addition, the thermal unit growth coefficient (TGC) was calculated according to Cho, (1992):

$$(TGC) = [\text{Final wt}^{1/3} - \text{Initial wt}^{1/3}] / [\text{Temp. x Day}] \times 100$$

Results

Table 2 shows the environmental factors of the water in the present experiment in the semi-closed recirculation system where the average of water temperature was 23.96 ºC, pH 7.92 and concentration of dissolved oxygen 9.18 mg/ L .The survival rate of both species were 100%.

Table 2. Some water quality parameters in the recirculation system during the experimental period (8 weeks).

Week	Temperature (ºC)	pH	D. Oxygen (mg/L)
First	22	7.9	10.38
Second	23	7.5	10.30
Third	23	8.0	9.90
Fourth	25	7.9	9.40
Fifth	24	8.2	8.95
Sixth	24	8.0	8.20
Seventh	25	8.2	8.12
Eighth	26	8.0	8.20
Average	23.97	7.9	9.18

The weight increment of grass and silver carp larvae in different periods (Fig.2) were fluctuated without any significant difference ($P>0.05$) ,where the highest values were after 57 (0.516 g) and 43 days (0.802g) respectively while growth rate (Fig.3) were 0.00926 and 0.0301 g/day after 19 and 26 days from the start of experiment respectively .

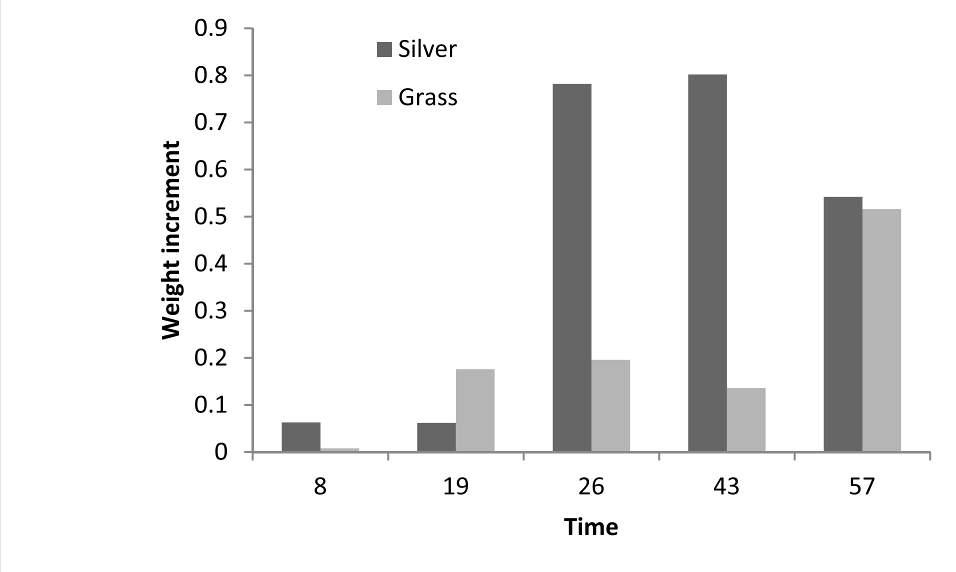

Fig. 2. Weight increment (g) of silver and grass carp larvae during the experimental period (days).

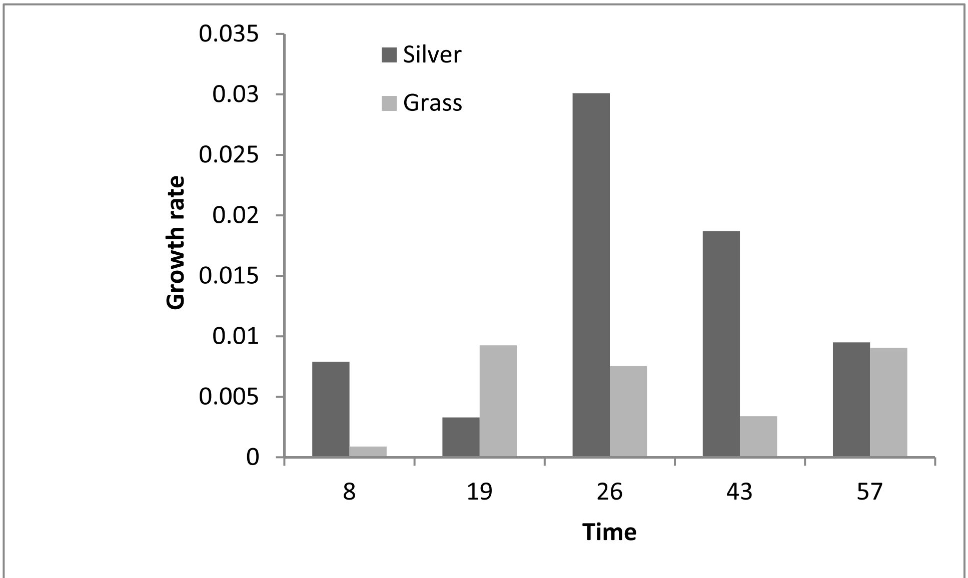

Fig. 3. Growth rate (g/day) of silver and grass carp larvae during the experimental period (days).

The results of specific growth rate (SGR%) as well as relative growth rate (RGR%) of grass and silver carp larvae during the experimental period (Fig.4 & 5) were also not significantly different ($P>0.05$) and revealed that after 19 and 8 days specific growth rate were 11.159 and 18.801 %/day while relative growth rate were 2150 and 4455.56 % after 57 and 43 days for the two species respectively.

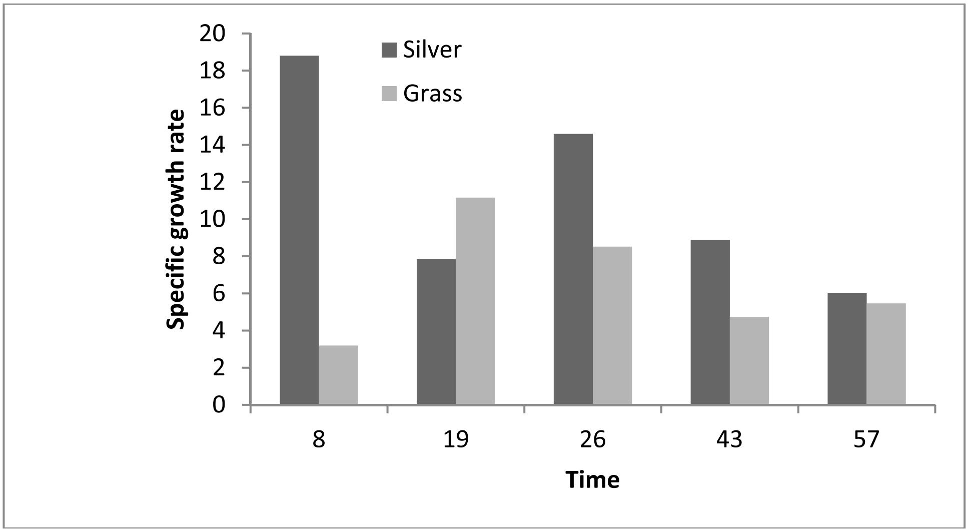

Fig. 4. Specific growth rate (SGR%) of silver and grass carp larvae during the experimental period (days).

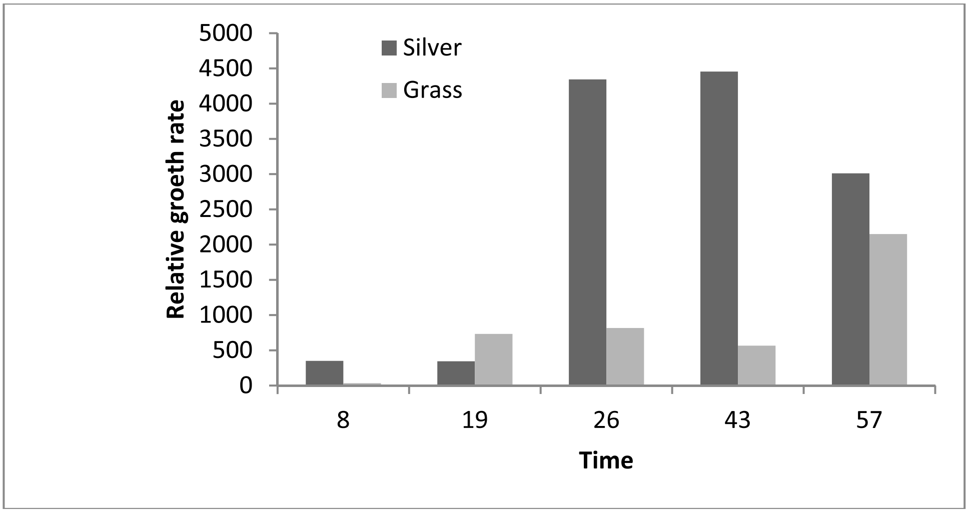

Fig. 5. Relative growth rate (RGR%) of silver and grass carp larvae during the experimental period (days).

Thermal unit growth coefficient (TGC%) as presented in Table 3 ranged between 0.0078 (40 days) to 0.0604(19 days) while the total was 0.0578 for grass carp larvae and 0.0084 (57 days) to 0.0890 (8 days) and 0.0865 for silver carp larvae respectively, also the relation between observed and predicted growth of grass carp larvae (Fig.6) during the experimental period using TGC model was more matching than for silver carp larvae particularly after 43 days, however the differences were not significant (P>0.05) for both species .

Table 3. Thermal unit growth coefficient (TGC%) of silver and grass carp larvae.

Days		Weight (g)		TGC (%)	
silver carp	grass carp	silver carp	grass carp	silver carp	grass carp
0	0	0.018	0.024		
8	9	0.081	0.032	0.0890	0.0135
19	19	0.143	0.208	0.0198	0.0604
26	26	0.925	0.404	0.0724	0.0235
43	40	1.727	0.54	0.0219	0.0078
57	57	2.269	1.056	0.0084	0.0149
Total				0.0865	0.0578

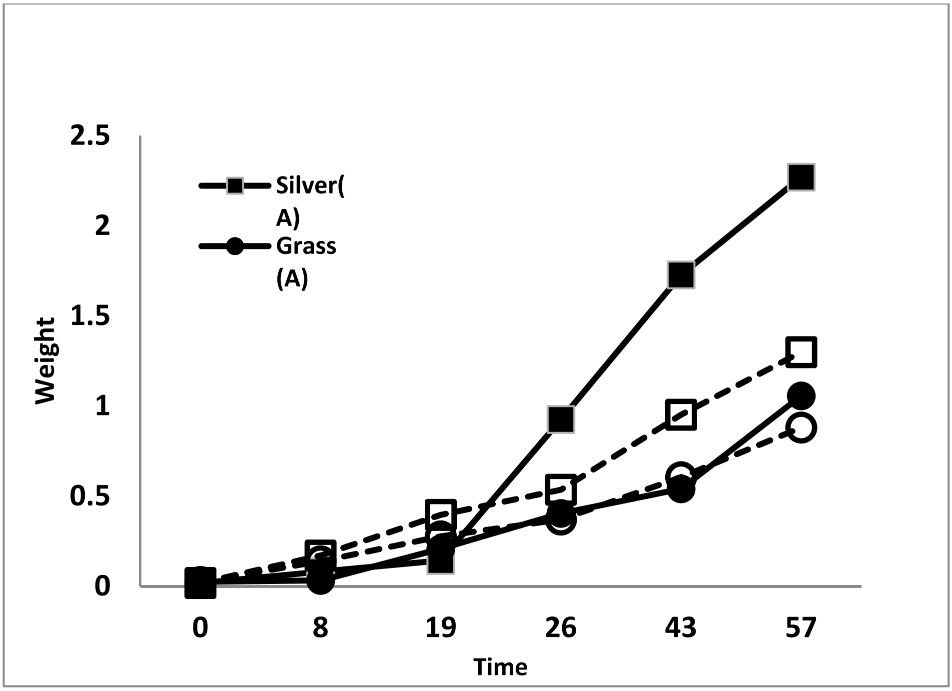

Fig. 6. Observed (A)and predicted (B) growth of silver and grass carp larvae (using TGC model) during the experimental period.

Discussion

Recirculation or closed water systems continue to be used primarily for experimental work and for the rearing of larval organisms in commercial and research facilities (Stickney, 2000).The present study demonstrated that the environmental factors of the water in the recirculation system was in the range of tolerance of both species, A water temperature between 20°C and 30°C is generally good for fish (Assiah *et al*., 2004). Grass carp tolerate a wide range of environmental extremes in temperature, pH, dissolved oxygen, and salinity (Masser, 2000). Silver carp larvae are tolerant of oxygen conditions as low as 0.5 mg/L ,also reported its larvae growth at pH 7.1-9.7 (USGS,2005).

The flow rate of water in the present experiment (9L/min) was not a limited growth factor since, water turnover times in culture chambers may exceed 24 hr for larvae and may be several times an hour for juveniles (Stickney, 2000).

The result revealed that growth of silver carp larvae was superior in comparison with grass carp larvae for all biotic indices, which reflect that the feeding regime and quality were more appropriate for the former, although Hepher, (1988) stated that most fish feed in their young (late larvae and fry stages) on zooplankton ,even when the larger fish becomes herbivorous, Wu *et al.* (1997) found that silver carp consume planktonic algae, but have also been reported to consume larger zooplankton. Various studies have demonstrated the beneficial effect of high-energy diets on growth and food conversion efficiency in fish (Steffens, 1989; and Cho, 1992), this could be explained by the work of Dabrowski and Kozak (1979), with grass carp fry, which found that an increased soybean meal content of the diet resulted in growth depression, which they attributed to incomplete destroyed trypsin inhibitor.

Since growth rate is highly dependent on species, genetics, nutrition, environment, husbandry and other factors, it is essential to calculate growth rate for a given aquaculture condition (Cho and Bureau, 1998).Talbot (1993) emphasizes that the most frequently used numerical description of growth is the instantaneous or specific growth rate (SGR%) , The results of the presently described growth with thermal-unit growth coefficient (TGC) , while it has only been demonstrated to be valid for salmonids, preliminary observations suggest that it also faithfully represent the growth curve of some non-salmonid fish species, such as the Nile tilapia, *Oreochromis nilotica* (Bureau *et al*, 2000) , using this coefficient for grass and silver larvae carp could be applicable as results were comparable to other studies, such as for *Leporinus macrocephalus* (Edivaldo *et al*., 2006).It was noticed that silver carp larvae were most sensitive to water temperate in the present study than grass carp larvae since at 26 ºC (after 57day) it has the lowest TGC value compared to 23 ºC ,but no significant correlation observed ,while Iwama and Tauz (1981) found strong evidences that at constant water temperature, cubic root of live weight of salmonids increases linearly with time when the fish are reared under optimal conditions.

From the results of the present experiment it can be concluded that growth grass and silver carp larvae growth in recirculation system were acceptable and TGC values were fairly stable. However silver carp was superior than grass carp and this needs more investigation.

References

Assiah van, E.; Schie, Tv. and **Hilbrands, A.** (2004) *Small-Scale Freshwater Fish Farming*. Agromisa Foundation, Wageningen, 79 pp.

Austreng, E., Storebakken, T. and **Asgird, T.** (1987) Growth rate estimates for cultured Atlantic salmon and rainbow trout. *Aquaculture* **60**: 157-160.

Bureau, B.P., Azevedo, P.A., Tapia-Salazar, M. and **Cuzon, G.** (2000) *Pattern and cost of growth and nutrient deposition in fish and shrimp: Potential implications and applications*. In: Cruz -Suárez, L.E., Ricque-Marie, D., Tapia-Salazar, M., Olvera-Novoa, M.A. Y Civera- Cerecedo, R., (Eds.). Avances en Nutrición Acuícola V. Memorias del V *Simposium Internacional de Nutrición Acuícola. 19-22 Noviembre, 2000.* Mérida, Yucatán, Mexico.

Cho, C.Y. (1992) Feeding systems for rainbow trout and other salmonids with reference to current estimates of energy and protein requirements. *Aquaculture*, **100**: 107-123.

Cho, C.Y. and **Bureau, D.P.** (1998) Development of bioenergetic models and the Fish-PrFEQ software to estimate production, feeding ration and waste output in aquaculture. *Aquatic Living Resources* **11**: 199-210.

Corey, P.D., Leith, D.A. and **English, M.J.** (1983) A growth model for Coho salmon including effects of varying ration allotments and temperature. *Aquaculture* **30**: 125-143.

Dabrowski, K. and **Kozak, B.** (1979) The use of fish meal and soyabean meal as a protein source in the diet of grass carp fry. *Aquaculture*, **18:**107-114.

Edivaldo, B.N.; Rodrigo, E.B.; Robson, F.C. and **Helton, C.D.** (2006) Effects of Betaine on the Growth of the Fish Piauçu, *Leporinus macrocephalus. Brazilian Archives of Biology and Technology*. **49**: 757-762.

Hepher, B. (1988) Nutrition of pond fishes. Cambridge Univ. press. 338 pp.

Huisman, E.A. (1979) *Report of the EIFAC Workshop on Mass Rearing of Fry and Fingerlings of Freshwater Fishes*. F.A.O. Rome, EIFAC /T35.

Iwama, G.K., Tautz, A.F. (1981) A simple growth model for salmonids in hatcheries. *Can. J. Fish. Aquat. Sci.* **38**: 649-656.

Jobling, M. (1993) *Bioenergetics: feed intake and energy partitioning*. In Fish Ecophysiology**,** pp. 1-44 [J. C.Rankin and F. B. Jensen, editors]. London: Chapman Hall.

Jobling, M. (2003) The thermal growth coefficient(TGC)model for fish growth: a cautionary note. *Aquaculture Reserch*. **34**: 581-584.

Lavens, P. and **Sorgeloos, P.** (1996) *Manual on the Production and use of live food aquaculture*. F.A.O. Fisheries Technical Paper No. 361. Rome, 295 pp.

Lekang, O.I. (2007) *Aquaculture Engineering*. Blackwell Publishing Ltd. 340 pp.

Masser, M.P. (2000) *Aquatic vegetation control.51 – 61 Encyclopedia of aquaculture* / [edited by] R. R. Stickney.

Muller-Feuga, A. (1990) *Modélisation de la croissance des poissons en élevage*. Rapports scientifiques et techniques de Ifremer, n°21, 58 pp

Steffens, W. (1989) *Principles of Fish Nutrition.* Chichester: Ellis Honvood.

Stickney, R.R. (2000) Recirculation water systems.722 -731Encyclopedia of aquaculture / [edited by] Robert R. Stickney.

Szlaminska, M.; Escaffre, A.M. and **Bergot, P.** (1991) Utilization of dietary pregelationized starch by Common carp (*Cyprinus Carpio L.*) Iarvae. *J. Anim. Physiol. a. Anim. Nutr.*, 65-71.

Talbot, C. (1993*) Symposium on 'Fish and Nutrition' Some aspects of the biology of feeding and growth in fish* .Proceedings of the Nutrition Society A meeting of the Scottish Group of the Nutrition Society was held at the University of Aberdeen on 7-8 April I993, **52**: 403-416.

USGS. (United States Geological Survey) (2005) http://fisc.er.usgs.gov/Carp_ID/index.html

Wu, L.; Xie, P; Dai, M. and **Wang, J.** (1997) Effects of silver carp density on zooplankton and water quality: implications for eutrophic lakes in China. *Journal of freshwater, Ecology* **12**: 437-444.

أداء النمو وتطبيق وحدة الحرارة (TGC) ليرقات الكارب العشبي والكارب الفضي المربّيان في نظام تدوير الماء

عادل يعقوب الدبيكل[١]، وعامر عبدالله جابر[٢]، و قصي حامد الحمداني[٢]

قسم الأسماك والثروة البحرية، كلية الزراعة، جامعة البصرة ، البصرة،العراق[١]

مركز علوم البحار، جامعة البصرة، العراق[٢]

E-mail: [1]aaldubakel@yahoo.com [2]amirabdullah80@yahoo.com [3]qusayhamid@yahoo.com

المستخلص. تهدف الدراسة الحالية لتقييم نمو يرقات نوعين من الكارب هما الكارب العشبي *Ctenopharyngodon idella* والكارب الفضي *Hypophthalmichthys molitrix* المرباة في نظام تدوير الماء وتطبيق معامل النمو لوحدة الحرارة (TGC) لتقييم والتبوء بإمكانيات النمو. كانت العوامل البيئية للماء في نظام تدوير الماء ضمن مدى تحمل كلا النوعين ولم تسجل أية وفيات. أظهرت النتائج أن يرقات الكارب الفضي تفوقت على الكارب العشبي في جميع المقاييس الحياتية، ووصل وزنها ٠,٨٠٢ جم بعد مرور ٤٣ يومًا بينما كان معدل النمو ٠,٠٣٠١ جم/يوم بعد مرور ١٩ و ٢٦ يومًا من بدء التجربة. وجد أن معامل النمو لوحدة الحرارة (TGC) ليرقات الكارب العشبي ٠,٠٥٧٨ وللكارب الفضي ٠,٠٨٦٥، كما وجد أن العلاقة بين النمو المشاهد والمتوقع ليرقات الكارب العشبي متطابقة أكثر من يرقات الكارب الفضي. يستنتج من الدراسة الحالية أن نمو النوعين في نظام تدوير الماء مقبول وأن قيم TGC كانت ثابتة.

الكلمات المفتاحية: النمو، الكارب، اليرقات، تدويرالماء، TG.