Alexandria Journal of Veterinary Sciences
www.alexjvs.com

AJVS. Vol. 57 (2): 87-94 April 2018.
DOI: 10.5455/ajvs.301007

Effect of Nursery Age (Stunting) and Density on Polyculture Performance of Mullet Species; *Mugil Capito* and *Mugil Cephalus*

Waleed N. El-Hawarry
Department of Animal Husbandry and Animal Wealth Development, Faculty of Veterinary Medicine, Alexandria University. Egypt.

Key words:
Nursery age (stunting), Stocking density, Polyculture, *Mugil capito*, *Mugil cephalus*.

***Correspondence to:**

waleed.elhawarry@alexu.edu.eg

ABSTRACT

Eight earthen ponds (4-5 feddan pond^{-1}) were used for polyculture of *Mugil capito* and *Mugil cephalus*. Each pond was assigned a rearing density and a nursery age for both *M. capito* and M. cephalus. For each species of mullet, a 2 x 2 factorial design was assembled with two age groups (A1, A2) and two stocking densities (low stocking density; LSD and high stocking density; HSD) in an experiment extended for 214-days. Juvenile *M. capito* (A1; 16 months and 3.32 ± 0.37: 4.23±0.37g) and *M. cephalus* (A1; 8 months and 6.86±0.55: 8.22±0.55 g) were distributed into two earthen ponds (pond no 1 and 2) and stocked at two densities; *M. capito* (Low stocking density “LSD”, 1200 fish feddan-1 and high stocking density “HSD” 2000 fish feddan^{-1}) whereas *M. cephalus* were stocked at rates of 500 fish feddan^{-1} (LSD) and 1000 fish feddan^{-1} (HSD). The second age group fish (A2) of each species; *M. capito* (A2; 28 months and 7.28±0.37: 7.61±0.37 g) and *M. cephalus* (A2; 20 months and 12.8±0.55: 13.29±0.55 g) were also distributed in another two ponds (pond no 3 and 4) with the same density trend applied for the first age group fish where each treatment was duplicated. The obtained results notify the significant effect ($P < 0.05$) of both nursery age (stunting) culture density in the growth of both species with regard to the FBW, TBG and SGR %. The highest FBW, TBG and SGR (%) was attained by *M. capito* and *M. cephalus* having longer nursery age (stunting) and cultured at LSD. Whereas the NFY and TFY increased as the culture density did. Additionally and irrespective of culture density the RTFY impressively improved ($P < 0.05$) as the nursery age (stunting) increased. This study clarified that increasing space and food availability as compared to what is happening in the nursery ponds together with the nursery age (stunting) had synergistic effects in the subsequent culture period. Also, increasing the nursery duration (stunting) had relieved the density effect for both species when compared to their younger mates maintained at LSD. It can be concluded that stunted mullet species showed compensatory growth in both stunted groups. Also, the availability of good-quality fry or juveniles together with the nursery age (stunting period), stocking density, as well as the market size preferability, would be of concern in polyculture of *M. capito* and *M. cephalus*.

1. INTRODUCTION

Fish harvests from aquaculture surpassed one million tonnes per year positioning Egyptian aquaculture eighth among the preeminent fish producers on the planet (FAO, 2016). Tilapia is the foremost species; it accounts for more than half of all fish produced through aquaculture. Tilapia is followed in importance by mullets and together these two species contributed 85.1 % of total aquaculture production (El-Sayed, 2017). Since polyculture improves the utilization of accessible assets to deliver benefits associated with advanced ecological stability and increases producer profitability (McKinnon et al., 2002). Nile tilapia, mullet and carp polyculture principally practiced in freshwater and brackish earthen ponds (El-Sayed, 2007). The cultured species are different in their ecological requirements and feeding behaviors thus they effectively utilize the natural food available in the pond (Zimmermann and New 2000). Tilapia and Mullet are mainly practiced by private farms as tilapia-mullet polyculture rather

than tilapia monoculture (Dickson 2016). Extruded feed is supplied to semi-intensive polyculture ponds to cover only the feeding requirements of both tilapias and carps grown in the same ponds; mullets profit from the remains of artificial feed for tilapias and carps (Sadek 2016).
Several mullet species are cultured of which *Mugil capito*
(Thin-lipped mullet) and *Mugil cephalus* (flathead grey mullet) have higher growth rates hence; they are the species of choice for Egyptian farmers (Saleh, 2008). The production of both species reached 119 647 Ton ranking Egypt as the world leader in mullet production (FAO. 2016).). The culture of mullet depends on fries collected from the wild (Saleh, 2008). The largest portion of mullet production is dedicated to *Liza ramada* due to its higher seed availability as compared to *M. cephalus* (Sadek and Mires, 2000).

On the other hand, it is well known that fish display stunted growth or suppression when reared under high stocking density (Pickering, 1981; Wedemeyer and McLeay, 1981; Wedemeyer, 1997) or experience diet limitations and/ or starvation for a transitory or extended period (Ali et al., 2003; Abdel-Hakim et al., 2009). Stunted individuals of many fishes exhibited an accelerated growth behavior in a phenomenon known as compensatory growth (CG) including rohu, *Labeo rohita* (Das et al., 2016), bighead carp (Santiago et al., 2004), sunfish (Hayward et al. 1997), Nile tilapia (Little et al., 2003; El-Hawarry, 2006) and African catfish, (Ali and Jauncey, 2004). This compensatory growth occurs as a response to safeguard the deviancy from the ultimate growth course during their re-alimentation period (Ali et al., 2003). Therefore, this phenomenon had dragged the attention, principally in commercial aquaculture, as it represents a way to ameliorate fish growth performance since its intensity can force some fish species to show higher growth rates than continuously fed ones. Such reports, approving and alongside the CG response in the various studied species constitute vagueness on the existence of the phenomenon.

Concerning mullet species; they grow slowly at their initial life stage (Hickling, 1970; Bishara, 1978; De Silva, 1980; Saleh, 2008) hence the direct stocking of small fry (15-25 mm) to growout ponds yield small sized fish. Therefore, initial rearing step will be a prerequisite to get fingerlings (100-120 mm) that attain higher growth rates during the culture period. Fry of *M cephalus* are kept in the nursery ponds for four-six months (from August-November till April) until they are about 10 g in weight. Over-wintered mullet fingerlings are sold for on-growing in various culture systems, but especially in semi-intensive ponds (Saleh, 2008). When fingerlings survival and availability surpasses culture needs, they are reserved in the nurseries at high stocking densities for the next growout season.

This has likewise turned into a prominent tactic to secure a continuous supply of mullet fingerlings at culture time. Despite the fact that fish culturist trust that these stunted fingerlings attain higher growth rates in the ensuing culture stage, the idea does not have any logical premise because of few investigations. Accordingly, some fundamental inquiries come with regards to stunted mullet fingerlings: do they display CG in the following culture period? Does the CG reaction, assuming any, connect to the nursery duration or the subsequent culture density of the stunted fingerlings? Is the stunted mullet size at stocking neglected by the fish culturist hence conveying biased results?

Therefore this study aims to clarify the influence of nursery age (stunting) and stocking density on the growth performance, production parameters and the related water quality of *M. capito* and *M. cephalus* under semiintensive culture condition.

2. MATERIAL AND METHODS

2.1. Experimental fish

This experiment was conducted in a private fish farm located in Edko, Bhaira Governorate, Egypt. Overwintered *M. capito* and *M. cephalus* fingerlings were obtained from four different nursery ponds belong to the farm. For each species two ages were chosen; the *M. capito* nursery ages were 16 and 28 months (i.e. stunted for 16 and 28 mos), whereas, the *M. cephalus* were 8 and 20 months (i.e. stunted for 8 and 20 mos).

2.2. Experimental design and set up

The experimental design and set up is displayed in table 1. Eight earthen ponds (4-5 feddan pond^{-1}) were used for polyculture of *M. capito*, *M. cephalus* and tilapia. Each pond was assigned a rearing density and a nursery age for both *M. capito* and *M. cephalus*. The stocking density of Nile tilapia was fixed at 12600 fish feddan^{-1} in all experimental ponds. For each species of mullet, a 2 x 2 factorial design was assembled with two age groups (A1, A2) and two stocking densities (LSD and HSD) in an experiment extended for 214-days.

Table (1): Experimental design

Nursery Age	***Age 1***				***Age 2***			
Pond number	Pond1		Pond2		Pond3		Pond4	
Species	*M capito* (16 mos)	*M. cephalus* (8 mos)	*M. capito* (16 mos)	*M. cephalus* (8 mos)	*M. capito* (28 mos)	*M. cephalus* (20 mos)	*M. capito* (28 mos)	*M. cephalus* (20 mos)
Stoking density (fish $feddan^{-1}$)	1200	500	2000	1000	1200	500	2000	1000

Juvenile *M. capito* (A1; 16 months and 3.32 ± 0.37: 4.23±0.37g) and *M. cephalus* (A1; 8 months and 6.86±0.55: 8.22±0.55 g) were distributed into two earthen ponds (pond no 1 and 2) and stocked at two densities; juvenile *M. capito* were stocked at rates of 1200 fish $feddan^{-1}$ (LSD) and 2000 $feddan^{-1}$ (HSD) whereas *M. cephalus* were stocked at rates of 500 $feddan^{-1}$ (LSD) and 1000 $feddan^{-1}$ (HSD). The second age group fish (A2) of each species; *M. capito* (A2; 28 months and 7.28±0.37: 7.61±0.37 g) and *M. cephalus* (A2; 20 months and 12.8±0.55: 13.29±0.55 g) were also distributed in another two ponds (pond no 3 and 4) with the same density trend applied for the first age group fish where each treatment was duplicated.

2.3. Pond preparation and management

Pre-stocking dryness of all ponds was carried out for 4 weeks. Thereafter initial fertilization was carried out using poultry manure at the rate of 500 kg $feddan^{-1}$ (Green et al., 2002). Then water was allowed to fill the ponds to maintain a water column of 30 cm for 7-10 ds. Thereafter the different fish species were distributed in each pond as assigned in the experimental design. The water level was then elevated to 1.5–1.75 m within a week. To keep high natural pond productivity, poultry manure was applied daily to attain nitrogen, phosphorus inputs, of 28 kg N ha^{-1} $week^{-1}$ and 7 N ha^{-1} $week^{-1}$ (Lin et al., 1997). Supplemental feeding was adjusted biweekly and provided to meet the daily feed requirements of tilapias grown in the same ponds whereas the tested species (*M. capito* and *M. cephalus*) profit from the uneaten feed provided to tilapia (Sadek 2015).

2.4. Water quality sampling and analysis procedure

For each pond assigned in this study, water samples were gathered from five places (Boyd and Tucker 1992). The collected water samples from each pond were pooled together to obtain a one litter sample $pond^{-1}$. The dissolved oxygen (Oxyguard handy III, Oxyguard International, Birkerod, Denmark, DO; mg l^{-1}) and pH (Wide range pH paper; 1-14, Whatman, UK) of each sample were measured in the farm. The homogenously pooled samples were then taken to the laboratory to measure the total ammonia nitrogen (TAN; mg l^{-1}), organic matter (mg l^{-1}) and total hardiness (mg l^{-1}) (HACH Company analytical kits, Loveland, CO 80539 USA). Also, the water temperature was determined daily (°C) while the water transparency (cm) of each pond was measured biweekly (12:00-13.00 hours) (Boyd and Tucker 1992). Also, the total phytoplankton *(*cells ml^{-1}*)* and zooplankton (animals' l^{-1}) were estimated following the methods described in APHA (2012).

2.5. Growth measurements

At the pre-stocking immediate time, the fingerlings of each tested species and age were counted and batch weighted during its collection from their respective nursery ponds. Biweekly samples were also weighed to monitor the growth rates. At final harvest, fishes were washed, species differentiated, size graded and batch weighed in plastic boxes (25 kg fish box^{-1}) and the total number of fish was determined for each experimental pond. The following growth variables were calculated; final body weight (FBW, g $fish^{-1}$), total body gain (TBG, g $fish^{-1}$), specific growth rate (SGR, % day^{-1}), net fish yield (NFY, kg $feddan^{-1}$), total fish yield (TFY, kg $feddan^{-1}$) and relative total fish yield, were calculated. The survival rate was also calculated.

2.6. Statistical analysis

The growth and yield attributes in terms of cumulative weights and growth variables (i.e., FBW, TBG, SGR %, NFY and TFY) of *M. capito and M. cephalus* of different nursery (stunting) age polycultured under different stocking densities were calculated and analyzed.

2.6.1. Total body gain (TBG g $fish^{-1}$) = Mean final weight – Mean initial weight

2.6.2. Specific growth rate (SGR, % day^{-1}):

$$\mathrm{SGR}\ \% = \frac{\mathrm{Ln}\ \mathrm{W}_1 - \mathrm{Ln}\ \mathrm{W}_0}{\mathrm{T}} \times 100$$

Where W_1 = final mean fish weight (g), W_0 = initial mean fish weight (g), t= time in days and Ln= natural log.

2.6.3. Total fish yield (TFY, kg $feddan^{-1}$)

TFY = Mean final weight × number of fish at harvest

2.6.4. Net fish yield (NFY, kg $feddan^{-1}$)

NFY= Total harvest weights - initial weight of stocked fish

2.76.5. Survival Rate (SR, %)

SR% = Final No. of fish /initial No. of fish ×100

The diverse growth factors are elements of body weight of fish (Jobling, 1994; Wootton, 1998). At the start of the experiment, there were noticeable variances in the initial weight of the tested mullet species. Consequently, the means of the initial mullet weights should be adjusted to get rid of the initial weight effect on the subsequent production variables. Hence, the appropriate analysis of covariance (ANCOVA) was performed where the initial mullet weight was taken as a covariate (Huitema, 2011). Analysis of variance was also applied to assess the effects of the treatment of on water quality criteria and total yield of both species. SAS (2004) was used for analysis of data; significant differences were deliberated at $P < 0.05$.

3. RESULTS

The growth and yield as well as the survival of both *M. capito* and *M. cephalus* polycultured together are presented in table 2. The obtained results notify the significant effect ($P < 0.05$) of both nursery age (stunting) culture density in the growth of both species with regard to the FBW, TBG and SGR %. The highest FBW, TBG and SGR (%) was attained by *M. capito* and *M. cephalus* having longer nursery age (stunting) and cultured at LSD. Whereas the NFY and TFY increased as the culture density did. Additionally and irrespective of culture density the RTFY impressively improved ($P < 0.05$) as the nursery age (stunting) increased (Figure 1). Likewise, there was a significant difference ($P < 0.05$) in the survival rate among different mullet groups. However, it should be noted that survival rate was generally high. No mortalities observed among mullet species throughout the culture period hence these differences might be due to a count error at the start of the experiment. Regarding the water quality parameters (table 3); no significant effect ($P > 0.05$) detected among the different treatments except for the dissolved oxygen contents but still, it was within the desirable limits required by both species. Also, the zooplankton content considerably differed with the highest levels observed in the ponds stocked with young mullets (nursery age1) at LSD.

Table (2): Growth and yield attributes (LS means + SE) of stunted *M. cephalus and M. capito* juveniles in subsequent polyculture grow-out phases

*For each species; means within the same raw with different superscript are significantly different (p< 0.05).
**FBW, g fish^{-1}: final body weight, TBG (g fish^{-1}): total body gain, SGR (% day^{-1}): specific growth rate, NFY (kg feddan^{-1}): net fish

Species	***M. capito***				***M. cephalus***			
Nursery age (stunting)	***16 mos***		***28 mos***		***8 mos***		**20 mos**	
Stoking density (fish feddan^{-1})	**1200**	**2000**	**1200**	**2000**	***500***	***1000***	***500***	***1000***
Initial weight	3.32±0.37^{b}	4.23±0.37^{b}	7.28±0.37^{a}	7.61±0.37^{a}	6.86+0.55^{b}	8.22+0.55^{b}	12.8+0.55^{a}	13.29+0.55^{a}
FBW (g fish^{-1})	238.28±9.42^{b}	141.02±7.72^{c}	438.01±8.21^{a}	213.19±8.83^{b}	253.28±9.42^{b}	156.02±7.72^{c}	488.01±8.21^{a}	263.19±8.83^{b}
TBG (g fish^{-1})	232.67±9.42^{b}	135.41±7.72^{c}	432.4±8.21^{a}	207.58±8.83^{b}	242.98±9.42^{b}	145.73±7.72^{c}	477.72±8.21^{a}	252.9±8.83^{b}
SGR (% day^{-1})	1.79±0.02^{b}	1.52±0.02^{c}	2.09±0.02^{a}	1.76±0.02^{b}	1.52±0.02^{b}	1.28±0.02^{c}	1.83±0.02^{a}	1.55±0.02^{b}
NFY (kg feddan^{-1})	241.87±15.61^{c}	235.66±12.79^{c}	479.27±13.59^{a}	421.99±14.62^{b}	111.94±7.19^{c}	138.07±5.89^{b}	233.46±6.26^{a}	245.68±6.73^{a}
TFY (kg feddan^{-1})	248.88±15.62^{c}	245.31±12.82^{c}	484.64±13.63^{a}	433.99±14.66^{b}	117.85±7.13^{c}	147.49±5.84^{b}	237.72±6.21^{a}	256.24±6.68^{a}
SR (%)	94.74±0.43^{b}	97.34±0.35^{a}	96.04±0.38^{b}	97.79±0.41^{a}	95.87±0.17^{a}	95.48±0.14^{b}	96.23±0.15^{a}	96.42±0.16^{a}
RTFY (%)	100	99	195	174	100	125	202	217

yield, TFY (kg feddan^{-1}): total fish yield SR (%): survival rate and RTFY ***(%):*** relative total fish yield, were calculated.
Relative total fish yield (RTFY)*** is reported in relation to the yield of young nursery age at low stocking density of each species

Table (3): Yield attributes (LS means + SE) of polycultured *M. capito* and *M. cephalus* as affected by nursery age (stunting) and stocking density

Treatment Parameters	*Nursery Age1* *(M. capito;* 16 mos and *M. cephalus*; 8 mos)		*Nursery Age2* *(M. capito;* 28 mos and *M. cephalus*; 20 mos)	
	LSD	HSD	LSD	HSD
Total net fish yield (kg feddan^{-1})	389.72±16.08^{b}	395.34±16.08^{b}	686.53±16.08^{a}	636.3±16.08^{a}
Total fish yield (kg feddan^{-1})	393.51±15.88^{b}	403.05±15.88^{b}	694.26±15.88^{a}	651.12±15.88^{a}
Relative total fish yield (%)	100	102	176	165

* Means within the same raw with different superscripts are significantly different (P < 0.05).
Nursery Age1, LSD: *M. capito*: (16 mos; 1200 fish feddan^{-1}) and *M. cephalus*; (8 mos; 500 fish feddan^{-1})
Nursery Age2: *M. capito* (28 mos; 2000 fish feddan^{-1}) and *M. cephalus*; (20 mos; 1000 fish feddan^{-1})

Table (4): Physico-chemical parameters of water in different treated ponds of various *M. capito and M. cephalus* groups (least squares means ± standard errors) through 214 days polyculture period.

Treatment	*Nursery Age1* *(M. capito;* 16 mos and *M. cephalus*; 8 mos)		*Nursery Age2* *(M. capito;* 28 mos and *M. cephalus*; 20 mos)	
Parameters	LSD	HSD	LSD	HSD
DO (mg l^{-1})	6.06±0.21^{ab}	6.11±0.21^{ab}	6.49±0.21^{a}	5.57±0.21^{b}
Ammonia (mg l^{-1})	0.06±0.03	0.07±0.03	0.05±0.03	0.06±0.03
pH (mg l^{-1})	7.71±0.2	7.43±0.2	7.5±0.2	7.5±0.2
Transparency (cm)	16.71±1.07	14.43±1.07	15.43±1.07	13.43±1.07
Organic matter (mg l^{-1})	46.29±6.4	47.57±6.4	48.64±6.4	52.86±6.4
Total hardiness (mg l^{-1})	31.57±3.41	29.57±3.41	24.43±3.41	25.71±3.41
Temperature	26.35±0.19	26.35±0.19	26.35±0.19	26.35±0.19
Total Phytoplankton (cells ml^{-1})	652.43±51.68	589.71±51.68	609.71±51.68	583.14±51.68
Total Zooplankton (animals l^{-1})	837.71±40.47^{a}	742.86±40.47^{ab}	717.86±40.47^{b}	720±40.47^{b}

* Means within the same raw with different superscripts are significantly different (P < 0.05).

4. DISCUSSION

In the wild, stunting in fish could be due to resource limitation arising from intraspecific density dependence (Ylikarjulaet al., 1999). In aquaculture, stunting is related mainly to husbandry techniques (De Graaf al., 1996). The Mullet species fingerlings in the present study obtained from a population nursed at high stocking conditions. This manipulation of space and food quality hindered growth and weight gains. Generally, advanced nursery (stunting) duration of *M capito and M cephalus* had yielded compensatory growth. Meanwhile, the elongation of nursery period had improved the growth pattern of both *M capito and M cephalus* as compared to their younger mates. Saleh (2006) revealed that *M cephalus* can reach 750–1000g when polycultured with tilapia and carp in 7-8 months growing season after nursery phase (from August-November till April). He also added that if this population continued for another growing season they grow to 1500–1750 g. The relatively rapid growth in ponds exhibited by the stunted mullet presumed to be due to a larger rearing space with higher food availability in the growout ponds hence accounting for growth compensation (Degraaf et al. 1996; Jobling and Koskela 1996; Nicieza and Metcalfe 1997; Ylikarjula et al.1999). Similarly, Biswas et al. (2017) conveyed higher net fish yield from periphyton- fertilized pond when *M. cephalus* L reared in brackishwater ponds. Also, stunted rohu and mrigal had attained higher compensatory growth rates than younger fish (Hossain et al., 2003).

In the meantime the influence of culture density was quite clear in this investigation; increasing culture density had decreased the growth rates of both *M. capito* and *M. cephalus*. However, increasing the nursery duration had relieved the density effect for both species when compared to their younger mates maintained at LSD. Rearing density is a fundamental element governing the production of any aquaculture species (Jobling, 1995; Yi et al. 1996; Hengsawat et al. 1997 and Maragoudaki et al., 1999). The space available and its full use under intensive culture conditions are critical for the farm profitability. Results of this study (Table 2 and 3) demonstrated a direct relationship between stocking density and TFY (kg feddan^{-1}) and also NFY (kg feddan^{-1}). This is in accordance with several earlier studies that addressed positive yield-density relationships, (e.g. Delincé, 2013; Yi et al. 1996). However, the relationship between the fish yield and the number of stocked juveniles should be considered with regard to the preferred final weight both for the individual species and the total fish yield of both species.

Regarding the total yield of both species and irrespective of stocking density, the present study provided clear evidence of the advantage of polyculture of *M. capito* and *M. cephalus* as each species attained normal growth pattern. There was no interaction between cultured species as appeared by the growth increment maintained by both mullet species. This might be attributed to the feeding habit of each. *M. cephalus* boosted phytoplankton propagation through removing major consumers (zooplankton). Additionally, they stalwartly revised the benthic community, probably through direct consumption (Torras *et al*., 2000). A conclusion that was additionally confirmed by the different levels phytoplankton and zooplankton detected in this study (table 3). Similarly, Abdel-Hakim et al., (2001) noted an improved performance of tilapia, mullet and eel when polycultured in earthen ponds compared with each species monoculture. Likewise, Ammar et al. (2008) reported higher growth performance and net returns when Nile tilapia (15000 feddan^{-1}) and *Mugil cephalus* (750 feddan^{-1}) polycultured together and fed extruded pellets.

The reordered survivals among the treatments were 94% to 97% and 95 % to 96% for *M. capito* and *M. cephalus* respectively. Similarly, cage culture of stunted mullet juveniles in the Nile cages stocked at appropriate density (8,000 fish cage^{-1}, 11.4 fish m^{-3}) attained both high growth rate (0.83 g fish d^{-1}) and survival rate (99.0%) (Essa et al., 2012). Also, the SR % detected in this experiment was much higher than the earlier (80%-95%) observed survivability in the *M. cephalus* high stocking monoculture (Bakeer et al., 2008). However, it should be noted that the issue of stunted fingerlings or nursery duration was not clarified in the later study. Such levels were also higher than the range (75%–88%) reported in rohu from different studies of carp polyculture in India (Das et al., 2004; Jena and Das, 2011; Sahu et al., 2007). Das et al. (2016) described a positive correlation between juvenile stunting and growout survival existed and this wide range of survival to the differences in the nursery duration (non-stunted fry to highly stunted population). The longer nursery (stunting) duration possibly steered a regular eradication of poor quality juveniles in the population, resulting in an increased grow-out phase survival.

No significant differences detected in total ammonia, transparency, organic matter, pH, total hardiness and temperature the treatment ponds (Table 4). The DO levels were within the appropriate levels as defined by Boyd and Tucker (2012). Values of total ammonia ranged between 0.05 and 0.07 mg l^{-1} and thus were lesser than the extreme concentration of TAN (1.0 mg l^{-1}) recommended in the earlier literature (Meade 2012; Lawson 1995; Ridha and Cruz 1998).

5. CONCLUSION

This study clarified that increasing space and food availability as compared to what is happening in the nursery ponds together with the nursery age (stunting) had synergistic effects in the subsequent culture period. Increasing levels of natural feed were complemented by the greater demand from larger, faster-growing fish as carrying capacity was increased. There was no interaction between cultured species as appeared by the growth increment maintained by both mullet species. Also, increasing the nursery duration (stunting) had relieved the density effect for both species when compared to their younger mates maintained at LSD. Management or profitability of polyculture depends on the fish species combinations, stocking rates, climate, pond fertility and market demand for fish; hence it can be concluded that for the stunted mullet species in this experiment, the availability of good-quality fry or juveniles together with the nursery age (stunting period), stocking density as well as the market size preferability would be the main concern.

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