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Reproductive performance and the growth of pre-stunted and normal Nile tilapia (*Oreochromis niloticus*) broodfish at varying feeding rates

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Abstract

A 119-day experiment was conducted to investigate the effects of feeding rate and reproductive performance of stunted (S) and non-stunted or normal (N) Nile tilapia (*Oreochromis niloticus*). Both the groups were reared in tanks re-circulated with bio-filtered water and fed with floating pellets (30% crude protein) twice daily. Seed were harvested weekly from the mouths of incubating females. The study showed that early stunting with subsequent high feeding rate can improve both growth and reproductive output in female Nile tilapia. Broodfish type and feeding rate showed significant ($P<0.05$) effects on both the frequency of spawning and the seed output. In general, seed output from normal broodfish increased linearly over the experimental period at all the feeding rates. However, seed output from stunted broodfish showed a linear increment for 3% feeding rate, exponential increment for 2% but quadratic for 1% showing decline after 10th week of the trial period. Results also showed that trends of seed output from stunted broodfish increased linearly with the increase in feeding rate showing that optimum rate could be higher than 3%. While from normal group the relationship was quadratic; increasing from 1%, peaked at 2% and declined at 3% feeding rate. Final GSI of the stunted females was significantly ($P<0.05$) higher than that of normal females. The GSI of stunted fish showed a decreasing trend with the increased feeding rate. Both the broodstock groups fed at 1% biomass grew linearly whereas at 2 and 3%, they grew exponentially. As compared to the normal, stunted broodfish had significantly ($P<0.05$) higher fat content in viscera although similar levels were in carcass and ovary. Carcass fat content was significantly ($P<0.05$) lower in fish fed at 1% biomass but significantly ($P<0.05$) higher in the ovary and viscera of fish fed at 3% biomass. This study shows that tilapia hatchery operators could manipulate the seed production according to the seasonal demand by using appropriate broodstock stunting and feeding strategies.

Keywords: Nile tilapia; Broodfish; Reproduction; Stunting; Seed production; Feeding rate

As a female *Oreochromis* produces small clutches of eggs, commercial hatchery operators have to keep and manage a large number of broodfish to fulfill the demand for seed. For instance, more than 60,000

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working broodfish are required to produce 5–10 million fry per month (Bhujel et al., 2001a,b). Moreover, broodfish grow continuously even when reproducing at a high frequency (Macintosh and Little, 1995). Bigger fish require more feed and space and are difficult to handle while seed harvesting; therefore, broodfish need to be replaced frequently. Tilapia hatchery operators have to make the same number of broodfish ready to replace the working broodstock. Therefore, cost associated with broodstock production and maintenance is one of the major parts of operation cost for commercial tilapia hatcheries. Broodstock management is one of the most important aspects of tilapia seed production (Bhujel, 2000). In the tropics, Nile tilapia (*Oreochromis niloticus*) can reproduce throughout the year. However, lack of spawning synchrony among females (Little et al., 1993) and the failure of induced spawning further intensify the problem of mass seed production on a commercial scale predictably.

Availability of water quite often restricts the market for seed to less than 6 months of a year in various parts of the world. Typically in Thailand, for example, demand for tilapia fry peaks for a period of only 6 months (May–August) in a year when farmers have enough water to stock fish. Appropriate techniques have to be developed to prevent the tilapia broodfish from spending energy to produce fry during low demand and to boost the fry production quickly when high demand starts. One of the suitable ways to prevent tilapia broodfish from spawning might be the stunting which can be achieved using restricted feeding, stocking at high densities and/or holding at low temperatures (Mironova, 1978; Dan and Little, 2000b).

Stunting or growth retardation in tilapia has been reported by several authors in experimental ponds as well as natural water bodies due to over crowding, limited food supply and other environmental stresses (Loya and Fishelson, 1969; Iles, 1973; Bruton and Alllanson, 1974; Eyeson, 1983; Blühdom and Arthington, 1990; Heath and Roff, 1996; Coward et al., 1998; Takagi, 2001). As stunting of any organism to the extent at which the ability of the living organisms is not affected to perform vital functions to survive i.e. below critical level of starvation, is a phenotypic change or reversible process. The stunted fish can compensate the growth including bone growth afterwards when they are exposed to suitable environments and fed sufficiently (Björnsson et al., 1989; Dan and Little, 2000a; Takagi, 2001). Although the phenomenon of compensatory growth is not clearly understood, it is due either to hyper-phagic response by fish, higher metabolic efficiency or the adaptation with low energy requirement for maintenance during stunting phase that allows more energy mobilization for growth in the later phase (Avault, 2000; Gaylord and Gatlin, 2001). Stunting in fish during winter is common natural phenomenon in temperate regions while intentional over-wintering has been a common practice in aquaculture in sub-tropics. It has been found to be profitable in grow-out culture of channel catfish and other species (Hatch et al., 1998). However, limited work has been carried out in reproductive performance. During over-wintering or stunting period, females may loose up to 80% of their body lipids and a substantial reduction may occur in males hampering their sexual maturation (Jobling et al., 1998; Morgan and Metcalfe, 2001). In Baltic herring, egg number, but not the size, was found to be affected by over-wintering just before spawning season. On the other hand, over-wintering of broodstock in prawn has been found to be technically and economically feasible (Canese et al., 1995). More over, increased broods and synchronized reproduction have been achieved from over-wintered female mosquito fish, *Gambusia affinis* (Hynes and Cashner, 1995). Research on over-wintering in tilapia is limited. Studies in Northern Vietnam has reported that over-wintered tilapia fry grew faster than normal fry, with improved economic performance (Dan and Little, 2000a,b). However, whether pre-stunting with restricted feeding of Nile tilapia broodfish had any impacts on the subsequent reproduction, seed output and growth of broodfish were not known. This study was; therefore, carried out to compare the performance of pre-stunted and normal Nile tilapia broodfish at varying feeding rates.

1. Materials and methods

A 119-day experiment was conducted at the Asian Institute of Technology (AIT) near Bangkok, Thailand in a re-circulated, bio-filtered water system using 18 circular tanks (area 1.75 m^2, 50 cm depth) under a roof of galvanized iron sheets. Water flow was maintained at 8–10 L/min in all the tanks which were also aerated. Eight concrete bricks were placed in each tank perpendicularly to the tank wall to provide nesting sites for broodfish (Little et al., 1993).

1.1. Experimental fish and feed

Two groups of broodstock derived from the same *Chitralada* broodstock line of Nile tilapia (*O. niloticus*) maintained at the Asian Institute of Technology (AIT) were used in the experiment. The attributes of the brood fish i.e. normal (N) or non-stunted and stunted (S) group are presented in Table 1. Age of the normal broodfish at which they spawned was 4 months (3 months + 1 week between hatching and swim-up stage + 3 weeks between stocking and spawning). Growth of