Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2021; 9(4): 231-233

Received: 10-05-2021
Accepted: 14-06-2021

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Comparative growth performance of diploids and triploids Snow Trout (*Schizothorax richardsonii*)

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Abstract
A field study of 60 days was conducted to evaluate the growth performance of the diploid and triploid *Schizothorax richradsonii,* which is one of the preferred indigenous food fish in Himalayan region. Slow growth of this fish is the major constraint for being a candidate species for coldwater aquaculture. Due to extra genetic material, triploid fish remain more heterozygous and supposed to be useful for increasing growth. Triploids were produced by heat shock after post fertilization of eggs. The control group of diploids was observed for final body length and weight in the range of 32.9±0.83mm to 33.0±0.84 mm (0.89±0.083g to 0.91±0.081g), while treated triploids were observed as 42.8±0.79 to 43.25±0.77 mm (1.05±0.033 to 1.07±0.033 g). Observed data showed a significant difference ($p < 0.05$) with 17.58% higher growth in triploids over diploids. Survival rate was in the range of 94-96% without any significant difference in both the groups. Study showed feasibility for achieving better growth of this fish in captive rearing with triploids.

Keywords: *Schizothorax richardsonii*, triploidy, heterozygous, post fertilization

1. Introduction

Schizothorax richardsonii is one of the dominant genera in Schizothoracinae group. In the group Schizothoracid, the species is widely distributed all along the Himalayas in India. Snow trout, a cold water autochthonous riverine and short-distance migratory fish, locally known as "Asela". Of the aquaculture interest, their inherent biological features such as slow growth, maturity at small size are the main constraints hindering their growth and population increase (Wagle, *et al*., 2015) [30].

Triploid sterile fish are beneficial in aquaculture due to extra genetic material and more heterozygocity. In triploids, most of the anabolic energy is transferred to somatic growth (Akhmad, *et al*., 2020) [1]. Somatic growth is one of the most fundamental biological processes required for survival and thus has important fitness consequences, and growth rate is frequently used as an indicator of the capacity to acquire food resources (Arnott *et al.,* 2006; Stephen *et al*., 2006; Pang *et al*., 2016a) [2, 24, 18]. Triploidy is characterized by the change in normal diploid (2n) set of chromosomes to the state of triploid (3n) with an additional set of chromosome (Beaumon and Hoare, 2003; Dunham, 2004; Haffray, 2005; Kalbassi and Johari, 2008; Kapuscinski and Miller, 2007) [3, 7, 10, 12, 13]. As compared to diploids, triploid cells are relatively big and will have a larger nucleus, however the ratio between the cytoplasm and the nucleus is constant (Benfey *et al*., 1999; Piferrer *et al*., 2009) [4, 19]. Increased cell size in triploids applies to all tissues and cells of the body. Several production related differences have been observed between triploid and diploid with respect to survival and hatchery performance (Taylor *et al*. 2011) [26], growth and harvest quality (Taylor *et al*. 2013; Cleveland *et al*., 2013) [27, 6], feeding behaviour (Preston *et al*. 2014), nutrient requirements (Burke *et al*., 2010; Fraser *et al*., 2012) [5, 9], body composition and energy reserves (Manor *et al.,* 2012) [5]. Based on the above reviews, the purpose of the present study is to investigate the effect of triploidization on growth performance of triploid with their diploid counterparts.

2. Materials and Methods

The study was carried out at ICAR-Directorate of Coldwater Fisheries Research (DCFR), situated at Bhimtal (Latitude 29^0 21'N, Longitude 79^0 34'E, 1370 masl), Uttarakhand. Approximately, 200 fries/tray (n=200) of both triploid and diploid stocks were reared for 60 days in triplicates under flow through system into trays (45cmx45cmx24cm) fitted in trough (240cmx60cmx30cm) with water flow rate of 0.5 l/min. mature wild brooders of *Schizothorax* *richardsonii* of age group 2-3 years were used for the production of diploids and triploids. Triploidy was induced by thermal shock at 28 °C temperature for 10 min. after 10 min. of post fertilization (Solar *et al*., 1984) [23]. After heat shock eggs were kept for incubation in trays with continuous water flow. Direct method of karyotyping, standardized by Felip *et al*. (2009) [8] based on Kligerman and Bloom (1977) [14] for obtaining chromosome plates from newly-hatched fish larvae was followed for conformity of ploidy. Initial length and weight of fry was recorded for both the groups in triplicates. Final survival was recorded for each rearing tray. Statistical analysis was done by one way analysis of variance (ANOVA) with 5% significance level.

3. Results

The growth performance of tested fish groups are shown in table-1, which showed that the triploid growth was significantly higher ($p < 0.05$) than the diploid. The observed final body length and weight data recorded for diploid (control) ranged between 32.9±0.83mm to 33.0±0.84 mm (0.89±0.083g to 0.91±0.081g) and triploid (treatment) 42.8±0.79 to 43.25±0.77 mm (1.05±0.033 to 1.07±0.033 g) in different rearing replicates. The data were analyzed by one way analysis of variance (ANOVA) for initial and final body length and weight analysis. Initially there was no difference observed on body length and weight between the control (diploid) and treated (triploid) group in all the replicates. After rearing of 60 days growth data showed a significant difference ($p < 0.05$) in length and weight of diploid and triploid fishes and it was observed that there is 17.58% better growth of triploids over diploids in initial larval rearing of 60 days (Fig-1, 2). The survival rate in control (diploid) and treated (triploid) replicates was observed in the range of 94-96% without any significant difference.

Table 1: Growth performance in terms of length and weight of triploid and diploid *S. richardsonii* in 60 days rearing.

Parameters	SET 1		SET 2		SET 3	
	Control (Diploid)	Treated (Triploid)	Control (Diploid)	Treated (Triploid)	Control (Diploid)	Treated (Triploid)
Avg. Initial length(mm)±SD	16.0±1.01a	15.9±1.01a	16.0±1.01a	16.0±0.101a	16.0±1.01a	15.9±1.01a
Avg. Final length(mm)±SD	32.97±0.83b	42.8±0.79c	33.0±0.84b	43.25±0.77c	33.0±0.83b	43.0±0.72c
Avg. Initial weight(g)±SD	0.05±0.055a	0.05±0.005a	0.05±0.005a	0.05±0.005a	0.05±0.005a	0.05±0.005a
Avg. Final	0.89±0.083b	1.06±0.34c	0.9±0.084b	1.07±0.033c	0.91±0.081b	1.05±0.033c

Data expressed as Mean±SD (n=40) values with different superscripts in a column are significantly different one way ANOVA ($p < 0.05$)

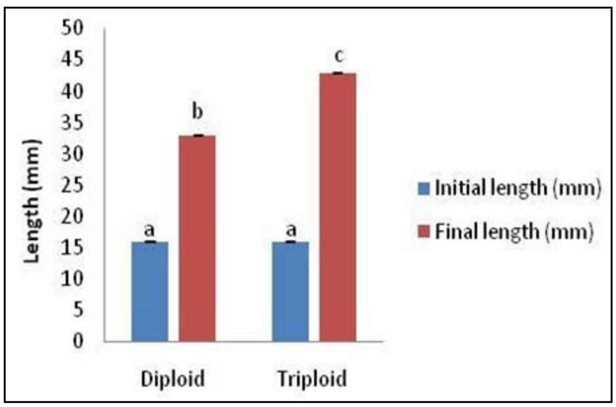

Fig 1: Initial and final Length of snow trout in 60 days rearing

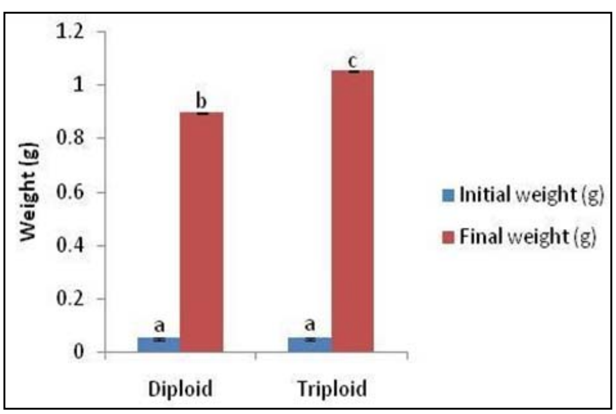

Fig 2: Initial and final weight of snow trout in 60 days rearing

4. Discussion

In general, triploids are functionally sterile due to the irregular meiotic division resulting in aneuploid gametes (Tiwary, *et al.,* 2004) [28]. Hence, it is expected that triploids would retain a normal growth (Henken *et al.,* 1987; Mol *et al.,* 1994) [11, 16]. Pradeep, *et al*., (2012) [20]; Akhmad, *et al*., (2020) [1] studied that the increase in triploid growth is due to the influence of sterility. Wang *et al*., (2015) [31] observed better growth in triploid salmon over the diploids. Higher growth rates of female triploid fishes have been shown for rainbow trout, *Oncorhynchus mykiss* (Suresh and Sheehan, 1998; Sheehan *et al*., 1999) [25]. In catfish and tilapia, triploids have a better growth rate than diploids at maturation (Tiwary *et al.,* 1997) [29]. Nwachi (2011) [17] stated that a triploid *Clarias gareipinus* grew faster and larger than its ordinary diploids. Results of the present study are in conformity of the earlier studies. Pradeep *et al.,* (2013) [21] reported inferior survival in triploid tilapia rather than diploids, but in contradictory present study does not reflect any significant difference in survival of diploid and triploid snow trout.

5. Acknowledgement

The authors express sincere gratitude to ICAR-Directorate of Coldwater Fisheries Research Bhimtal (Uttarakhand) for providing facility to carry out the work successfully and smoothly. They are also grateful to faculty of Fishery Sciences, West Bengal University of Animal and Fisheries Sciences, Kolkata for able guidance to carry out the study.

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