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Egg incubation and larval rearing of rainbow trout (*Onchorhynchus mykiss)* at higher thermal regime in mid hills

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Abstract
Culture and hatchery management of rainbow trout is a temperature dependent activity. An attempt has made to observe the response of higher thermal regime of optimal range on incubation, growth and survival rate of eyed ova of this fish in coldwater condition. Incubation and larval rearing were observed at temperature range of 16-200C for 90 days at Bhimtal. 10000 eyed ova were used during the observation. Vigorous aeration and water flow at 1.5 LPM was maintained for the favorable environment. During the observation hatching was observed on 8d at hatching rate of 69%. Survival of larvae after 90 days of observation was recorded as 64%. The results showed a successful incubation and larval rearing at higher thermal regime, however, sufficient Dissolved Oxygen and water flow is required for getting desirable results in mid hills.
The findings enable the feasibility of hatchery operation of this species even at higher thermal regime.

Keywords: rainbow trout, egg incubation, higher thermal regime, hatching rate, survival.

Introduction
The Himalaya is known as the 'water tower' of Asia Besides thousands of glaciers and permanent snow covered peaks, there are thousands of glacial lakes, and many large rivers and their hundreds of tributaries originate here. Hence, coldwater fishery occupies an important position among all freshwater fishery activity of India. Rainbow trout (*Oncorhynchus mykisss)* is an exotic fish species of salmonid family and considered one of the important coldwater fish species due to its delicacy, nutritional prospects and game fish nature. Rainbow trout culture is a temperature dependent field activity which requires cool, clean and continuous flowing water as the basic requirement for this species. Temperature is one of the most important criteria for the trout culture and ideal temperature for trout farming is 10-16 °C (Boyd and Tucker, 1998) [1].

Temperature is the main abiotic factor that influences the life cycle of poikilotherms. The water temperature should not exceed beyond 20 °C. Temperature is inversely proportional to the dissolved oxygen.

Thus, an increasing temperature will reduce the dissolved oxygen in the culture system. At water temperatures below 4 °C and above 20 °C the intensity of its nutrition and growth is reduced. Temperature above 20 °C is not conducive for trout, but the lethal temperature as a function of temperature acclimation is from 24.9 to 26.3 °C (Matschak *et al*., 1998) [2]. From many studies, the critical thermal maxima (CTM) for *O.mykiss* is approximately 24 - 26 °C (Bidgood 1980) [3].

[CTM's are calculated by steadily increasing the temperature of a water body until fish movements become disorganised and/or its sense of balance is upset and normal activity is no

longer possible (Currie *et al*. 1998) [4]. At 18 °C, rainbow trout feed very intensively, but the digestion of consumed feed remains less at this temperature. The water temperature in the range of 13 °C to 16 °C is optimal for growth, utilization of feed and the maximum appetite of rainbow trout. Cold water fish have a specific type of metabolism: their metabolic rate may continue at relatively low temperatures, otherwise at high temperatures, usually above 20 °C they consume less food and become less active. Water temperature also has a strong influence on the initiation and course of the fish diseases. The immune system of most fish species has optimal performance at a water temperature about 15 °C (Schmidt & Nielsen, 1991) [5]. (Joshi, 2009) [6] reported egg incubation period of 61 days at water temperature 4.5 – 7.5 °C with a survival rate of 42.6 %. Of all environmental factors to date in poikilothermic vertebrates, temperature exerts the most significant influence on all aspects of biology in fishes (Conover & Kynyard, 1981) [7] (Policansky, 1982) [8] (Seikai *et al.*, 1986) [9] (Polo *et al*., 1992) [10] (Fuiman *et al.*, 1998) [11] (Koumounddouros *et al.*, 2001) [12] (Pandey, 2015) [13] reported better performance was achieved with best nutrition and feeding to brooders as fertilization rate 94%, survival upto eyed ova 87%, hatching rate 92% and cumulative survival of 78%. Several studies have already been made on the effect of higher temperature on sex ratio (Ospina-Alcarez and Piferrer, 2008) [14] and on embryonic development and performance in salmonids (Beachem and Murray 1990) [15] (Ojanguren *et al*., 1999) [16]. Previous studies also indicate that temperature based genetic variation has been observed between strains, populations but also between families within the same population (Baroiller *et al*, 2009 [17], (Magerhans *et al.*, 2009) [18]. The aim of this field study was to assess the consequences of the exposure to higher temperature than the average optimum
temperature required to rainbow trout eggs during incubation and larval rearing when Dissolved Oxygen was maintained at optimum level.

Material and Method

An observational study for 90 days was undertaken to evaluate the consequences of exposure to high temperature regime of coldwater conditions to the eyed ova of rainbow trout in terms of hatching, growth performance and survival. The experiment was conducted at Bhimtal, Uttarkhand at MSL of 1332 m, where the temperature ranged between low to moderate (in summer 15 °C to 29 °C, while winter temperature ranges from 4 °C to 18 °C (Malik & Panwar, 2014) [19]. Ten thousand eyed ova (21 d old at 7-90C water temperature) transported from Trout farm Patlikhul, Himachal Pradesh were used for the observation. The eyed ova incubation and larval rearing was conducted at temperature range of 16-200C. The obtained eyed ova were introduced to a flow-through hatching troughs (240x240x170 mm) with a maintained water flow of 1.5LPM and vigorous aeration was provided by aerators to maintain conducive environment. Observations were made for hatching period, hatching %, survival and yolk absorption at temperature range of 16-200C. The larval rearing was done till 90 d with the recording of initial and final length-weight and survival. After yolk absorption the swim up fry were fed manually 8- 10 times a day, on formulated feed of ICAR-DCFR, Bhimtal. These are improved feed having low FCR, farm design with greater efficiency, optimization of stocking density, brood stock maintenance and hatchery practices (Pandey and Ali, 2015). The quantity of feed is expressed as percentage of the weight of the fish being fed (Vass *et al.*, 2010) [20]. The quantity of feed was depending upon weight of the stock, temperature of water and response of the fish to eat (Sehgal, 1999) [21]. To the better prevention from any fungal *(Saprolagnia spp.)* infection eyed ova were treated with a standard dose of malachite green (@ 0.02 mg/l) by flushing through (Sehgal *et al.*, 1976) [22]. All relevant water quality parameters were estimated regularly as per standard methods (APHA, 1989) [23]. The juveniles were reared in FRP tank having carrying capacity of 10000 larvae with water volume of 2m2. The larvae were reared in this tank upto fingerling stage for next 60 d and were observed for growth performance and survival.

Result and Discussion

Incubation of fertilized eggs

The hatching started to begin after 8th day of eyed ova stage (21 d old eyed ova at 7-9 0C) at the temperature range of 16-200C. Due to higher thermal regime the incubation of egg begin earlier and hatching took place in 29 days and last for next 2-3 days. The fish were reared in the trays itself till the complete absorption of yolk material. The complete absorption of the yolk took 9-12 days with final survival of 69%. A survival of 78% was recorded from alevin to swim up fry stage. Joshi (2009) [6] reported 60% fertilization, 80% hatching and 61% survival of fry to fingerling (Incubation period 58 d) at water temperature 5-12 °C. In another field experiment Joshi (2010) [24] reported 71% fertilization, 72% hatching (Incubation period 54 days) was observed at water temperature 6-14 °C. Similar trend was followed by the present study but incubation period of 29 d might have effect by thermal variation during incubation.

Table 1: Observation during the incubation and larval rearing

Sr. No.	Measures/ Parameters	Unit
1.	Total numbers of egg	10000
2.	Temperature during first incubation phase (till 21 d)	7-9 0C
3.	Temperature during second incubation (till hatching)	16-200C
4.	Hatching begin to start	8 d
5.	Total incubation day	29 d
6.	Hatching %	69%
7.	Yolk sac absorption	9-12 d
8.	Survival % alevin to swim up fry	78%
9.	Survival % hatching to till 90 d	64%

The size of yolk-laden alevin ranged from 15-18mm. Advance alevin started feeding after 10-12 d of hatching. The fry attained average length of 28.0±3.0 mm with corresponding weight of 0.48±0.07g after completion of experiment. A higher temperature imposes two antagonistic effects on growth: increased temperature has a negative effect on the growth due to higher energy cost for maintenance metabolism, but a negative due to higher efficiency of transforming food energy into net energy (Sheather, 1994) [25]. The growth rate increases with increasing temperature but within the temperature range tolerated by a fish species. In present observation all the fluctuation in temperature considered as optimal variation for earlier hatching and faster Incubation.

Water Quality Parameters during experimentation

Overall the water quality parameters were fairly suitable for rearing of rainbow trout fry. Temperature ranged between 16-200C; dissolved oxygen 7.0-8.8 mg/l; pH 7.0-8.2, free CO2

nil to 2.0 mg/l, total alkalinity 50.0-60.0 mg/l and TDS ranged between 85.0-105.0 g/l during the experiment. While Nitrate recorded 1.0-2.0 mg/l and nitrite recorded in the range between nil to 1.1 mg/l. Trout requires more than 7 ppm dissolved oxygen (DO) (Gibson's Limited 1998) [26].

The preferred pH range for trout is between 6.5 and 8.0 with optimum value between 7.0-7.5. At higher pH levels, relatively low level of ammonia can also be dangerously toxic (Bromage & Shepherd 1990) [27].

Conclusion

The present observation provides a basis for the increasing temperature due to the impact of changing climate would not be effected the egg incubation and larval rearing of this species in mid-hill condition if DO and water flow is maintained to meet the favorable conditions for egg incubation and larval rearing for trout.

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