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Assessing the Effectiveness of Cow Manure and Gypsum Soil Amendments in Mitigating Sodic Soil Conditions and their Influence on the Length-weight Relationship of *Labeo rohita*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aquaculture practices in sodic soil conditions pose significant challenges, necessitating the exploration of sustainable and efficient methods to promote fish growth. This study focused on investigating the growth of *Labeo rohita* fry under sodic soil conditions in circular plastic tanks. The experiment involved seven treatments with varying levels of cow dung and gypsum application, conducted in triplicate sets. Results showed a diverse relationship between length and weight in *L. rohita*, with regression coefficients ranging from 0.242 to 3.234 across treatments. The findings indicated negative allometric growth for treatments T1 to T6 and the control group, where length increased more rapidly than weight, resulting in a slimmer profile as the fish grew. In contrast, treatment T7 exhibited positive allometric growth, with the highest doses of cow dung and gypsum, suggesting that weight increased more rapidly than length.

Keywords: Cow dung; gypsum; L. rohita; length weight relationship; sodic soil.

1. INTRODUCTION

The relationship between length and weight in fishes is a fundamental aspect of their biology and ecology. This relationship is not only crucial for understanding the growth patterns and overall condition of individual fish but also has implications for population dynamics and ecosystem functioning. Essentially, it describes how the weight of a fish changes as its length increases or decreases. Each species of fish has specific length-weight relationships that can vary between sexes, stocks, or geographical regions [1]. The length-weight relationship is crucial for assessing the condition of fishes, with weight per unit length indicating good condition [2]. It helps in estimating biomass, setting up yield equations, and differentiating small taxonomic units. Additionally, this relationship aids in determining the condition factor of fish and detecting seasonal changes in their condition, which can reflect food availability and growth dynamics [1] Studying the length-weight relationship in fishes is essential in fish biology for a multitude of reasons. This relationship serves as a fundamental tool for assessing fish populations and understanding their health and condition. By analyzing the numerical estimates derived from the length-weight equation, we can gauge the well-being of fish populations and make comparisons across different groups.Additionally, this relationship helps in understanding fish growth dynamics by revealing whether growth is isometric, negatively allometric, or positively allometric, thereby shedding light on how fish change in shape and size as they mature [3].

The length-weight analysis in fishes differs from other morphometric characters in several key ways. While morphometric and meristic characters provide valuable information about the size, shape, and countable traits of fish species, the length-weight relationship focuses specifically on the quantitative relationship between the length and weight of individual fish [4]. Additionally, the length-weight analysis serves as a sustainable proxy for assessing the "fatness" and general health of fish species, providing insights into their overall condition and growth patterns [5].

Rohu, scientifically known as *L. rohita*, is a prominent freshwater fish species widely distributed across South Asia, including countries like India, Bangladesh, Nepal, Pakistan, and Myanmar. This fish is highly adaptable to various aquatic environments such as rivers, lakes, reservoirs, and ponds, making it a crucial component of both natural ecosystems and aquaculture in the region [6]. Numerous studies have been conducted on the length-weight relationship of *L. rohita* under diverse dietary regimes and in various natural aquatic ecosystems [7,8,9,10,11,12]. However, limited investigations have been carried out to elucidate the efficacy of cow dung and gypsum amendments in ameliorating sodic soil conditions and their subsequent impact on the length-weight relationship *L. rohita.*

2. MATERIALS AND METHODS

2.1 Experimental Setup

The current study was conducted at the College of Fisheries, Acharya Narendra Deva University of Agriculture and Technology, Ayodhya. Experiment aimed to study the growth of *L. rohita* fry (5.00±1.03gm) in circular plastic tanks under sodic soil condition. The capacity of plastic tank was 500 liters. At the base of the tanks 6.0-inch sodic soil was added in all the experimental

Table1. Ingredient (%dry weight)used in the experimental diets fed with

Sl. No	Ingredients	Quantity (%)
1.	Fishmeal	10
2.	Mustard oil cake	30
3.	Defatted Soybean meal	24
4.	Ricebran	20
5.	Wheat flour	10
6.	Ragee seed	2.5
7.	Fish oil	02
8.	Vit-mineral mix	01
9.	Carboxymethylcellulose	0.5

tanks. The experiment was conducted in triplicate set. Total treatment taken were seven (seven treatment X three replication =21 tanks). In this work, *L. rohita* fry of 5.03±1.03 gm wasused. Well mixed sodic soil was filled up to six inches of plastic tank (158kg soil). The soil was moistened with water in the tank itself. The rate of Cow dung application was kept to T1 0.0kg (Control), T2 ($15tha^{-1}$), T3 ($25tha^{-1}$), T4($30tha^{-1}$).In T5,T6 and T7 cow dung and gypsum were applied together. In T5 (15 t ha^{-1} cow dung + gypsum @$5000kgha^{-1}$), T6 ($25tha^{-1}$ Cow dung + gypsum @$5000kgha^{-1}$) and in T7 (30 tha^{-1} cow dung + gypsum @$5000kgha^{-1}$) were applied.

2.2 Feeding

The fishes were reared on a feed containing 30% crude protein, 4% crude fat, 5% and fiber. The feeding was done twice 8.00 am in the morning and 5.00 pm in the evening. The feed was given ad-libitum. Feed was prepared by 02 mm hand pelletizer and were dried in hot air oven at40 ^{0}C temperature overnight. The dried feed pellets were crushing and sieved to get a uniform size. This feed was packed into air-tight containers and stored at room temperature in air tight container until further use.

2.3 Length-Weight Relationship

The logarithmic transformation of the length-weight relationship formula, which estimates fish weight (W) based on length (L), is expressed as Log W = log a + log b.

The LWR in the present study was calculatedusing the following equation (Froese, 2006):

$$W=aL^b,$$

where, *W* is the weight of fish (g), *L* is the length of fish (cm), *a* is the intercept of the regression, and *b* is an exponential expressing the relationship between length and weight. When *b*=3, the increase in weight is isometric. When the value of *b* is other than 3, weight increase is allometric (positive if $b>3$, negative if $b<3$).

2.4 Statistical Analysis

The length-weight relationship of fishes was analyzed by using Microsoft Excel 2007. The coefficient of determination (R^2) was calculated during the regression analysis to assess the predictive quality of the linear regression model. A value of R^2 closer to 1 indicates a better fit of the model to the data.

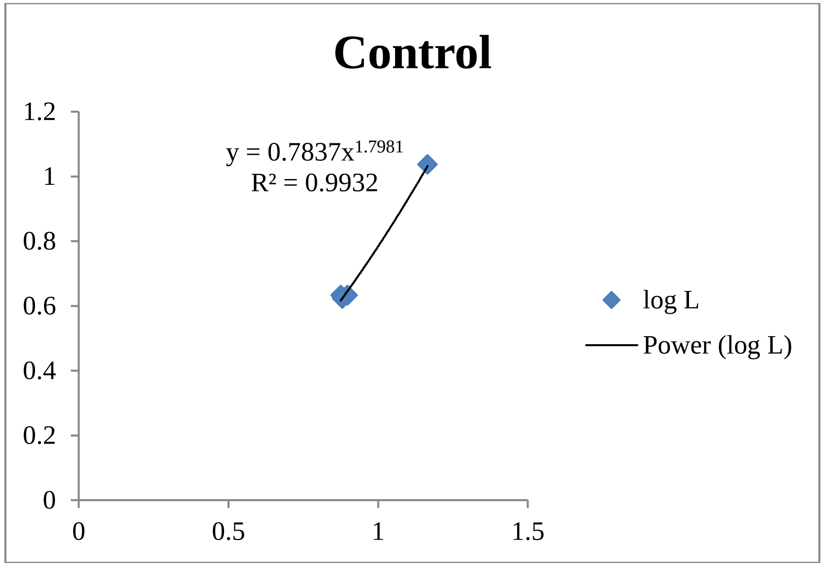
3. RESULTS AND DISCUSSION

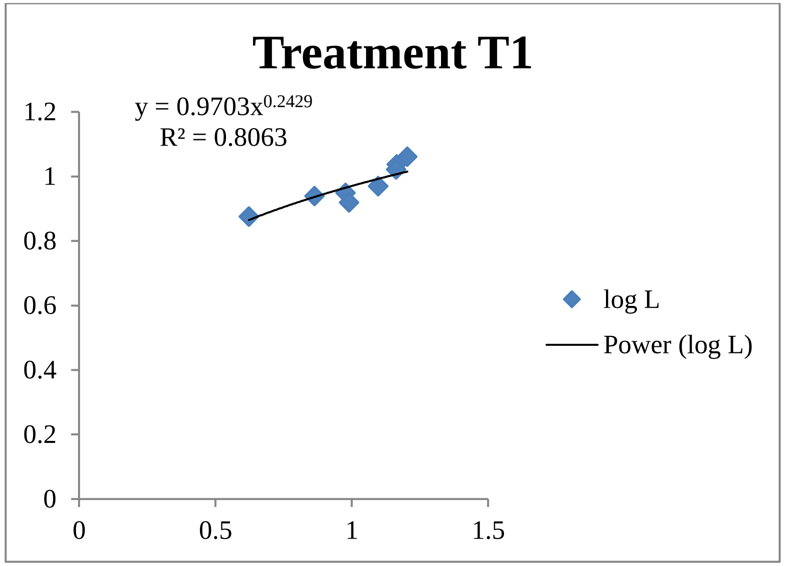
The study investigated the relationship between length and weight in *Labeo rohita*. The analysis revealed varying regression coefficients (b) across different treatments, ranging from 0.242 to 3.234. These findings align with the principles of allometry, which describe the differential growth patterns between body dimensions. Positive allometric growth occurs when the regression coefficient exceeds 3, indicating that weight increases more rapidly than length. Conversely, negative allometric growth is observed when the coefficient falls below 3, suggesting that length increases more rapidly than weight.

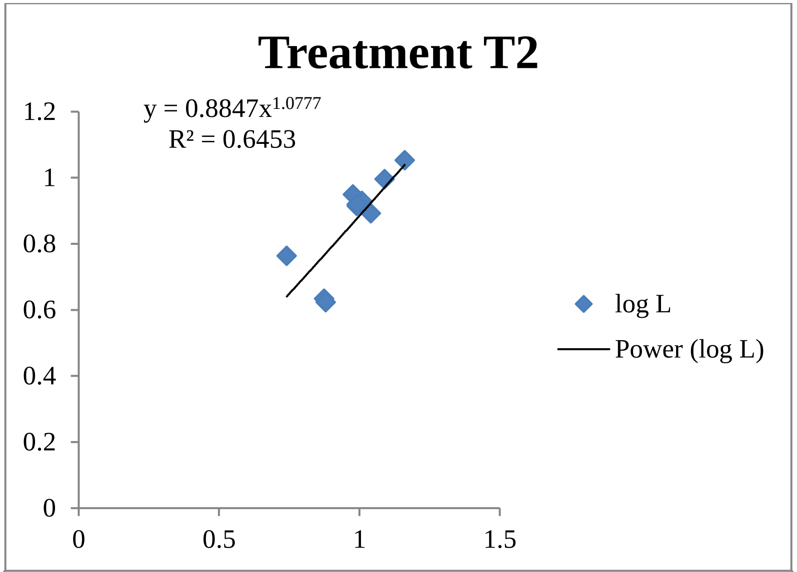
Treatments T1, T2, T3, T4, T5, T6, and the control group showed negative allometric growth, indicating that the fish became slimmer as they grew longer. In contrast, treatment T7, which received the highest dose of cow dung (30t ha^{-1}) and gypsum (5000 kg ha^{-1}), exhibited positive allometric growth, suggesting that the species became heavier relative to their length as they grew. These findings align with observations reported by other researchers studying length-weight relationships across different environmental conditions and supplementation

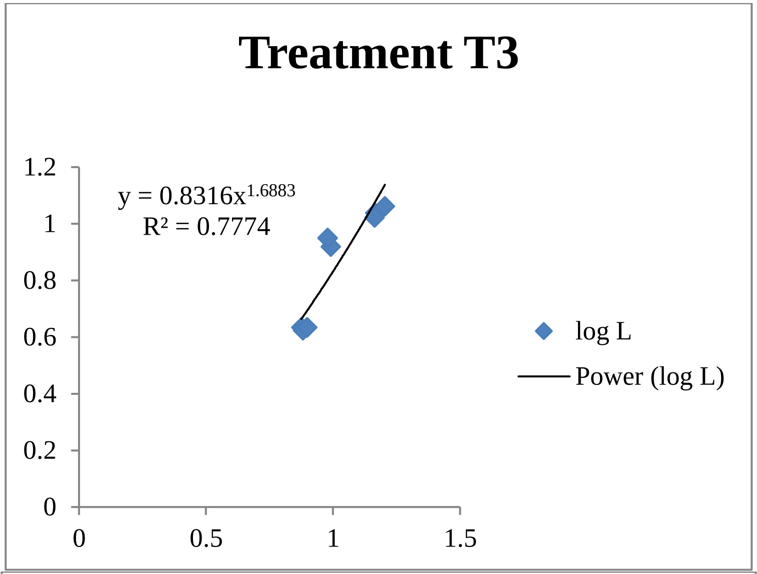
Table 2. Logarithmic equation for different treatments

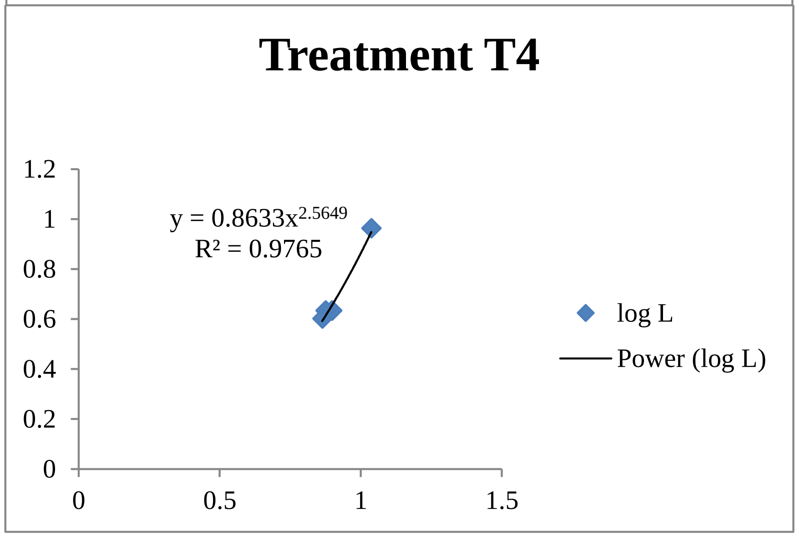
Treatments	Logarithmic equation	r^2	b
Control	Log W = log 0.805 + 1.629 log L	0.928	1.629
T1	Log W = log 0.970 + 0.242 log L	0.814	0.242
T2	Log W = log 0.884 + 1.077log L	0.567	1.077
T3	Log W = log 0.831+ 1.688log L	0.791	1.688
T4	Log W = log 0.863 + 2.564log L	0.965	2.564
T5	Log W = log 0.792 + 1.659log L	0.995	1.659
T6	Log W = log 0.783 + 1.798log L	0.988	1.798
T7	Log W = log 0.973 + 3.234log L	0.916	3.234

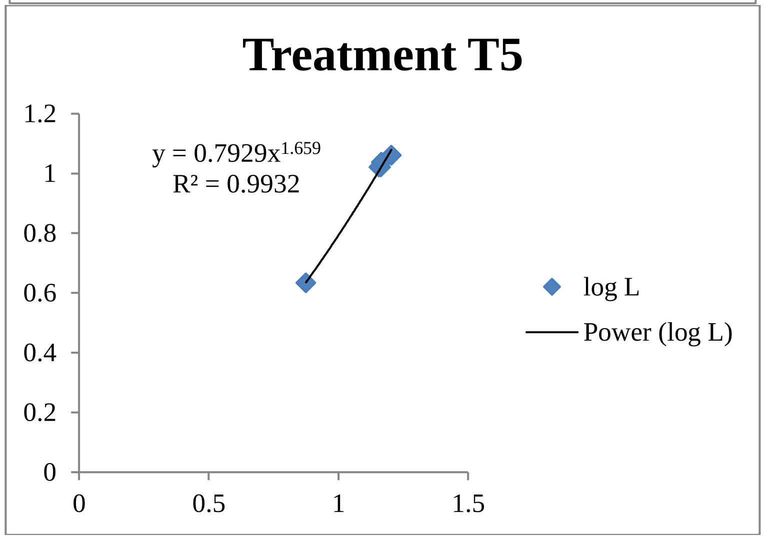





Treatment T2
y = 0.8847x^1.0777
R² = 0.6453
log L
Power (log L)
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5


Treatment T3
y = 0.8316x^1.6883
R² = 0.7774
log L
Power (log L)
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5


Treatment T4
y = 0.8633x^2.5649
R² = 0.9765
log L
Power (log L)
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5


Treatment T5
y = 0.7929x^1.659
R² = 0.9932
log L
Power (log L)
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5

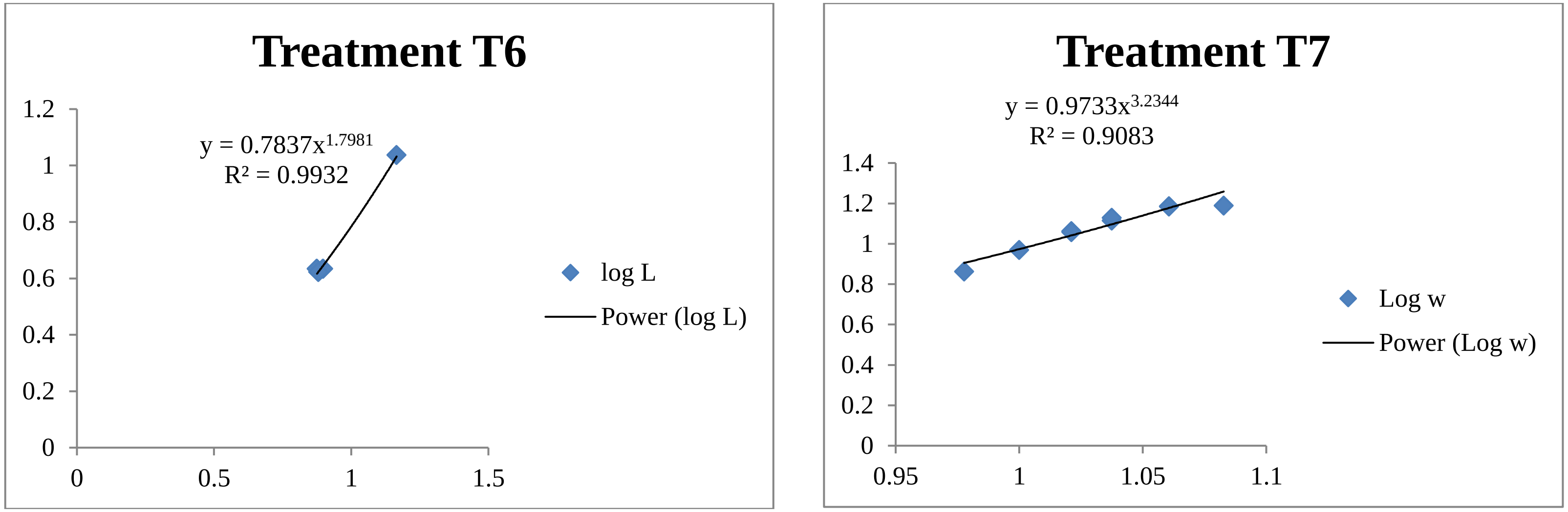


Fig. 1. Regression analysis curve of control and different treatments

regimes [12]. Documented negative allometric growth in *L. rohita* fingerlings reared in ponds with high stocking densities and limited fertilization, likely due to restricted food availability [13]. Found that *Sarotherodon melanotheron* exhibited negative allometry under low nutrient input conditions but positive allometry when provided with higher inputs of organic manure and inorganic fertilizers [14]. Reported that *Cyprinus carpio* exhibited negative allometry in control and low-fertilization treatments but positive allometry in higher fertilization treatments, implying that increased nutrient availability promoted better growth and body condition. The contrasting allometric patterns observed in this study can be attributed to the varying levels of nutrient input and soil amendment across treatments. The highest doses of cow dung and gypsum in treatment T7 potentially enhanced nutrient availability and improved the overall pond environment, thus facilitating more robust growth in the fish [15,16].

4. CONCLUSION

In conclusion, the study highlights the importance of proper soil management and nutrient supplementation in aquaculture, especially in areas with challenging soil conditions like sodicity. The use of cow dung and gypsum amendments can be an effective strategy to enhance the growth and body condition of *Labeo rohita*, leading to improved fish production and sustainable aquaculture practices.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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