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EVALUATION OF THE SEASONAL EFFECTS ON LAYING PERFORMANCE OF AFRICAN GIANT LAND SNAILS, (*Archachatina marginata), (Achatina achatina)* AND (*Achatina fulica)*, IN CAPTIVITY.

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ABSTRACT

A total of 150 land snails, 50 each of Archachatina marginata, Achatina fulica and Achatina achatina of weight range (≤100g, 101-150g and >150g) were reared in captivity to determine the effect of seasons on laying performance at the snail unit of Federal College of Education, Special, Oyo State, Nigeria. Data were collected on the clutch size of each species of snail; temperature and relative humidity were also observed and recorded for analysis. The result showed that there was a significant (P<0.01) effect of species on the laying performance of Archachatina marginata, Achatina fulica and Achatina achatina at with the least square mean values of 5.35± 7.39; 236.37± 7.66 and 90.38±28.52 respectively. It also showed that the effect of different seasons on the clutch size and the interactive effect of species and seasons were not significant.

Keywords: Season, laying performance, Land snail, Captivity

INTRODUCTION

African Giant land snails are recognized as a form of mini-livestock, belonging to the phylum Mollusca. Specifically, they are classified within the Class Gastropoda, Subclass Pulmonata, Order Stylommatophora, and Family Achatinidae. The species *Archachatina marginata, Achatina achatina,* and *Achatina fulica* are extensively cultivated in tropical regions for their meat and shells, driving a lucrative snail farming industry (Ezemonye *et al.,* 2018). This industry has become a vital contributor to the livestock sector in many tropical countries, providing a valuable source of protein and income for rural communities. However, snail productivity is significantly influenced by environmental factors such as temperature, humidity, and season, highlighting the need for optimized farming practices (Adewumi *et al.,* 2019).

The African giant land snails, specifically *Archachatina marginata, Achatina achatina,* and *Achatina fulica,* are prominent species in snail cultivation due to their exceptional growth rates, high reproductive capacity, and adaptability to diverse environments (Adewumi *et al.,* 2019). Nevertheless, snail productivity is susceptible to environmental influences, including temperature, humidity, and seasonal fluctuations (Opara *et al.,* 2020). Seasonal variations in temperature and humidity can profoundly impact snail growth, reproduction, and overall productivity. Therefore, elucidating the effects of season on the laying performance of these snail species is essential for optimizing snail farming practices, enhancing snail health, and boosting productivity.

Several studies have investigated the effects of environmental factors on snail productivity. Temperature has been shown to significantly impact snail growth and reproduction, with optimal temperatures ranging from 24°C to 31°C (Opara *et al.,* 2020). Humidity also plays a crucial role, with snails requiring a relative humidity of 60-80% for optimal growth and reproduction (Pokryszko *et al.,* 2020).

Seasonal fluctuations in temperature and humidity can profoundly impact snail laying performance. Research has shown that certain snail species exhibit increased egg production during specific seasons. For instance, Adewumi *et al.,* (2019) observed that Achatina achatina snails laid more eggs during the wet season compared to the dry season. Similarly, Ezemonye et al. (2018) reported higher egg production in Archachatina marginata snails during the rainy season. However, a knowledge gap exists

regarding the comparative laying performance of Archachatina marginata, Achatina achatina, and Achatina fulica snails under varying seasonal conditions. This study aims to bridge this gap by investigating the effects of season on the laying performance of these snail species in captivity.

Breeds and Breeding of Snail

Several species of giant African land snails are recognized, including *Archachatina marginata, Achatina fulica, Achatina achatina,* and *Limicolaria species* (Ezemonye *et al.,* 2018).

1. ***Archachatina marginata***, is distinguished by its larger size and greater adaptability to unfavorable climatic conditions (Adewumi *et al.,* 2019). This species is particularly abundant in southwestern Nigeria, where mature adults can attain weights of 600-800g (Opara *et al.,* 2020) as shown below:

Plate 1: Archachatina marginata

2. Achatina achatina: *Achatina achatina* is predominantly found in Ghana, the Republic of Benin, and specific regions of Nigeria, including Rivers and Akwa-Ibom states (Ezemonye *et al.,* 2018). This species exhibits a strong preference for humid environments, which may contribute to its higher mortality rate in the relatively drier southwestern region of Nigeria (Adewumi *et al.,* 2019). Mature Achatina achatina specimens can attain a maximum weight of approximately 60g as shown below;

Plate 2: Achatina achatina

3. **Achatina fulica** is characterized by its relatively small size and lower economic value compared to Archachatina marginata and Achatina achatina (Ezemonye et al., 2018). This species is often considered less desirable for commercial purposes due to its smaller size and lower market demand as indicated in the image below;

Plate 3: Achatina fulica

Breeding

Snails are hermaphrodites but cross fertilization has to take place between two sexually mature snails. *Archachatina marginata* will start to lay eggs when it is sexually matured around 8-12 months. Under domestication, they lay eggs both in rainy and dry season. The incubation period varies between 24-35 days.

Justification of the study

Snails exhibit heightened sensitivity to seasonal variations, demonstrating increased activity during the rainy season (Ezemonye *et al.,* 2018). Conversely, growth and reproductive activities are severely impeded by dry environmental conditions. To optimize snail productivity throughout the year, particularly during the dry season when weather conditions become unfavorable, it is essential to investigate the impact of season on the egg-laying performance of giant African land snails in captivity. Elucidating this relationship will enable the development of strategies to mitigate the challenges encountered by snails during adverse weather conditions.

Objective of the study

The main objective is to evaluate the effect of seasons on laying performance of *Archachatina marginata*, *Achatina fulica* and *Achatina achatina* in captivity.

Specific Objectives

The specific objectives are to:

- estimate the number of egg laid for the three species of African Giant land snails,
- determine the interactive effect between the season and species on clutch size,
- identify the optimal seasonal conditions for snail laying performance.

MATERIALS AND METHODS

Experiments site

The research work was carried out at the snail unit of the Agricultural Education teaching and research farm, Federal college of Education (Special), Oyo State

Experimental snails' management

Materials used include Plastic basket of 30 x 20 x 24cm in dimension which was used to house the snails. The Snails were paired in each basket for effective fertilization. Air dry loam soil was used for the snails to burrow. A dry banana leaf was introduced to make the condition as natural as possible. Management of the snails also covered 20 weeks. A total of 150 snails; fifty of each species of *A. achatina, A. marginata* and *A. fulica* of weight range 50-200g & 11/2 years of age were used. Pawpaw leaves and fruits were given to the snails as feed in appropriate ration.

Data collection

Data were collected on the number of eggs laid per clutch for each species of snail for the period of 20 weeks, Hygrometer was also utilized to take the record of relative humidity of the medium and thermometer functioned to record the temperature in degree Celsius were observed and recorded for analysis.

Statistical analysis

A general linear model procedure of Systat (1992) was used to analyze all the data collected

$$Y_{ijk} = N + C_i + W_j + CW_{ij} + \Sigma_{ijk}$$

Where,

Y_{ijk} = The value of traits of interest
N = Overall mean
C_i = Effect of i*th* species (i=1, 2, 3)
W_j = Effect of j*th* season (j=1, 2)
CW_{ij} = Interactive effect between species and season.
Σ_{ijk} = Error term

RESULTS AND DISCUSSION

Clutch size of Archachatina marginata, Achatina fulica and Achatina achatina.

Table 1: Analysis of variance showing the effects of species, season and the interactive effect between species and season on the clutch size.

Source of variation	D-f	Mean square value
Species	2.00	614545.77*
Season	1.00	1288.79
Species * season	2.00	5011.43
Error	96.00	2602.82

*P<0.01

The analysis of variance presented in Table 1 reveals significant differences in clutch size among three species of African giant land snails, with species being the primary influencing factor ($P < 0.01$). Conversely, seasonal variations and the interaction between species and season had no notable impact on clutch size. A comparative analysis of clutch sizes among the species showed substantial variation, ranging from 1-10 eggs per clutch for A. marginata, 66-112 eggs per clutch for A. achatina, and 113-346 eggs per clutch for A. fulica. This finding aligns with previous research indicating an inverse relationship between clutch size and egg size in gastropod mollusks (Kappes *et al.,* 2018, Pokryszko *et al.,* 2020;). Specifically, species laying larger eggs tend to have smaller clutch sizes, whereas those producing smaller eggs have larger clutch sizes. Ultimately, this suggests a negative correlation between egg size and number, where increased egg production results in smaller egg sizes.

Table 2:*Least square mean value showing the effect of species on the clutch size*

Class (variable)	sub class	No	LSM± S.E
Species	*A. marginata*	48.00	5.35± 7.39^{c}
	A. fulica	49.00	236.37± 7.66^{a}
	A. achatina	5.00	90.38±28.52^{b}

Table 2 shows that average clutch size of *Archachatina marginata, Achatina fulica* and *Achatina achatina* were 5.35 ±7.39 eggs, 236.37± 7.66 eggs and 90.38± 28.52 eggs respectively.

The effects of season on clutch size of *A marginata*, *A fulica* and *A achatina*

Table 3: *Least square mean value showing the effect of season on the clutch size*.

Variable	Subclass	No	LSM± S.E
Season	Season 1	1.00	103.56± 17.59
	Season 2	1.00	117.84± 10.12

Season1 (December- February), Season2 (March-May)

Table 3 presents the least square mean values for clutch size during the late dry and early wet seasons, with values of 103.56 ± 17.59 and 117.84 ± 10.12, respectively. Although the analysis revealed no significant effect of season on clutch size (P > 0.01), the three species of African giant Land Snails demonstrated satisfactory laying performance in both seasons. These findings align with previous research, which suggests that the presence of food and environmental factors like moisture stimulates normal snail activities, including feeding, growth, and reproduction (Ejidike *et al.,* 2004). Additionally, studies have shown that snails thrive in areas with moderate temperatures and high humidity (Cobbinah, 1990).

While the current study found no significant seasonal effect on clutch size, previous research has reported that clutch size is generally larger during the wet season than during the dry season for Archachatina marginata (Opara *et al.,* 2020), Achatina achatina (Adewumi *et al.,* 2019), and Achatina fulica (Ezemonye *et al.,* 2018). These findings collectively suggest that seasonal variations in temperature and humidity influence clutch size, with larger clutches typically laid during the wet season.

The interactive effect of species and season on the clutch size

Table 4: *Least square mean value showing the interactive effect of species and season on the clutch size.*

Variable	subclass	LSM± S.E
Species*Season	*A. marginata** season 1	5.12±10.01
	*A. marginata** season 2	5.19± 10.89
	A. fulica * season 1	215.56± 9.02
	A. fulica * season 2	257.18 ± 12.38
	*A. achatina** season 1	90.00 ± 51.02
	*A. achatina** season 2	90.75± 25.51

Table 4 presents the least square mean values for the interaction between snail species and season. The values indicate that A. marginata laid an average of 5.12 ± 10.01 and 5.19 ± 10.89 eggs in seasons 1 and 2, respectively. A. fulica laid significantly more eggs, with averages of 215.56 ± 9.02 and 257.18 ± 12.38 eggs in seasons 1 and 2, respectively. A. achatina laid an average of 90.00 ± 51.02 and 90.75 ± 25.51 eggs in seasons 1 and 2, respectively. The study found that the interactive effect of species and season on laying performance was not significant (P > 0.01). This suggests that the snails performed equally well in both seasons, with no significant difference in clutch size. This is consistent with previous research, which found that land snails thrive in humid environments with optimal food availability (Imevbore, 1990). Many West African snail species, including Archachatina and Achatina, are adapted to forest environments and coastal zones, where humidity is generally higher.

The bar chart showing relationship among the control temperature, inner temperature and relative humidity with the clutch size

For *A. marginata* the optimum temperature were 29.52°C and 28.46°C both control and inner. Also for relative humidity 80.04%, but for this, the result of the average clutch size was 5.33 shown in the figure below

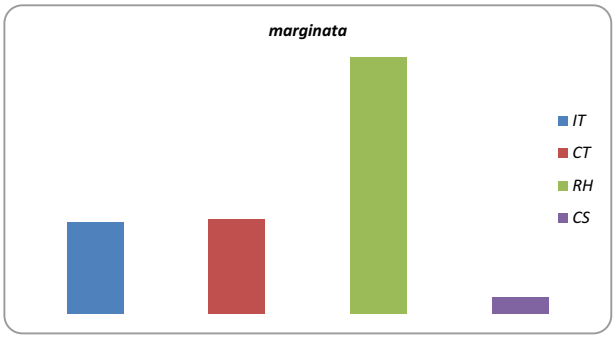
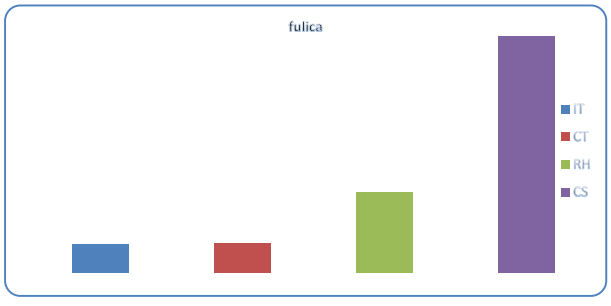


Fig. 1: *Bar chart showing the relationship between Average Temperature, Humidity and the Clutch size of A. marginata. Where IT- Inner Temperature, CT-Control Temperature, RH-Relative Humidity, CS- Clutch Size*

Similarly, for *A. fulica* the optimum temperature 29.04°C and 28.06°C control and inner respectively and the relative humidity of 78.1% with the clutch size of 230. For *A. achatina* the optimum temperature were 26.4°C and 25.5°C both for the control and inner respectively, with the relative humidity of 81.43% and the average clutch size of 90.6



ig.2: *Bar chart showing the relationship between Average Temperature, Humidity and the Clutch*

size of A. fulica. Where IT- Inner Temperature, CT-Control Temperature, RH- Relative Humidity, CS- Clutch Size

shown in figure 3 below;

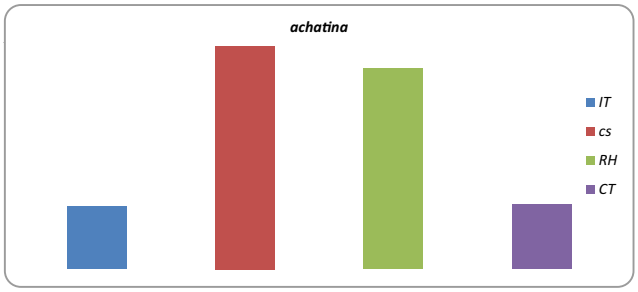


Fig. 3: *Bar chart showing the relationship between Average Temperature, Humidity and the Clutch size of A. achatina*

***Fig.3: Bar chart showing the* Optimum egg laying temperature and relative humidity**

From the result obtained it shows that optimum Egg laying performance occurred with the temperature range from 24^{0}C to 31^{0}C at the relative humidity range of 75%to 82%. This conform to Ayodele (2004) that at lower temperature egg laying normally reduced while at an average temperature of 25-30^{0}C with relative humidity of 75%, oviposition increased by up to 70%.

Conclusion

In conclusion, this study highlights the significant impact of species on clutch size, with substantial variations observed among the three species of African Giant land snails. The findings also underscore the importance of providing a natural environment and preferred food sources for optimal snail performance. Specifically:

- Snails thrive best in natural environments with access to their choice food.
- Natural environments stimulate normal snail activities, including feeding, growth, and reproductive performance, regardless of the season.
- The optimal temperature range for egg laying is between 24°C and 31°C.
- The ideal relative humidity range for egg laying is between 75% and 82%.

These conclusions provide valuable insights for snail farmers and researchers seeking to optimize snail productivity and reproductive performance.

Recommendation

Based on the findings of this study, the following recommendations are made:

1. Commercial rearing of *Archachatina marginata, Achatina achatina,* and *Achatina fulica* is feasible and recommended for both late dry and early wet seasons, provided that their natural environment and preferred food sources are replicated.
2. Future research should focus on creating a simulated natural environment to enhance snail reproductive performance during both seasons.
3. To mitigate predator attacks, which were found to be significant, the use of wire mesh enclosures is strongly recommended to protect the snails and ensure optimal productivity.

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