A COMPARATIVE PHYSIOLOGICAL ASSESSMENT OF SALT STRESS ON GERMINATION DYNAMICS AND SEEDLING GROWTH PERFORMANCE IN TWO LANDRACES OF JUTE *Corchorus oliotorius* (L)

BY

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SR/2293/RPR/25/35

DEPARTMENT OF PLANT BIOLOGY AND BIOTECHNOLOGY

FACULTY OF LIFE SCIENCES

UNIVERSITY OF BENIN

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF PLANT BIOLOGY AND BIOTECHNOLOGY, IN THE FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN, BENIN CITY, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE (B.Sc.) DEGREE IN PLANT BIOLOGY AND BIOTECHNOLOGY.

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SUPERVISOR

PROF. B. IKHAJIAGBE **DATE**

HEAD OF DEPARTMENT

EXTERNAL EXAMINER **DATE**

DEDICATION

This project is dedicated to God, my late parents Mr. and Mrs. Okorie, Mr. and Mrs. Duhu, Mr. Jude Chizoba, my supervisor, all my colleagues, my siblings and my friends, for their encouragement and support all through to this point of my work completion.

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Lastly, to every individual, my lecturers, classmates, colleagues, and well wishers whose names may not be written here but whose influence has touched my journey in one way or another, I say thank you. Your kindness, words of encouragement, and quiet acts of support have been the unseen threads weaving this tapestry of achievement. This accomplishment is not mine alone; it is a testament to the collective faith, love, and guidance of all who walked beside me.

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ABSTRACT

Soil salinity is one of the major environmental problems limiting seed germination and crop productivity in tropical agriculture. *Corchorus olitorius* L. (jute) is an important fibre and vegetable crop in Nigeria, yet its early growth is highly sensitive to saline conditions. This study evaluated the physiological response of two jute landraces. Landrace C (from NIHORT) and Landrace D (from Delta State) were treated to different salt concentrations to determine their level of tolerance. The experiment was conducted using a Completely Randomized Design (CRD) with five sodium chloride (NaCl) levels: 5 ppm (control), 200, 2000, 5000, and 10,000 ppm, each replicated three times. Growth parameters observed included germination percentage, shoot height, number of leaves, stem girth, number of branches, internode length, and leaf area. Data collected were analyzed using Analysis of Variance (ANOVA) at a 5% significance level. Results showed that salt stress caused a steady decline in all growth parameters. Landrace C had the highest germination rate (90.00 ± 17.32%) and best seedling growth at 200–2000 ppm, recording maximum shoot height (26.83 ± 4.64 cm) and leaf number (34.67 ± 1.70). Landrace D performed poorly, with peak germination at 200 ppm (20.00 ± 0.00%) and no growth beyond 2000 ppm. Analysis of variance (ANOVA) indicated significant differences ($p < 0.05$) among treatments and between landraces. Overall, Landrace C exhibited stronger salt tolerance due to better osmotic adjustment and growth stability, making it suitable for cultivation and improvement in saline prone soil.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

Soil salinity is one of the most severe abiotic pressures affecting agricultural output worldwide and it is a serious threat to food and fiber security (Munns and Tester, 2008). It is estimated that salinity affects more than 20% of the world's irrigated land and 7% of total land area and is expanding in extent due to unsustainable irrigation techniques, climate change and poor drainage systems. High concentrations of soluble salts particularly sodium chloride (NaCl) limit water uptake, modify osmotic balance and cause ionic toxicity in plants leading to stunted development and reduced yield potential (Zhu, 2001; Hao et al., 2021).

Salinity at germination and seedling stages inhibits seed imbibition and interferes with enzymatic activity necessary for mobilization of stored food reserves, leading to delayed or incomplete germination (Fiaz et al., 2022). Salt stress on seedlings leads to inhibition of root elongation, chlorosis and oxidative stress that together limit early establishment and vigor of the plant (Atta et al., 2023). These effects are especially important for crops such as jute, where early growth is vital for fibre yield and quality (Hand et al., 2024).

Corchorus olitorius L. (often known as Tossa jute) is a dual purpose crop grown for bast fibre and edible leaves (Islam et al., 2017). Jute leaves are an Important food vegetable in West Africa, rich in vitamins, proteins and minerals while its fiber is still significant in textile and packaging sectors (Rutto, 2024). Despite its high economic potential, production of jute in Nigeria and other tropical nations is hampered by growing soil salinity, particularly in coastal and irrigated areas (Roy et al., 2018).

Jute is generally thought to be somewhat salt tolerant, although there is substantial genotypic heterogeneity among landraces that influences the response of individual landraces to salt-induced stress during early growth (Loko et al., 2020). It has been shown that several landraces exhibit physiological processes, such as ion compartmentalization, osmolyte accumulation and increased antioxidant activity, that improve the tolerance to saline environments (Deinlein et al., 2014; Zhao et al., 2021). Therefore, it is important to investigate these variations in local landraces of C. *olitorius* to find resistant genetic material that can survive in saline environments (Negacz et al., 2022). Thus, research on jute germination and seedling responses to salt stress can improve the physiological understanding of stress adaption and also aid in breeding for salt tolerant cultivars for sustainable production (Makhadmeh et al., 2022).

1.2 PROBLEM DESCRIPTION

The value of jute is well known but research on its physiological reactions at the early stage to salinity in Nigeria is lacking. Most of the research on salt stress has been done on staple crops like rice, maize and wheat, however fibre crops like jute have been understudied . As salinity progresses into productive regions, an understanding of crop specific responses becomes an agricultural priority (Negacz et al., 2022).

There is a great research vacuum on comparative salt tolerance of C. *olitorius* landraces grown in different agro ecological zones. While genetic diversity has been documented in several other crops, the degree of variation in germination rate, seedling growth and vigour of jute landraces under salt stress is not well understood (Roy et al., 2018). This knowledge gap limits crop enhancement initiatives and proper management measures for saline prone locations (Hand et al., 2024).

The present work, therefore, aims to fill this vacuum by exploring the impact of different salt stress levels on seed germination and early seedling responses in two unique jute landraces. The findings will provide insights into tolerance mechanisms, identify potentially robust landraces and contribute to the overall goal of increasing food and fibre production on marginal soils (Munns and Tester, 2008).

1.3 OBJECTIVES AND AIM OF THE STUDY

Salinity stress is one of the key abiotic stress factors affecting plant growth and crop yield throughout the world (Munns and Tester, 2008). The growing significance of salt tolerant landraces because to irrigation mismanagement, climate change, and poor soil drainage has raised the demand for scientific evaluation of salt tolerant landraces especially in crops of nutritional and economic importance such as *Corchorus olitorius* L. .

The main objective of this study is to evaluate the effects of salt stress on seed germination and seedling growth and to compare the physiological responses of two landraces of *Corchorus olitorius* L. in controlled laboratory circumstances.

The specific aims are the following in order to fulfill the main objectives:

I. To analyze the influence of various concentrations of sodium chloride (NaCl) on the characteristics of germination such as germination percentage, germination rate and mean germination time in two landraces of C.*olitorius* L. (Abdul Baki and Anderson, 1973; Roy et al., 2018). This will set the critical level of salinity that limits early germinative activity, a critical step for plant establishment (Hao et al., 2021).

II. To evaluate the effect of salt stress on growth variables of the seedlings such as root length, shoot length, and total seedling biomass (Tebini et al., 2022). The goal is based on the assumption that early seedling vigor is a good predictor of plant performance under stress, and hence quantifies developmental flexibility under salinity (Zhao et al., 2021).

III. To evaluate the salt tolerance of the two jute landraces by comparing their differential growth and germination responses under similar salinity regimes (Deinlein et al., 2014). The observed variance will provide an idea about the genotypic adaptability and possibilities for breeding programs (Atta et al., 2023).

IV. To select the most salt tolerant landrace of C. *olitorius* for agriculture in salt impacted or marginal soils in Nigeria (Loko et al., 2020). This is in line with national aims of agricultural sustainability through promotion of resistant indigenous crop varieties (Makhadmeh et al., 2022). These aims link physiological plant science to applied crop improvement and feed into broader initiatives for climate adaption and sustainable land use (Negacz et al., 2022).

1.4 RESEARCH QUESTIONS

The following research questions are established to guide the investigation and ensure an organized approach:

I. Effects of salt stress on germination behavior of *Corchorus olitorius* L.

This is an issue of how far rising salt concentrations affect the percentage and time of germination as a reflection of the potential of the seeds for metabolic activation under osmotic stress (Zhu, 2001).

II. How do varying levels of salinity affect growth parameters of seedlings such as root elongation, shoot length and seedling biomass in the two landraces?

This is intended to uncover morphological markers of salt tolerance that represent performance at early embryonic stages (Roy et al., 2018; Zhao et al., 2021)

III. Are there any major differences in the response to salt stress of the two landraces of C. *olitorius* during germination and seedling growth?

This comparison is important to determine if genotypic variation provides differential tolerance and could drive future selection or breeding programs (Loko et al., 2020; Hand et al., 2024).

IV. Which of the two jute landraces demonstrate a higher saline tolerance and what physiological features attribute to the tolerance?

This will help in boosting the cultivation of hardy varieties in salt impacted locations, which would contribute to food security and sustainable production systems (Islam et al., 2017).

V. Implications of the observed reactions for crop improvement and for sustainable agriculture in saline prone areas

This broad topic links the study to national and global goals for resilient agriculture systems under climate change scenarios (Makhadmeh et al., 2022; Negacz et al., 2022).

These questions together guide the experimental design and highlight the biological, agronomic and environmental significance of the study. This means that the inquiry is not limited to simple measurement but makes a substantial contribution to the understanding of stress physiology in crop plants.

1.5. IMPORTANCE OF THE STUDY

The present study is relevant as it tackles the global concern of soil salinity and its adverse consequences on crop productivity. The salinity problem is gradually creeping into Nigeria particularly in low-lying and irrigated farmlands therefore the need to identify crops and landraces that can tolerate saline settings.

The study adds to the scientific knowledge by examining the physiological responses of C. *olitorius* L. to salt stress during germination and seedling growth, which are extremely vulnerable to environmental perturbations (Hao et al., 2021). The information obtained will enhance the understanding of salt tolerance mechanisms such as osmotic adjustment, ion control and antioxidant defense in jute landraces (Deinlein et al., 2014).

In addition, the search for a salt-tolerant landrace of jute could lead to sustainable production in marginal soils and contribute to improved food security, as jute leaves represent a major vegetable in many Nigerian diets (Islam et al., 2017; Rutto, 2024). The results will also give baseline data that can be utilized by breeders, agronomists and policy makers for developing improved management strategies and breeding programs for salt resistant jute cultivars (Roy et al., 2018; Negacz et al., 2022).

In short, this research bridges the gap between academic investigation and real-world application in sustainable agriculture by combining physiological information with practical agricultural consequences (Makhadmeh et al., 2022).

1.6. SCOPE AND DELIMITATIONS OF THE STUDY

This study was limited to two different landraces of *Corchorus olitorius* L. acquired locally in Nigeria. The experimental study focused mainly on the response of germination and early seedling development to different concentrations of sodium chloride (NaCl) under controlled laboratory circumstances (Tebini et al., 2022).

The metrics such as germination percentage, mean germination time, root length, shoot length and biomass accumulation will be evaluated which are recognized as reliable markers of salt tolerance (Abdul Baki and Anderson, 1973; Pecetti et al., 2024).

Some restrictions are, nevertheless, noted. However, the controlled laboratory environment may not fully duplicate the field conditions where other factors such as variations in temperature, microbial interactions, and soil composition may alter the plant response to salt (Cope et al., 2022). The study is also limited to early stages of growth and so may not account for long term effects of salt stress on yield and fibre quality (Roy et al., 2018). However, the results will provide a useful basis for further field and molecular work.

1.7 JUTE (*Corchorus olitorius* L.) PLANT

Jute (*Corchorus olitorius* L.) is a significant annual fibre crop of the family Malvaceae and is cultivated extensively for its bast fibres and edible leaves (Islam et al., 2017). It is one of the world's most valuable natural fibers, second only to cotton in terms of world production and commercial importance (Roy et al., 2018). It is mainly grown in the tropical and subtropical countries such as Bangladesh, India, China and portions of Africa including Nigeria where it is popularly known as "ewedu". (Rutto, 2024).

Corchorus olitorius has dual use; the stems provide long, lustrous fibres for use in textile and industrial products, while the young leaves are consumed as a mucilaginous vegetable rich in vitamins, minerals and antioxidants (Loko et al., 2020). The plant's capacity to adapt to warm and humid regions, as well as its comparatively short growth cycle, make it a suitable crop for resource limited farmers seeking nutritional and economic benefits (Makhadmeh et al., 2022). Besides, the production of jute also enhances the soil by adding organic matter and is an environmentally friendly crop.

Plate 1.1: *Corchorus olitorus* L. **(Jute Plant)**

1.8 Taxonomy of Jute Plant (*Corchorus olitorius* L.)

The classification of *Corchorus olitorius* reflects its phylogenetic placement within the angiosperms. Taxonomically, the species is described as follows:

Kingdom: Plantae

Subkingdom: Tracheobionta – Vascular plants

Division: Magnoliophyta – Angiosperms

Class: Magnoliopsida – Dicotyledons

Order: Malvales

Family: Malvaceae

Genus: *Corchorus*

Species: *Corchorus olitorius* L.

The genus *Corchorus* comprises about 40–100 species distributed mainly in tropical and subtropical regions of Asia and Africa (Hand *et al*., 2024). Historically, *C. olitorius* was placed in the family Tiliaceae. However, recent molecular phylogenetic studies have repositioned it under the Malvaceae family, aligning it with other fibre producing species (Hao *et al*., 2021). The species is diploid with a chromosome number of 2n = 14, which has facilitated studies on genetic diversity and breeding (Loko *et al*., 2020; Roy *et al*., 2018).

1.9 Botanical Description (*Corchorus olitorius* L.)

Corchorus olitorius L. is an annual upright growing herb of height 1-3 m, depending on the landrace and environmental conditions (Islam et al., 2017). The stem is cylindrical, glabrous and fibrous, green yellow in color, which turns brown as the plant ages (Rutto, 2024). The leaves are simple, alternating, ovate-lanceolate with serrate edge, with two little auricles close to the petiole base, which is a unique morphological characteristic utilized for identification (Roy et al., 2018). The flowers are tiny, yellow, single or paired in the leaf axils. The flowers have five sepals and petals and many stamens surrounding a superior ovary (Hand et al., 2024). The fruit is an elongated, cylindrical capsule holding a large number of tiny, angular seeds, dark brown to black at maturity. The root system is dominated by a tap root, providing moderate drought resistance and anchoring in soil (Makhadmeh et al., 2022). Jute is a physiologically C3 photosynthetic plant that thrives best in warm (25–35 °C), humid settings with ample sunlight and rainfall (Hao et al., 2021). Its growing performance is reduced in cold or too saline situations, which can lower both fibre yield and leaf productivity (Zhao et al., 2021).

1.10 JUTE PLANT: HISTORY AND ORIGIN

Jute has been cultivated and used for a long period of time, with records dating back more than 2000 years (Islam et al., 2017). According to historical sources, C. *olitorius* is native to Africa, notably the Nile basin, and then dispersed to Asia via trade and migration (Rutto, 2024). In Egypt, jute leaves were eaten as a staple vegetable called "Molokhia" which is still a culturally important meal to this day (Loko et al., 2020).

In the 19th century, commercial cultivation of jute spread fast in Bengal (now Bangladesh and eastern India) where the humid monsoon climate encouraged large scale fiber production (Roy et al., 2018). By the middle of the 20th century, jute had become a major export product and was known as "the golden fibre" for its economic importance and versatility in making ropes, sacks, mats and fabrics (Hand et al., 2024).

The plant's use as a leafy vegetable became prominent in Africa, especially in Nigeria, but its fibre potential is underexploited (Makhadmeh et al., 2022). Today's C. *olitorius* is of economic and nutritional importance. It bridges the gap between agriculture, industry and food security.

1.11 SOIL AND NUTRIENTS NEEDS

Jute grows best on fertile alluvial soils rich in organic matter and well drained (Islam et al., 2017). Ideal soil pH is between 6.0 and 7.5 for maximum uptake of nutrients and fibre production (Roy et al., 2018). Heavy clay soils and wet conditions restrict root respiration and lower yields; sandy soils do not retain enough moisture for strong growth.

Nutrient wise, jute needs enough supply of nitrogen (N) for vegetative growth, phosphorus (P) for root development and potassium (K) for fibre strength and physiological activities (Tebini et al., 2022). The organic manures like compost or green manure are usually recommended for increasing the fertility and structure of the soil (Makhadmeh et al., 2022). The application of balanced NPK fertilizers in low fertility regions increases the growth rate and fibre production dramatically (Deinlein et al., 2014).

Micronutrients such as iron, zinc, and boron are also important for chlorophyll synthesis and metabolism in cells (Hao et al., 2021). Proper soil management, crop rotation and organic amendments, in addition to improving nutrient balance, help to reduce the effects of salt by promoting soil microbial activity and cation exchange capacity (Negacz et al., 2022).

1.12 MILLENNIUM DEVELOPMENT GOALS (MDGs) OF THE STUDY

The Millennium Development Goals (MDGs) are a global commitment to enhancing human well-being by reducing poverty, using resources sustainably and protecting the environment. These objectives guide research and policies promoting social and economic development, especially in developing countries where agriculture is the main pillar of the livelihood related to food security, environmental sustainability and international cooperation for development.

1. Eliminate Extreme Poverty and Hunger (MDG 1)

The first Millennium Development Goal deals with the eradication of severe poverty and hunger and highlights the need of food security as a basis for sustainable development . Soil salinity is a severe threat to agricultural output in many locations particularly in sub–Saharan Africa, by impeding seed germination, limiting seedling growth and diminishing crop yield. The current study provides significant insight into the influence of salinity on early growth of plants and also discovers variants with higher tolerance to salt stress by studying the effect of salt stress on two landraces of Jute. Such knowledge is important to farmers and plant breeders as it can help in selecting and growing crops that are resilient and can sustain productivity under poor soil conditions. Hence, the study adds to the efforts of ensuring availability of food, increasing income stability to farmers and reducing poverty levels in the agricultural areas.

2. Environmental Sustainability (MDG 7)

The MDGs' target 7 stresses on incorporating environmental sustainability in national policies and development processes. This paper contributes to this objective, focusing on the problems of soil degradation and salinization that endanger agricultural and ecological equilibrium. Jute (Corchorus olitorius L.) is an important multipurpose crop. It is a sustainable crop due to its short life cycle, flexibility and utility as a green vegetable and fibre crop. The physiological and morphological responses to salt stress were investigated which improve the sustainable use of saline prone soils, minimize the dependence on high input farming systems and encourage the regeneration of damaged agricultural areas. This study thus contributes to the global effort towards sustainable land management and conservation of natural resources for future generations.

3. Global partnership for development (MDG 8)

The eighth Millennium Development Goal is about building international relationships and cooperation to meet the common development objectives. In line with this objective, our study contributes to the scientific understanding of abiotic stress tolerance, an area that demands collective global effort. The results of this study could be a reference for cooperative efforts between universities, agricultural research centers and international organizations on crop improvements. Additionally, it contributes to encouraging knowledge transfer and fosters the inclusion of local research in wider development agendas as it provides data that can inform sustainable agriculture plans at regional and global levels.

4. Improving Health and Nutrition (MDGs 4 & 5)

This research is also contributing to the MDGs on health and nutrition, while its main concentration is on agriculture. Jute leaves are an excellent source of micro minerals, vitamins and therapeutic substances and play a vital role in human nutrition. The successful germination and growth of Jute in salt stress circumstances ensures the availability of this nutritious vegetable, which in turn supports community health and reduces malnutrition. Through this indirect contribution, the study strengthens the interconnection of agricultural resilience, food security, and public health important elements of sustainable human development.

5. Scientific knowledge dissemination and biodiversity conservation

Apart from the immediate MDGs, the study also contributes to biodiversity conservation by comparing two different landraces of Jute. Knowledge of the genetic variation affecting salt stress tolerance improves the scientific understanding of the mechanisms of plant adaptation and assists in the conservation of genetic diversity. Biodiversity is an important factor for the stability of ecosystems and the resilience of agriculture and the research is in line with the broader developmental vision of a balanced and diverse natural environment.

CHAPTER 2

MATERIALS AND METHODS

2.1. STUDY LOCATION

The experiment was conducted at the Department of Plant Biology and Biotechnology, Faculty of Life Sciences, University of Benin, Benin City, Edo State, Nigeria.

2.2. EXPERIMENTAL MATERIALS

The major ingredients used in this investigation are two different land races of jute (*Corchorus olitorius* L.), sodium chloride (NaCl), pure water and laboratory grade glassware. Seeds of C. *olitorius* were collected from specific areas in South Western and South South regions of Nigeria. The seeds were sourced from NIHORT (The National Horticultural Research Institute) and some specific areas in Delta state and were typical of indigenous types adapted to the agroecological conditions of the area. These landraces were purposely selected to provide a comparative assessment of their physiological responses to salinity stress.

The salt stress agent was sodium chloride (NaCl) and the different salinity concentrations were prepared with water. Other items utilized were measuring cylinder, loamy soil (Dry weight), kegs and containers for storage of salt solution and for proper watering of plants.

2.3. EXPERIMENTAL ARRANGEMENT

The study was conducted using a Completely Randomized Design (CRD), which is a statistical design that gives each treatment an equal chance of being subjected to any experimental condition. The experiment was conducted at 5 salinity levels and 3 replicates per category.

The categories used are as follows:

Category 0 (Control): 5 ppm – Treatment V

Category 1 (Non saline sodic) 200 ppm- Treatment W

Category 2 (Slightly sodic saline) 2000 ppm – Treatment X

Category 3 (Moderate) 5,000 ppm – Treatment Y

Category 4 (Extremely sodic saline): 10,000 ppm – Remedy Z

The treatments were five salinity levels

Each treatment was repeated three times and each repeat comprised of 10 seeds in 8kg dry soil filled bags. This design was chosen because it is simple and has the potential to reduce bias from environmental variation.

The set up will be irrigated with the salt solutions every 2 days.

Plate 2.1: Randomized lay out of the *Corchorus olitorius* landraces and salt treatments

Plate 2.2: ***Corchorus olitorus*** L. **in measured bags**

2.4 GERMINATION PROCEDURE

The following germination parameters were calculated:

Germination percentage is the estimate of the viability of seed. It is represented mathematically as;

Germination Percentage (GP) = (Number of seeds germinated / Total number of seeds) × 100

These indices provided an objective assessment of the influence of salt stress on early physiological processes associated with seed germination.

2.5 SEEDLING GROWTH ASSESSMENT

At the end of the germination period (day 10), healthy seedlings were randomly selected from each treatment, per replicate, for the evaluation of growth parameters. Growth parameters such as; Shoot height, Leaf Area, Internode length were measured using a meter rule.

Other parameters taken includes; Number of branches, Number of leaves, and Girth.

2.5.1 MEASUREMENT OF SHOOT HEIGHT

Plant height was measured from the visible sprouting point of the plant to the terminal bud at steady intervals using a meter rule, results were recorded in CM.

2.5.2 MEASUREMENT OF LEAF AREA

Leaf area was measured by calculating the length area of a particular leaf in a plant, a specific formula was used and it was measured via the aid of a meter rule, results were in CM^2

2.5.3 MEASUREMENT OF INTERNODE LENGTH

Internode length was measured in cm with the use of a ruler and was measured at steady intervals.

2.5.4 MEASUREMENT OF NUMBER OF BRANCHES

At the appearance of branches, results were taken at steady intervals and numbers were counted

2.5.5 MEASUREMENT OF NUMBER OF LEAVES

At the appearance of branches, results were taken at steady intervals and numbers were counted

2.5.6 MEASUREMENT OF GIRTH

The stem girth was measured via the aid of a divider and then the distance between the divider was measured using a ruler, results were in CM.

2.6 DATA COLLECTION AND RECORDING

All quantitative data were recorded systematically using standardized observation sheets to maintain consistency and accuracy. Observations were made daily, and data were compiled at the end of the experimental period for statistical analysis. To avoid measurement errors, all instruments were calibrated before use, and the same measurement techniques were employed throughout the study.

CHAPTER 3

RESULTS

The results of the effect of salt stress on the germination and seedling growth, alongside other specific parameters of two different landraces of *Corchorus olitorius* seeds are presented below. The two landraces were seeds from NIHORT (Landrace C) and Delta State (Landrace D).

Table 3.1 shows the effect of salinity on the germination of *Corchorus olitorius* after 8 days of planting. The first four treatment V, W, X, Y all experienced growth for the first landrace C (from NIHORT), for this same landrace the last treatment Z experienced no growth for the period of data collection. Both treatment V and W recorded higher germination percent (80.00±17.32%) than other treatments on day 8. For treatments X and Y there were significantly differences from the V and W with lesser salt levels revealing an adverse effect high levels of salt treatment on germination.

Table 3.2 shows the effect of salinity on the germination of *Corchorus olitorius* seeds after 8 days of planting on landrace D (seeds from Delta state). Only salinity treatments V, W, and X recorded germination. On day 8 the treatment W had the highest percent germination (20.00±0.00%). At the end of the germination study, treatment V (control) recorded the highest germination.

Table 3.1: Effects of NaCl on the Germination (%) of *Corchorus olitorus* L. (Landrace C)

TREATMENT	**DAY 8**	**DAY 9**	**DAY 10**	**DAY 11**	**DAY 12**	**DAY 13**
V	80.00±17.32[a]	80.00±17.32 [a]	80.00±17.32 [a]	80.00±17.32 [a]	86.67±11.55 [a]	86.67±11.55 [a]
W	80.00±17.32 [a]	83.33±15.27 [a]	83.33±15.27 [a]	86.67±15.27 [a]	90.00±17.32 [a]	90.00±17.32 [a]
X	66.67±5.77[b]	70.00±10.00 [b]	70.00±10.00 [b]	73.33±15.27 [b]	76.67±11.55 [b]	76.67±20.82 [b]
Y	43.33±11.55[c]	46.67±15.27 [c]	36.67±15.27 [c]	36.67±15.27 [c]	33.33±15.27[c]	30.00±17.32 [c]
Z	0.00±0.00[d]	0.00±0.00 [d]	0.00±0.00 [d]	0.00±0.00 [d]	0.00±0.00 [d]	0.00±0.00[d]

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at $p = 0.05$

Table 3.2: Effects of NaCl on the Germination (%) of *Corchorus olitorus* L. (Landrace D)

TREATMENT	DAY 8	DAY 9	DAY 10	DAY 11	DAY 12	DAY 13
V	3.33±5.77 [a]	10.00±10.00 [a]	16.67±11.55 [b]	23.33±15.28 [b]	30.00±11.55 [b]	16.67±5.77 [b]
W	20.00±0.00 [b]	20.00±0.00 [b]	20.00±0.00 [b]	26.67±5.57 [b]	26.67±5.57 [b]	20.00±0.00 [b]
X	16.67±11.55 [b]	20.00±17.32 [b]	20.00±17.32 [b]	20.00±17.32 [b]	23.33±.27.00 [b]	20.00±17.32 [b]
Y	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]
Z	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at $p = 0.05$

Table 3.3 shows the shoot height of *Corchorus olitorius* seeds for landrace C. Readings were taken weekly following after the completion of germination studies. Treatment X, recorded the highest height (26.83±4.64 cm) throughout the study. At the same time, V and W, had heights of 21.00±0.82 cm and 22.83±0.83 cm respectively. There was no significant difference between treatments V, W and X. There was however, significant difference between treatments V, W, X and Y, Z which recorded no germination.

Table 3.4 shows the shoot height of *Corchorus olitorius* seeds from landrace D (Delta state). Readings were taken weekly after concluding the collection of data for seedling germination. Treatments W and X recorded the significantly higher heights than control. Low salt treatment apparently enhanced growth while treatments Y and Z did not record growth. Thus at the end of the study, treatments V, W, X, Y and Z recorded heights of 4.87±8.43 cm, 22.13±19.54 cm, 30.27±3.43 cm, 0.00±0.00 cm and 0.00±0.00 cm respectively.

The results of the number of leaves of *Corchorus olitorius* from Landrace C are shown in Table 3.5. Treatment V, W, X, Y and Z had values of 34.67±1.70, 29.00±5.66, 31.67±10.14, 0.00±0.00, 0.00±0.00 respectively. The adverse effects of salt treatments were along the concentration gradient. No leaves were recorded in treatments Y and Z.

Table 3.3: Effects of NaCl on the shoot height (cm) of *Corchorus olitorus* L. (Landrace C)

TREATMENT	DAY 8	DAY 9	DAY 10	DAY 11
V	3.53±0.75 ^{a}	6.27±1.56 ^{b}	11.33±1.65 ^{b}	21.00±0.82 ^{c}
W	4.40±0.08 ^{a}	7.63±0.33 ^{b}	12.50±0.41 ^{b}	22.83±0.85 ^{c}
X	4.70±0.22 ^{a}	8.50±0.71 ^{b}	15.50±.80 ^{b}	26.83±4.64 ^{c}
Y	1.40±1.98 ^{a}	2.43±3.41 ^{a}	4.17±5.89 ^{a}	8.67±12.2b
Z	0.00±0.00 ^{d}	0.00±0.00 ^{d}	0.00±0.00 ^{d}	0.00±0.00 ^{d}

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at $p = 0.05$

Table 3.4: Effects of NaCl on the shoot height (CM) of *Corchorus olitorus* L. (Landrace D)

TREATMENT	DAY 8	DAY 9	DAY 10	DAY 11
V	0.83±5.77 ^{a}	1.30±2.25 ^{a}	2.43±4.21 ^{a}	4.87±8.43 ^{a}
W	5.77±0.73 ^{a}	10.30±0.41 ^{b}	11.33±10.13 ^{b}	22.13±19.54 ^{b}
X	5.60±0.70 ^{a}	9.13±1.29 ^{a}	15.97±1.95 ^{b}	30.27±3.43 ^{b}
Y	0.00±0.00 ^{d}	0.00±0.00 ^{d}	0.00±0.00 ^{d}	0.00±0.00 ^{d}
Z	0.00±0.00 ^{d}	0.00±0.00 ^{d}	0.00±0.00 ^{d}	0.00±0.00 ^{d}

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at $p = 0.05$

Table 3.5: Effects of NaCl on the number of leaves of *Corchorus olitorus* L. (Landrace C)

TREATMENT	DAY 8	DAY 9	DAY 10	DAY 11
V	5.33±0.47 ^{a}	7.33±1.16 ^{a}	18.67±1.70 ^{b}	34.67±1.70
W	5.00±0.00 ^{a}	7.67±2.05 ^{a}	18.00±3.56 ^{b}	29.00±5.66 ^{c}
X	5.00±0.00 ^{a}	6.67±1.25 ^{a}	19.67±6.65 ^{b}	31.67±10.14 ^{c}
Y	1.67±2.89 ^{a}	3.00±5.20 ^{a}	8.67±15.02 ^{a}	13.33±23.09 ^{b}
Z	0.00±0.00 ^{d}	0.00±0.00 ^{d}	0.00±0.00 ^{d}	0.00±0.00 ^{d}

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at $p = 0.05$

Table 3.6, the result of the number of leaves on *Corchorus olitorius* from Landrace D (seeds from Delta state) are shown on the table. The control treatment (V) did not undergo a lot of growth. Treatment V,W,X, Y and Z had values of 0.00±0.00, 10.26±2.16, 30.67±2.05, 0.00±0.00, 0.00±0.00. Readings were taken a week after concluding the collection of seedling germination. The adverse effects of salt treatments were along the concentration gradient; the results for Y and Z showed no growth or leaves as there was no germination.

Table 3.7, shows the effect of salinity on the girth of the stem of Landrace C. The following are readings gotten from treatment V,W, X, Y, and Z, they had values of 0.43 ±0.06, 0.40±0.10, 0.40±0.10, 0.17±0.29, 0.00±0.00. Readings were taken a week after concluding the collection of seedling germination. The control treatment recorded the highest value (0.43±0.06). Results were not recorded in the last treatment, as the salinity levels affected germination.

Table 3.8, shows the effect of salinity on the girth of the stem of Landrace D. The following are readings gotten from treatments V, W,X, Y and Z had values of 0.13 ±0.23, 0.37±0.32, 0.53±0.06, 0.00±0.00, 0.00±0.00. Readings were taken a week after concluding collection of seedling germination. The third treatment (X) recorded the highest value (0.53±0.06). Results were not recorded in the last treatment, as the salinity levels affected germination.

Table 3.9, the result of the number of branches of *Corchorus olitorius* from Landrace C are shown on the table. The control treatment recorded the highest number of branches (9.33±1.16) from the other treatments. Treatment W and X recorded (6.67±2.52) and (8.00±2.00) Readings were taken a week after concluding the collection of seedling germination. The adverse effects of salt treatments was along the concentration gradient.

Table 3.6: Effects of NaCl on the number of leaves of *Corchorus olitorus* L. (Landrace D)

TREATMENT	DAY 8	DAY 9	DAY 10	DAY 11
V	1.67±2.89 ^{a}	1.67±2.89 ^{a}	2.00±3.46 ^{a}	3.38±5.77 ^{a}
W	6.00±0.00 ^{a}	10.00±2.16 ^{b}	11.33±10.26 ^{b}	23.33±20.82 ^{c}
X	5.33±0.47 ^{a}	6.67±1.25 ^{a}	13.00±2.16 ^{b}	30.67±2.05 ^{c}
Y	0.00±0.00 ^{d}	0.00±0.00 ^{d}	0.00±0.00 ^{d}	0.00±0.00 ^{d}
Z	0.00±0.00 ^{d}	0.00±0.00 ^{d}	0.00±0.00 ^{d}	0.00±0.00 ^{d}

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at $p = 0.05$

Table 3.7: Effects of NaCl on the stem girth (CM) of *Corchorus olitorus* L. (Landrace C)

TREATMENT	DAY 8	DAY 9	DAY 10	DAY 11
V	0.30±0.00 [a]	0.30±0.00 [a]	0.37±0.06 [a]	0.43±0.06 [a]
W	0.30±0.00 [a]	0.30±0.00 [a]	0.33±0.06 [a]	0.40±0.10 [a]
X	0.27±0.06 [a]	0.30±0.10 [a]	0.33±0.06 [a]	0.40±0.10 [a]
Y	0.10±0.17 [a]	0.10±0.17 [a]	0.13±0.23 [a]	0.17±0.29 [a]
Z	0.00±0.00 [a]	0.00±0.00 [a]	0.00±0.00 [a]	0.00±0.00 [a]

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at $p = 0.05$

Table 3.8: Effects of NaCl on the stem girth (CM) of *Corchorus olitorus* L. (Landrace D)

TREATMENT	DAY 8	DAY 9	DAY 10	DAY 11
V	0.10±0.17 [a]	0.10±0.17 [a]	0.10±0.17 [a]	0.13±0.23 [a]
W	0.30±0.00 [a]	0.33±0.06 [a]	0.30±0.26 [a]	0.37±0.32 [a]
X	0.30±0.00 [a]	0.33±0.06 [a]	0.37±0.06 [a]	0.47±0.06 [a]
Y	0.00±0.00 [b]	0.00±0.00 [b]	0.00±0.00 [b]	0.00±0.00 [b]
Z	0.00±0.00 [b]	0.00±0.00 [b]	0.00±0.00 [b]	0.00±0.00 [b]

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at $p = 0.05$

Table 3.9: Effects of NaCl on the number of branches of *Corchorus olitorus* L. (Landrace C)

TREATMENT	DAY 8	DAY 9	DAY 10	DAY 11
V	0.00±0.00 [a]	1.67±1.53 [b]	5.67±0.58 [b]	9.33±1.16 [b]
W	0.00±0.00 [a]	1.33±2.31 [b]	4.33±2.52 [b]	6.67±2.52 [b]
X	0.00±0.00 [a]	0.67±0.58 [b]	4.67±1.53 [b]	8.00±2.00 [b]
Y	0.00±0.00 [a]	1.00±1.73 [b]	2.33±4.04 [b]	3.67±6.35 [b]
Z	0.00±0.00 [a]	0.00±0.00	0.00±0.00	0.00±0.00

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at p = 0.05

Table 3.10, the result of the number of branches of *Corchorus olitorius* from Landrace D are shown on the table. The third treatment (X) recorded the highest number of branches (12.33±1.15) from the other treatments. Treatment V and W recorded (3.33±5.77) and (8.33±7.37). Readings were taken a week after the concluding the collection of seedling germination. The adverse effects of salt treatments was along the concentration gradient.

Table 3.11 shows the effect of salinity on the internode length of Landrace C. The following are readings gotten from treatments V, W,X, Y and Z, they had values of 1.47 ±0.04, 1.40±0.53, 2.37±1.16, 0.53±0.92, 0.00±0.00. Readings were taken a week after concluding the collection of seedling germination. The third treatment (X) recorded the highest value (2.37±1.16). Results were not recorded in the last treatment, as the salinity levels affected germination.

Table 3.12 shows the effect of salinity on the internode length of Landrace D. The following are readings gotten from treatments V, W,X, Y and Z, they had values of 1.03 ±1.79, 2.07±1.89, 2.17±0.69, 0.00±0.00, 0.00±0.00. Readings were taken a week after concluding the collection of seedling germination. The third treatment (X) recorded the highest value (2.17±0.69). Results were not recorded in the last treatments, as the salinity levels affected germination.

Table 3.10: Effects of NaCl on the number of branches of *Corchorus olitorus* L. (Landrace D)

TREATMENT	DAY 8	DAY 9	DAY 10	DAY 11
V	0.00±0.00 [a]	0.00±0.00 [a]	0.00±0.00 [a]	1.33±1.89 [b]
W	0.00±0.00 [a]	0.00±0.00 [a]	4.33±3.79 [b]	5.67±4.93 [b]
X	0.00±0.00 [a]	1.33±1.53 [b]	5.00±1.00 [b]	9.67±0.58 [b]
Y	0.00±0.00 [a]	0.00±0.00 [a]	0.00±0.00 [a]	0.00±0.00 [a]
Z	0.00±0.00 [a]	0.00±0.00 [a]	0.00±0.00 [a]	0.00±0.00 [a]

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at $p = 0.05$

Table 3.11: Effects of NaCl on the internode length (CM) of *Corchorus olitorus* L. (Landrace C)

TREATMENT	DAY 8	DAY 9	DAY 10	DAY 11
V	0.40±0.69 [a]	0.83±0.24 [a]	1.17±0.17 [a]	1.47±0.04 [a]
W	0.53±0.46 [a]	0.93±0.24 [a]	1.27±0.10 [a]	1.40±0.53 [a]
X	0.73±0.17 [a]	1.63±0.61 [a]	2.23±1.11 [a]	2.37±1.16 [a]
Y	0.17±0.29 [a]	0.40±0.69 [a]	0.50±0.87 [a]	0.53±0.92 [a]
Z	0.00±0.00 [b]	0.00±0.00 [b]	0.00±0.00 [b]	0.00±0.00 [b]

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at $p = 0.05$

Table 3.12: Effects of NaCl on the internode length (CM) of *Corchorus olitorus* L. (Landrace D)

TREATMENT	DAY 8	DAY 9	DAY 10	DAY 11
V	0.00±0.00 ^{a}	0.37±0.64 ^{a}	0.90±1.56 ^{a}	1.03±1.79 ^{a}
W	1.17±0.40 ^{a}	1.80±0.62 ^{a}	1.60±1.39 ^{a}	2.07±1.89 ^{a}
X	1.00±0.16 ^{a}	1.63±0.37 ^{a}	1.43±0.68 ^{a}	2.17±0.69 ^{a}
Y	0.00±0.00 ^{b}	0.00±0.00 ^{b}	0.00±0.00 ^{b}	0.00±0.00 ^{b}
Z	0.00±0.00 ^{b}	0.00±0.00 ^{b}	0.00±0.00 ^{b}	0.00±0.00 ^{b}

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at $p = 0.05$

Table 3.13 shows the leaf area of *Corchorus olitorius* seeds for landrace C (seeds from NIHORT), readings were taken a week after concluding the collection of data for germination. Treatment X , with salinity treatment 2000ppm recorded the highest height (12.15±3.2) throughout the study. At the same time, V and W , recorded (6.92±2.36) and (11.06±3.88), respectively. This means that at the end of the result recording process, there was significant difference. The result for treatment Z showed no shoot height as there was no germination.

Table 3.14 shows the leaf area of *Corchorus olitorius* seeds for landrace D, readings were taken a week after concluding the collection of data for germination. Treatment X , with salinity treatment 2000ppm recorded the highest height (29.86±5.91) throughout the study. At the same time, V and W , recorded (4.73±8.18) and (19.74 ±17.22), respectively. This means that at the end of the result recording process, there was significant difference. The result for treatment Z showed no shoot height as there was no germination.

Table 3.13: Effects of NaCl on the leaf area (CM^2) of *Corchorus olitorus* L. (Landrace C)

TREATMENT	DAY 8	DAY 9	DAY 10	DAY 11
V	2.867±1.36 [a]	5.87±2.29 [a]	7.05±2.84 [a]	6.92±2.36 [a]
W	2.01±0.38 [a]	5.01±1.52 [a]	9.36±3.32 [b]	11.06±3.88 [b]
X	2.83±0.84 [a]	10.42±2.88	11.64±3.24 [b]	12.15±3.24 [b]
Y	0.48±0.83 [a]	1.52±2.64 [a]	1.65±2.85 [a]	1.86±3.23 [a]
Z	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at p = 0.05

Table 3.14: Effects of NaCl on the leaf area (CM2) of Corchorus olitorus L. (Landrace D)

TREATMENT	DAY 8	DAY 9	DAY 10	DAY 11
V	0.35±0.61 [a]	0.60±1.03 [a]	1.74±3.02 [a]	4.73±8.18 [a]
W	2.35±1.75 [a]	7.13±3.83 [a]	12.68±3.83 [b]	19.74±17.22 [b]
X	2.30±0.68 [a]	6.74±1.19 [a]	19.31±6.64 [b]	29.86±5.91 [b]
Y	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]
Z	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]	0.00±0.00 [c]

The values in each column indicates the mean and standard error.
Means sharing the same letters are not significantly different at p = 0.05

CHAPTER FOUR

DISCUSSION AND CONCLUSION

4.1 DISCUSSION

The investigation into the physiological impact of increasing salt concentrations on *Corchorus olitorius* L. confirms that salt stress progressively compromises all vital physiological and morphological parameters. This observed decline is consistent with the established dual nature of salinity stress, which imposes both osmotic pressure and specific ion toxicity on plants (Munns and Tester, 2008). Importantly, the study revealed significant genotypic variation in tolerance, validating the need for comparative assessment between Landrace C (NIHORT) and Landrace D (Delta State).

Salinity severely inhibited the crucial process of germination in both landraces, primarily by restricting water uptake (imbibition) and disrupting the enzymatic activities necessary for mobilizing stored reserves (Xu *et al*., 2023). Landrace C demonstrated superior seed establishment under stress, achieving a peak germination of 90.00 ± 17.32% at 200 ppm and maintaining a strong percentage of 76.67 ± 20.82%, even at 2000 ppm (Table 3.1). This resilience suggests that Landrace C possesses a higher capacity for osmotic adjustment, likely through the accumulation of organic osmolytes to stabilize cellular function under ionic stress (Hao *et al*., 2021).

Conversely, Landrace D proved highly sensitive, its germination peaked at a much lower rate (30.00 ± 11.55%), in the control and only achieved 20.00 ± 0.00% at 200 ppm and 2000ppm (Table 3.2). Crucially, germination in Landrace D was totally inhibited at the 5000ppm concentration and above. This acute sensitivity is indicative of weaker membrane stability and insufficient defense against the rapid disruption of cellular metabolism caused by high salt levels (Roy *et al*., 2018). Salinity restricted overall vegetative development by disrupting cell division and elongation due to the accumulation of toxic ions (Munns and Tester, 2008; Tebini *et al*., 2022).

Landraces C and D recorded their maximum shoot height at the moderate 2000 ppm concentration i.e. 3.43 cm for Landrace D (Table 3.4) and 4.64 cm for Landrace C (Table 3.3). This slight stimulation at sub-lethal levels can be a mechanism involving temporary osmotic adjustment (Atta *et al*., 2023). However, Landrace D growth ceased entirely at higher concentrations. Similarly, internode length, which reflects cell elongation, peaked at 1.16 cm for Landrace C and 0.69 cm for Landrace D at 2000 ppm (Tables 3.11 and 3.12), with total inhibition at 10,000 ppm.

The reduction in stem girth at higher salinity is linked to osmotic imbalance and reduced cell expansion (Tebini *et al*., 2022). While Landrace D achieved a maximum girth of 0.53±0.06cm at 2000 ppm, Landrace C maintained a more stable, albeit slightly lower, parameters across treatments. Landrace C also demonstrated a higher overall branching capacity, recording 9.33±1.16 branches in the control (Table 3.9), reflecting superior hormonal homeostasis under stress (Roy *et al*., 2018).

Leaf development, a direct measure of photosynthetic potential, was highly sensitive to salinity. Landrace C maintained a high number of leaves at 2000 ppm (Table 3.5), indicating better tolerance to oxidative stress (Zhao *et al*., 2021). While Landrace D also showed a large leaf area at 2000 ppm (Table 3.14), it quickly suffered early leaf senescence and failed to produce leaves at concentrations above 2000 ppm (Ben Yakoub *et al*., 2018).

Based on the cumulative evidence, Landrace C (NIHORT) exhibited superior resilience and consistency, qualifying it as the more salt-tolerant landrace. Landrace D displayed vigorous, short-lived superior growth only at moderate stress levels (up to 2000 ppm). However, Landrace D performance was not sustainable, as all measured parameters, including germination and growth, collapsed entirely at the 5000 ppm and 10,000 ppm treatments. In contrast, Landrace C's ability to sustain the highest germination rate (90.00 ± 17.32%) and maintain measurable growth parameters across a wider, more challenging range of salt concentrations confirms its stronger underlying genetic mechanisms for adapting to both osmotic and ionic stress.

4.2 CONCLUSION

This experiment established that salinity exerts a strong negative influence on the germination and early seedling development of *Corchorus olitorius L.*, and that tolerance differs significantly between landraces. Landrace C (NIHORT) consistently outperformed Landrace D (Delta State) in germination percentage, leaf number, and sustained growth under higher salinity levels, identifying it as the more salt tolerant genotype. Conversely, Landrace D exhibited better performance under mild to moderate salinity but showed sharp declines under severe salt stress.

The essence of this experiment was to evaluate the comparative physiological responses of two jute landraces under salt stress, with the aim of identifying a more resilient genotype suitable for saline environments. The study's results have practical implications for crop improvement and sustainable agriculture, as they provide a physiological basis for selecting salt tolerant jute varieties.

By demonstrating that *C. olitorius* landraces differ in their capacity to tolerate salinity, this research contributes to ongoing efforts to enhance food and fibre production in marginal soils affected by salinization. Future research should integrate biochemical and molecular analyses, such as measurement of ion content, osmolyte accumulation, and antioxidant enzyme activity to further elucidate tolerance mechanisms and inform breeding programs aimed at developing salt resilient jute cultivars.

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