



Morpho-Physiological Screening of Some Selected Rice (*Oryza sativa*) Varieties For Salinity Stress Tolerance In Gashua Yobe State Nigeria

*Tijjani Abubakar, Abdurrahman Dunoma, Tahir Sani Tahir

Department of Biological Science Federal University Gashua, Yobe State, Nigeria.

*Corresponding authors' email: tijanikatuzu@gmail.com

ABSTRACT

Rice is one of the most important cereal crops and a primary food source for nearly half of the global population. In Nigeria, (*Oryza sativa* L.) is widely cultivated and consumed, but its production is increasingly threatened by environmental stresses such as salinity and drought, which significantly reduce yield and farmer productivity. This study evaluated the morpho-physiological responses of selected rice varieties to salinity stress at the Botanical Garden of the Department of Biological Sciences, Federal University Gashua, Yobe State, Nigeria. Eight rice varieties, comprising four improved types (Faro 42, Faro 44, Faro 61, And Nerica) and four local landraces (Yar Masaba, Yar Sani, Jamila, and Jarani Bazawara), were assessed using a pot experiment. Seedlings were transplanted into pots containing 4kg of soil and exposed to salinity treatments of 0, 3, 6, and 9 dS/m using sodium chloride (NaCl) one month after germination. The experiment followed a randomized complete design. Data were collected on germination percentage, plant height, leaf chlorophyll content, leaf area, 50% wilting, and regeneration potential, and analyzed using analysis of variance. Results showed that salinity significantly ($P < 0.05$) affected all measured parameters across the varieties. However, Faro 42, Faro 44, and Nerica demonstrated moderate tolerance by maintaining relatively higher growth and physiological performance. In contrast, Yar Sani was highly susceptible, showing marked reductions under increasing salinity. The findings highlight promising varieties for cultivation in salt-affected areas and emphasize the value of morpho-physiological traits in screening for salinity tolerance.

Received: 16 May 2026

Accepted: 01 June 2026

Published: 16 June 2026

Keywords: Rice, Salinity, Tolerance, Susceptibility, Stress

INTRODUCTION

Rice is one of the most vital food crops in the world, serving as a primary source of nutrition for more than 3.5 billion people. Although the crop exhibits a certain degree *et al.*, of tolerance to salinity during the germination stage, it becomes highly susceptible during the early seedling and reproductive phases. At these critical stages, exposure to salinity can severely hinder growth, disrupt physiological processes, and ultimately lead to substantial yield losses. (Mansuri *et al.*, 2020; Banumathy 2021).

The area under rice cultivation has been increased to counter the needs of the rapidly growing human population, which is expected to increase up to 9.5 billion by 2050 (Leridon, 2020). Due to its relatively small genome size, sufficient genetic diversity, molecular studies, and successful genetic transformation, rice has been labelled as a model crop (Chen *et al.*, 2021).

Soil salinity is a major abiotic constraint that significantly reduces the growth and productivity of rice (*Oryza sativa* L.) on a global scale. This problem is particularly severe in coastal areas, where saltwater intrusion and secondary salinization are widespread. Singh *et al.*, 2018; Li *et al.*, 2025. Currently, an estimated 1.4 billion hectares of land are affected by salinity, while an additional 1 billion hectares are at risk due to the combined effects of climate change and unsustainable human practices. (Singh 2022).

Developing and identification of rice genotype with improved tolerance to salinity has long being a key objective in crop improvement programs. However, progress has been slow

due to complex nature of salt stress which affect multiple physiological and biochemical processes within the plant. Salinity can lead to reduce growth diminished photosynthetic efficiency disruption of ionic balance and increases oxidative stress. (Zamani *et al.*, 2024).

Bearing in mind the increasing risk of soil salinity due to climatic changes and unsustainable farming practices, identifying and developing salt tolerant genotypes is indispensable to ensure food security (Hossain *et al.*, 2015). This researched intended to identify the most suitable among the selected rice genotypes that are tolerance to salt stress, which will significantly bring about a lasting solution to farmers, breeders, and researchers living in areas that are prone to soil salinity.

MATERIAL METHODS

Study Area

This research was conducted in a botanical garden of Federal University Gashua Yobe State. A community is in bade local government area Yobe State. The geographical coordinate of the botanical garden falls between 12°52'5" N and 11°2'47" E with average elevation of about 299mm above the sea level (Saleh and Ahmed, 2019). The area is characterized by two distinct seasons, the wet and dry season respectively. The wet season is between April and October while the dry season is between November and March. Rain fall distribution is bimodal with maximum rainfall occurring between June and September. Mean annual rain fall is between 1000mm1500mm, mean annual temperature is 30°C, and

relative humidity is about 80% but decreases in the early months of dry season (Ikyaabga, 2008).

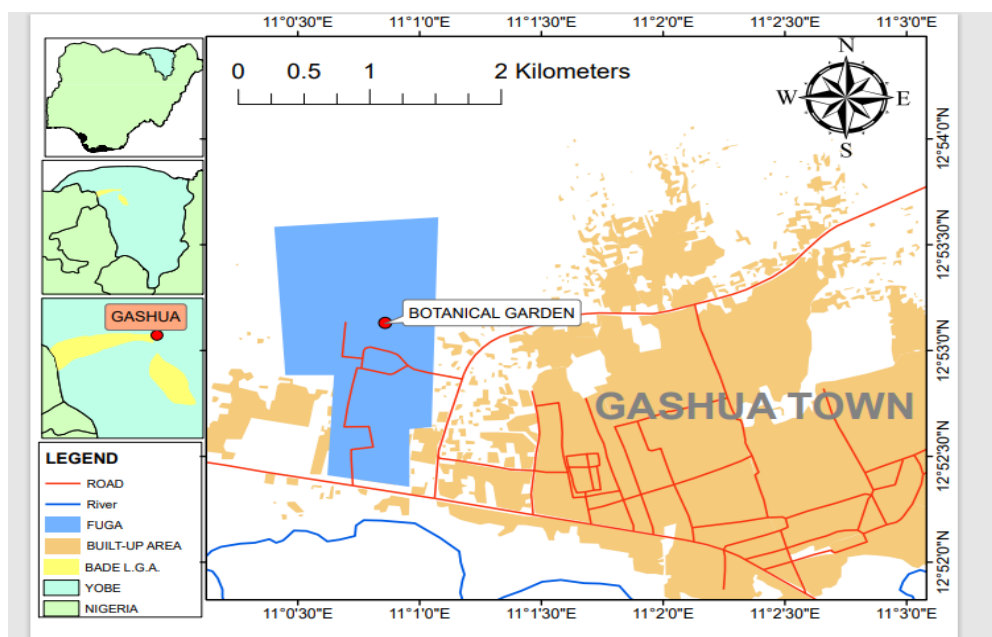


Figure 1: Location of Study Area (sources: Department of Geography Federal University Gashua)

Treatment Used

Eight (8) varieties of rice were tested for salinity tolerance which include four improved varieties (Faro 42, Faro 44, Faro 61 and Nerica) and four local landrace Yar Masaba, Yar Sani, Jamila, and Jarani Bazawara), four (4) level of salinity were induced at seedling stage from, 0, 3, 6, and 9 dS/m, respectively, 4kg of clay-loam soil in a ratio of 2: 2 was used. (Senanayakee *et al.*, 2017), method was adopted, eight seedlings were sown and after germination was thinned to three (3) per pot watering was done on the daily basis, early morning with the aid of a tap for four weeks before salinity stress was induced, the pots were then controlled on the basis of different treatment levels and replicated three times including the treatments in a completely randomized design.

Data Collection

Data collected includes percentage germination, plant height, leave length, stem girth, chlorophyll content, leave area, percentage wilting, no of days to maturity, were measured. Using the modified standard evaluation system in rating the visual symptoms of the injury imposed by the stress, the susceptible genotypes have been discriminated from the tolerant, moderately tolerant and highly tolerant genotypes.

Metrological Data

Metrological data was taken at the interval of each two weeks after sowing, transplanting Rainfall, Wind, Humidity and Temperature are most important factors that determine growth and Production (Shivaji *et al.*, 2014). Temperature and Relative humidity of botanical garden was measured in the morning and afternoon at every two weeks of the experiment.

Statistical Analysis

The Data on differences between genotypes for the recorded morpho-physiological traits were tested for significant using Analysis of Variance (ANOVA). Data obtained were subjected to R-Statistical package for the analysis of variance, and the mean values were compared using the least significant different test at 5% level of significance.

RESULTS AND DISCUSSION

Effect of Germination Rate on Selected Rice Varieties

The result on the effects of germination rate of some selected Rice varieties was presented in Table 1 below, the result indicated that Faro 42 and Nerica (improved varieties) recorded the highest rate of germination with 95% and 90% while Yarsani (local) recorded the lowest rate of germination with 67.5%, the overall results indicated that both improved and local varieties are viable with above 50% germination rate

Table 1: Effect of Germination Rate on Selected Rice Varieties

Number of Weeks				
Varieties	Week 1	Week 2	Total germ.	Percentage Germ
Faro 42	28	10	38	95
Faro 44	25	08	33	82
Faro 61	23	09	32	80
Nerica	28	08	36	90
Jamila	23	08	31	77.5
Yar Masaba	20	10	30	75
Yar Sani	15	12	27	67.5
Jirani Bazawara	19	11	30	75

Key: Germ. Germinated

Effect of Temperature and Relative Humidity

The effect of temperature and relative humidity of the experimental site (Botanical Garden) in the morning and afternoon throughout the experiment was presented in (Table 2). The average temperature in the morning ranges from 28°C to 32. °C while in the afternoon was 30.7 °C, to 37. °C while

the average relative humidity was 64% to 84.3%, and 58% to 66.5% in the morning and afternoon respectively. These shows that; the weather condition in the screen house was optimum during the experiment. However, the environment was generally cooler and has highest moisture in the morning than in the afternoon throughout the period of the experiment.

Table 2: Effect of Temperature and Relative Humidity

Time Weeks	Morning		Afternoon	
	Tempreture (°C)	Humidity (%)	Tempreture(°C)	Humidity (%)
Week 2	28.3	85.2	31.0	58.2
Week 4	26.4	79.3	28.4	71.1
Week 6	29.5	65.0	33.5	60.1
Week 8	28.9	60.0	34.7	60.3
Week 10	30.2	64.0	37.8	64.0
Week 12	32.8	70.2	37.5	50.0

IRRI Standard of Evaluation of Some Selected Rice Varieties

Classification of rice varieties on the Basis on IRRI Standard Evaluation System for Rice Salinity Tolerance, Based on the IRRI score for some selected for rice salinity tolerance, the varieties were categorized into four (4) different levels of stress response as presented in Table 3 below.

At 0dS/m all plants were scored 1 which indicated normal morphological growth and no salt stress symptoms, at 3dS/m the varieties were scored 3 based on IRRI standard evaluation system, indicating nearly normal growth, but leaf tips and few leaves turn a bit whitish or rolled. At 6dS/m Faro 42, 44 and

Nerica were scored 5 indicating retarded growth and most leaves rolling with just few elongated while Faro 61, Jamila, Yar Masaba, Yar Sani and Jirani Bazawara were scored 7 indicating completely cessation of growth with some plants dying. At 9dS/m Faro 42 and 44 and Nerica were scored 5 indicating retarded growth and most leaves rolling with just few elongated while Faro 61, Jamila, Yar Masaba, Yar Sani and Jirani Bazawara were scored 9 indicating all plants have died. On the basis of tolerance and susceptibility indices, Faro 42, 44 and Nerica were classified as moderately tolerant varieties Faro 61, Jamila, Yar Masaba, Yar Sani and Jirani Bazawara as susceptible varieties.

Table 3: IRRI Standard Evaluation System for Selected Rice Varieties Based on their Morpho-Physiological appearance in respect to Salinity Tolerance

Varieties	Concentration				Tolerance Level
	0dS/m	3dS/m	6dS/m	9dS/m	
Faro 42	1	3	5	5	Tolerant (Moderate)
Faro 44	1	3	5	5	Tolerant (Moderate)
Faro 61	1	3	7	9	Susceptible
Nerica	1	3	5	5	Tolerant (Moderate)
Jamila	1	3	7	9	Susceptible
Yar Masaba	1	3	7	9	Susceptible
Yar Sani	1	3	7	9	Susceptible
Jirani Bazawara	1	3	7	9	Susceptible

Key: dS/m- deciSiemen per metre (electrical conductivity units)

Effect of Salinity Stress on Number of Leaves of selected Rice Varieties

Effect of Salinity Stress on Number of Leaves of selected Rice Varieties was presented in Table 4 below, the result indicated that there significant difference between treatment and control line (Normal Watering and Salt stress watering), throughout the weeks with highest value of 9.00 Normal watering

(control) and the least value of 4.00 stress watering (salinity stress). For the varieties the improved variety Faro 44 shows highest significant different despite the stress number of leaf tends to increase despite the stress with about (9.00) at week 8, while the least was observed at almost all the local land-races with (4.00) while Yar Masaba Local inhibit a little increase of 5.00 at 12weeks.

Table 4: Effect of Salinity Stress on the Number of Leaves of Selected Rice Varieties after Stress Induction

Treatments	Weeks after Salt Induction			
	4	8	12	16
Treatment	4.00 ^d	4.00 ^d	5.00 ^{cd}	5.00 ^{cd}
Control	4.00 ^d	6.00 ^c	8.00 ^b	9.00 ^a
Genotypes				
Faro 42	4.00 ^d	5.00 ^{cd}	6.00 ^c	7.00 ^{cde}
Faro 44	4.00 ^d	6.00 ^c	8.00 ^b	9.00 ^a
Faro 61	4.00 ^d	4.00 ^d	4.00 ^d	4.00 ^d
Nerica	4.00 ^d	5.00 ^{cd}	5.00 ^{cd}	6.00 ^c
Jamila	4.00 ^d	4.00 ^d	4.00 ^d	4.00 ^d

Weeks after Salt Induction				
Yar Masaba	4.00 ^d	4.00 ^d	4.00 ^d	5.00 ^{cd}
Yar Sani	4.00 ^d	4.00 ^d	4.00 ^d	4.00 ^d
Jirani Bazawara	4.00 ^d	4.00 ^d	4.00 ^d	4.00 ^d
Tr x Var.	**	**	**	**

Significant at P value ≤ 0.05

*Means with different superscript a for both treatments and variety are significant

* LSD: Least Significant Difference

* SW: Stress Watering NW: Normal Watering

*Tr.: Treatment Var.: Variety

Effect of Salinity Stress on Plant Height (cm) of Selected Rice Genotypes (*Oryza Sativa L.*)

Effect of Salinity on Plant Height (cm) of selected Rice Genotypes (*Oryza sativa L.*) was presented in Table 5 below, the outcome of the findings show a significant differences ($p \leq 0.05$) among the treatments and varieties after salinity induction at different weeks intervals. The highest plant height was observed at (3dS/m) of 9 weeks and the lowest plant height was observed in plants treated with 9dS/m at Week three (3).

Generally there is significant difference between the heights of treated with (3dS/m, 6dS/m and 9dS/m) and untreated (0dS/m/ Control), ($p \leq 0.05$) plants respectively, the treated

with plants differs significantly with the control line, Plant treated with 9dS/m recorded lower plant height while those treated with (3dS/m) yielded the best result.

Unilateral trend was observed in 9 weeks after salinity induction, plant height being significantly higher in the control plants (0dS/m) and significantly lower in plants treated with 9dS/m compared to the control. The effect of genotypes was also significant at ($p \leq 0.05$), for the genotypes, improved varieties like (Faro 44 and 42) Perform the best At 9 weeks of Salinity induction, while the local landraces such as Jirani Bazawara and Yar Masaba (34 and 35cm) respectively recorded lowest level in terms of plant height.

Table 5: Effect of Salinity Stress on Plant Height (cm) of Selected Rice Genotypes (*Oryza sativa L.*)

Weeks after Salinity Induction			
Treatments	Week 3	Week 6	Week 9
0dS/m	45.50 ^a	61.40 ^a	104.3 ^a
3dS/m	37.60 ^b	53.60 ^b	92.40 ^b
6dS/m	20.80 ^c	29.60 ^c	46.50 ^c
9dS/m	8.20 ^d	12.10 ^d	14.79 ^d
LSD	0.66	1.240	2.130
Genotypes			
Faro 42	31.90 ^a	40.60 ^a	52.00 ^a
Faro 44	36.70 ^a	48.50 ^a	57.60 ^a
Faro 61	33.50 ^a	43.50 ^a	51.20 ^a
Nerica	30.20 ^a	41.30 ^a	48.10 ^b
Jamila	22.30 ^b	32.60 ^b	37.60 ^c
Yar Masaba	20.20 ^b	29.50 ^c	35.60 ^c
Yar Sani	21.50 ^b	30.80 ^b	36.50 ^c
Jirani Bazawara	19.00 ^c	30.10 ^b	34.90 ^c
LSD	0.840	1.580	2.316
Trt. x Var.	**	**	**

Key: dS/m- deciSiemen per metre (electrical conductivity units)

Significant at P value ≤ 0.05

*Means with different superscript a for both treatments and variety are significant

* LSD: Least Significant Difference

* SW: Stress Watering NW: Normal Watering

*Tr.: Treatment Var.: Variety

Effects of Different Level of Salinity on Chlorophyll Content of Selected Rice Genotypes (*Oryza sativa L.*)

The results for the effect of salinity on Chlorophyll Content on selected rice Genotypes was presented in Table 5 below, The results indicated statistical significant between treated and untreated rice genotypes, the highest concentration of

chlorophyll content after salinity induction was observed at (3dS/m) of week six (6) with about (38) while the lowest value of chlorophyll content was recorded at (9dS/m) of week 3 with about (5.20) but all the treatments are statistically significant compared to the control line at ($P \leq 0.05$).

Table 6: Effect of Salt Stress on Chlorophyll Content of Selected Rice Genotypes (*Oryza sativa* L.)

Weeks after Salinity Induction			
Treatments	Week 3	Week 6	Week 9
0dS/m	22.50 ^a	50.20 ^a	36.80 ^a
3dS/m	18.60 ^b	38.10 ^b	30.40 ^b
6dS/m	10.90 ^c	21.30 ^c	20.10 ^c
9dS/m	5.20 ^d	9.10 ^d	13.20 ^d
LSD	0.986	1.340	1.010
Genotypes			
Faro 42	13.90 ^a	38.60 ^a	34.40 ^b
Faro 44	14.80 ^a	40.30 ^a	37.60 ^a
Faro 61	13.20 ^b	39.00 ^a	33.20 ^b
Nerica	14.20 ^a	37.80 ^b	32.10 ^b
Jamila	12.30 ^b	30.60 ^c	22.40 ^c
Yar Masaba	11.20 ^c	26.50 ^d	21.10 ^c
Yar Sani	10.50 ^c	25.80 ^d	19.40 ^d
Jirani Bazawara	9.50 ^c	24.10 ^d	18.60 ^d
LSD	1.130	1.913	1.602

Discussion

Salt stress, like other environmental stresses, has a significant impact on both the physiological and morphological characteristics of plants. To properly assess how plants respond to such stress, several evaluation methods are used, which are widely accepted for determining the level of tolerance or susceptibility of different plant genotypes. Therefore, having a standard scoring system for morpho-physiological traits is very important, as it serves as a reliable tool for identifying salt-tolerant rice genotypes. In this study, the results grouped the rice genotypes into three categories: moderately tolerant, susceptible, and highly susceptible. This classification clearly shows that different rice genotypes respond differently when exposed to salinity stress.

The findings further indicate that salinity negatively affects rice growth at both the seedling stage and later developmental stages. In comparison to the stressed plants, the control plants (those not exposed to salt stress) consistently performed better, with statistically significant differences observed. Salinity treatment caused a noticeable reduction in important growth parameters such as plant height, leaf length, stem girth, chlorophyll content, and leaf area, while also increasing the percentage of wilting.

These observations are in agreement with the findings of Mayaki B. M. *et al.*, (2024), who reported that salinity significantly reduced plant height across all rice varieties studied, with the severity of the reduction increasing as the salt concentration increased. Similarly, Puvanitha *et al.*, (2017) found that rice cultivars exposed to salt stress showed a significant decrease in height compared to those grown under normal conditions. Efiuse *et al.*, (2020), also reported that exposing rice genotypes to a salinity level of 6dS/m led to a considerable decline in plant growth. In addition, Hayatu *et al.*, (2004), observed that salinity stress significantly reduced leaf area, relative water content, and grain yield in cereal crops. Together, these studies strongly support the results obtained in the present research.

Moreover, the results of this experiment showed that chlorophyll content decreased significantly in all the rice varieties as the level of salinity increased. Under normal (control) conditions, the plants maintained a healthy green color, indicating sufficient chlorophyll content. However, under salt stress, the leaves showed symptoms such as yellowing and discoloration. This observation is consistent with the findings of Ikhajiagbe *et al.*, (2020), who reported that rice plants grown under saline conditions exhibited

yellowish-white leaves, suggesting a loss of chlorophyll and the increased visibility of carotenoid pigments. This finding is also supported by Hussain *et al.*, (2017), who explained that the presence of sodium (Na⁺) and chloride (Cl⁻) ions in saline conditions can damage chlorophyll molecules and interfere with the electron transport process in Photosystem II (PSII), thereby reducing photosynthetic efficiency. Similarly, Heidari (2011), reported that increasing salinity levels lead to a reduction in chlorophyll a and b, which may be due to photoinhibition or a decrease in chlorophyll synthesis.

In general, the results of this study demonstrate that salinity stress has a harmful effect on the growth and physiological performance of rice plants. The reduction in growth parameters and chlorophyll content highlights the sensitivity of rice to saline conditions, although some genotypes showed moderate tolerance. This suggests that such genotypes could be useful in breeding programs aimed at developing salt-tolerant rice varieties.

CONCLUSION

The results of this study clearly demonstrate that salinity, like other forms of environmental stress, exerts a significant negative impact on the growth and development of rice genotypes at both the vegetative and reproductive stages. Exposure to saline conditions led to a consistent decline in important growth and physiological parameters, including plant height, chlorophyll content, and number of leaves. These reductions indicate that salinity interferes with normal plant metabolic processes, ultimately limiting growth performance and productivity. Despite the overall negative effects of salinity, the study revealed noticeable differences in the response of the rice genotypes evaluated. This variation highlights the genetic diversity that exists among rice varieties in their ability to cope with salt stress. Among the genotypes studied, improved varieties such as Faro 44, Faro 42, and Nerica exhibited a moderate level of tolerance. Their relatively better performance under saline conditions suggests that they possess adaptive mechanisms that enable them to withstand salt stress to a certain extent, particularly at specific stages of growth.

In contrast, the local genotypes generally showed a higher level of susceptibility to salinity stress. This was evident from the more severe reductions observed in their growth and physiological traits when compared to the improved varieties. The poor performance of these local genotypes under saline conditions indicates their limited capacity to tolerate salt

stress, making them less suitable for cultivation in affected areas. Based on these findings, Faro 44, Faro 42, and Nerica can be classified as moderately salt-tolerant varieties. Therefore, their cultivation is strongly recommended for farmers, agricultural practitioners, and researchers operating in regions with saline soils. The adoption of these improved varieties has the potential to enhance crop performance under stress conditions, increase agricultural productivity, and support sustainable farming systems. Ultimately, this could contribute significantly to improving food security, particularly in areas where soil salinity poses a major challenge to crop production.

Furthermore, the results of this study provide useful insights for future rice breeding programs aimed at developing more salt-tolerant varieties. By focusing on genotypes that demonstrate moderate tolerance, researchers can build on these traits to achieve higher levels of resistance, thereby ensuring better adaptation to changing environmental conditions.

REFERENCES

Banumathy, S., Kiruthikadevi, U., Arunachalam, P., Renuka, R., Thirumurugan, T., Raveendran, M., (2021). Screening of Salt introgressed backcross inbred lines of rice under hydroponic condition for salinity tolerance. *Cereal. Res. Commun.* 49, 235–243. <https://doi.org/10.1007/s42976-020-00102-4>.

Bashir M. M., Lawan A. S., Usman A., Jibril S. M. , Nuraddeen M. , Rukayya K. M. (2024). Morpho-Physiological Assessment of Some Rice (*Oryza Sativa L.*) Genotypes for Salinity Stress Tolerance, *Dutse Journal of Pure and Applied Sciences (DUJOPAS)*, Vol. 10 No. 2c. pp 188-200.

Chen, T., Shabala, S, Niu, Y., Chen, Z., Shabala, L., Meinke., H. (2021b) Molecular Mechanisms of Salinity Tolerance in Rice. *Crop Journal* 9, 506-520.

Efissue, A, A. and Dike, C, C. (2020). Screening Rice (*Oryza sativa. L*) for Salinity Tolerance for Yield and Yield Components in Saline Stressed Environment. *American Journal of Agriculture and Forestry* 8(1): 15-21.

Hayatu M., Muhammad S. Y., Habibu U. A. (2014). Effect of Water Stress on the Leave Relative Water Content and Yield of some Cowpea Varieties (*Vigna unguilata (L) Walp.*) Genotypes. *Inter. Journal of Sci. and Tech. Reserch* Vol. 3 ISSue 7.

Heidari, M. (2011).effect of salinity stresss on growth, chlorophyll content and osmotic component of two basil (*Occimum basilum L.*) genotypes. 11(2).

Hossain, M.S., Persicke, M., Kalinowski, J., (2015). Genome-wide association study in rice reveals role of salinity stress-responsive genes in salt tolerance. *Front. Plant Sci.* 6, 712. <https://doi.org/10.3389/fpls.2015.00712>.

Hussain, S., Zhang, J. H., Zhong, C., Zhu, L. F., Cao, X. C., Yu, S. M., Allen, B. J., Hu, J. J. and Jin, Q. Y. (2017). Effects of salt stress on rice growth, development characteristics, and the regulating ways: *Journal of Integrative Agriculture*, 16(11): 2357–2374

Ikhaijagbe, B. and Omoregie, U. E (2020) Growth, yield, genetic parameters and random amplified polymorphic DNA (RAPD) of five rice varieties treated with sodium azide and sown under different saline conditions. *Bulletin of the National Research Centre* 44:89

Ikyaagba, E.T. (2008). Plant biodiversity and Ethno botanical potential of University of Agriculture Makurdi wildlife park and Ikwe Game Reserves, Igbo Benue State Nigeria; (*Unpublished thesis in the Department of Forest Resources Management University of Ibadan, Ibadan Nigeria 1-123pp*).

Leridon, T. (2020). World Population outlook: Explosion or impllosion? *Popular. Soc.* , 573, 1-4.

Li, C., Guan, J., Liang, W.H., Yao, S., He, L., Wei, X.D., Zhao, L., Zhou, L.H., Zhao, C., Zhao, Zhu, Z., Huang, S., Wang, C., Zhang, D., Lu, K., Chen, T., Chen, T.,(2025). OsWRKY72 enhances salt tolerance in rice via SKC1-mediated Na⁺ regulation.

Plant Stress, 100962. <https://doi.org/10.1016/j.stress.2025.100962>.

Mansuri, R., Shobbar, Z.S., Babaeian Jelodar, N., Ghaffari, M., Mohammadi, S.M., Daryani, P., (2020). Salt tolerance involved candidate genes in rice: an integrative meta-analysis approach. *BMC. Plant Biol.* 20, 1–14

Puvanitha, S. and Mahendran, S. (2017). Effect of Salinity on Plant Height, Shoot and Root Dry Weight of Selected Rice Cultivars, *Scholars Journal of Agriculture and Veterinary Science*, 4(4):126-131.

Saleh, A. and Ahmed, A. (2019). Solid Waste Management Practice and Challenges in Gashua, Yobe State, Nigeria. *Nigerian Journal of Environmental Sciences and Technology*, 3(2): 298-303.

Senanayake, R. M. N. H., Herath, H. M. V. G., Wickramesinghe, I. P., Udawela, U. A. K. S. and Sirisena, D. N. (2017). Phenotypic Screening of Rice Varieties for Tolerant to Salt Stress at Seed Germination, Seedling and Maturity Stages. *Tropical Agricultural Research*, 29(1).

Shivaji, S., Singh, S. P., Neupane, M. P., and Meena, R. K. (2014). Effect of NPK Levels.

Singh, A., 2022. Soil salinity: a global threat to sustainable development. *Soil Manage* 38, 39–67. <https://doi.org/10.1111/sum.12772>.

Singh, V., Singh, A.P., Bhadoria, J., Giri, J., Singh, J., TV, V., Sharma, P.C., 2018. Differential expression of salt-responsive genes to salinity stress in salt-tolerant and salt-sensitive rice (*Oryza sativa L.*) at seedling stage. *Protoplasma* 255, 1667–1681.

Zamani, E., Bakhtari, B., Razi, H., (2024). Comparative morphological, physiological, and biochemical traits in sensitive and tolerant maize genotypes in response to salinity and pb stress. *Sci. Rep.* 14, 31036. <https://doi.org/10.1038/s41598-024-82173-5>.

APPENDICES
List of Plates



Figure 1: Some rice genotypes before Salinity Induction



Figure 2: Some rice Genotypes after Salinity Induction



©2026 This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International license viewed via <https://creativecommons.org/licenses/by/4.0/> which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is cited appropriately.