*PAT December, 2021; 17(2): 9- 22 ISSN: 0794-5213*

*Online copy available at www.patnsukjournal.net/currentissue*

*Publication of Nasarawa State University, Keffi*

# SCREENING OF LOWLAND RICE (*Oryza spp)* VARIETIES FOR FLOOD TOLERANCE IN FRESHWATER AND ESTUARINE ENVIRONMENTS IN DELTA STATE

**Uwuigbe E. U. [1], Akparobi S. O. [2] and Oroka F.O. [3]**

[1]*Dennis Osadebay University, Asaba, Delta State, Nigeria;* [2]*Delta State University, Abraka, Delta State, Nigeria;*
[3]*Delta State University, Abraka, Delta State, Nigeria*
**Corresponding author mail- sholaedith@yahoo.com*

**Abstract**

*This study was designed to investigate the screening of 51 lowland rice varieties for tolerance to flooding in Freshwater and Estuarine Environment in a two year cropping season. The Experimental design was a factorial experiment laid out in a Completely Randomized Design having three replications, and it involves screening of 51 lowland rice varieties for tolerance to flooding in submerged drums for 14 days. Parameters assessed includes; Germination%, Plant height (cm), Elongation per day (cm), Elongation % and Survival %. The result showed that there was significant difference at (P< 0.05) in survival % among the varieties screened in freshwater and estuarine environment. At the end of the 2 year screening exercise, the result showed that twenty one varieties namely; Faro 66, Faro 15, Faro 16 , Faro 17, Faro 18 , Faro 19, Faro 20 , Faro 22, Faro 24, Faro, 26 , Faro 33, Faro 37, Faro 4, Faro 50, Faro 52 , Faro 57 , Faro 44 , Faro 67 , Nicro 49, Rasa, and Swana sub 1 had highest survival% of between 76.10 -97.61% and 73.00 - 92.87% for freshwater and estuarine environments respectively (1$^{st}$year), 73.00-98.87% and 71.37-95.43% for freshwater and estuarine environments respectively (2$^{nd}$ year), while the following varieties namely; Faro 12, Faro 13, Faro 28, Faro 29, Faro 31, Faro 35, Faro 36,Faro 51, Faro 55, Faro 56 and Faro 61 exhibited least survival% of 22.77- 38.71% and 19.95-30.27% for freshwater and estuarine environments respectively (1$^{st}$ year), 30.27-39.53% and 18.13-37.10% for freshwater and estuarine environments respectively (2$^{nd}$ year). Thus, the study concluded that these21 lowland rice varieties have flood tolerant traits and can be recommended to the farmers who are interested in growing rice in flood prone areas.*

***Keywords: Freshwater, Estuarine, Varieties, Percentage, Survival***

## Introduction

Rice (Oryza *spp*) is a member of the family *Poaceae*. It is a staple food in several African countries. The FAO data shows that between 2014 and 2019, Nigeria maintained top most among rice producers in Africa (FAO, 2016). Between 2014 and 2016, Nigeria's rice paddy production figures constantly rose from 6.0 to 7.5 million metric tonnes respectively, but in 2017, Nigeria's production figure fell to 6.61 mmt, and increased in 2018 to 6.81 mmt, while in 2019, it dropped to 5.1 mmt (FAO, 2019). Rice has shaped the culture, diets and economic of thousands of millions of peoples around the world (USDA, 2018). In Nigeria, approximately 70% of rainfed lowland rice farms are prone to seasonal flooding, which has led to serious yield losses ranging from 10% to total destruction (Akinwale *et al.,* 2012) and the most frequently affected states are Delta, Ebonyi, Kebbi, Niger, Kogi and Taraba states respectively (Erenstein *et al.,* 2014) . According to Anugwara and Emakpe (2013), the flood which occurred in 2012 damaged over 1.9 million hectares of land and reduced food production along the flood plains, and rice production in the submerged areas was reduced by 22.4%, and was the most affected of all crops. Considering the prevailing flood problem, which has led to reduction in rice production especially in flood prone areas, hence, the objective of this study, is to screen some lowland rice varieties for tolerance to flooding in fresh water and estuarine habitat in Delta State of Nigeria.

## Materials and Method

### Study area

The experiment was carried out in Asaba and Warri, area of Delta State, Nigeria. The experiment was carried out for 2 years in 2019 and 2020 cropping seasons.

### Asaba

The experiment was conducted at the Teaching and Research Farms of Delta State University Asaba Campus, Asaba (freshwater environment). Asaba is located between latitude 6°11'53.66" N longitude 6°43'54.73" E, at the Equator with a hot humid climate, mixed vegetation of forest interspersed with shrubs and grasses. The rainfall pattern is bi-modal with peaks in July-September, and an annual mean rainfall amount of 2969mm; a temperature range of 26.3-33.5$^{0}$C and relative humidity varies from 61 to 89% (NIMET, 2021).

### Warri

The experiment was carried out in National Cereal Research Institute, Warri sub-station, (estuarine environment). Warri is located between latitude 5°31'.30"N and longitude 5°46'.9"E at the Equator. The region experiences moderate rainfall and moderate humidity for most part of the year. The climate is monsoonal and is marked by two distinct seasons: the dry season and the rainy season. The dry season lasts from about November to April and is significantly marked by the cool "harmattan" dusty haze from the north-east winds. The rainy season spans from May to October with a brief dry spell in August, but it frequently rains even in the dry season. The area is characterized by a tropical monsoon climate with mean annual temperature of 32.8 °C and annual rainfall amount of 2768.8 mm (NIMET, 2021).

### Experimental design and layout

The experiment was a 2 x 51 factorial experiment laid out in a Completely Randomized Design and was replicated three times given a total of 306 pots. Screening of germplasm (51 lowland rice varieties) was carried out under a controlled submergence condition using pots and drums. The seeds were planted directly into the pots for 21days and afterwards submerged in drums filled with water to the brim for 14days, and this was done in the two locations. Thereafter this number of the days, 21 best varieties that survives in terms of possessing highest survival percentage was identified.

### Data Collection

Data was collected on the following phenotypic parameters;
i. Germination%: Germination%=Number of germinated seeds/Total number of seeds X 100
ii. Pant height (cm): Before and after submergence was measured with the aid of a meter rule.
iii. Elongation (cm): = (Plant height after submergence-Plant height before submergence) /No. of days submerged.
iv. Elongation%: = {(Plant height after submergence – Plant height before submergence)/ Plant height before submergence.} x 100
v. Survival percentage %= {(No. of plants before submergence – No. of dead plants)/No. of plants before submergence} x 100

**Statistical Analysis**

The data collected were subjected to analysis of variance (ANOVA) using the Genstat package version 8.1 and means separation using LSD at 5% level of probability.

**Sources of Germplasm**

The varieties that were used for the study were sourced from National Cereal Research Institute, Bida Niger State and Africa World Rice Centre, Ibadan respectively.

**Table 1: List of Varieties and their Source**

| S/N | NAME OF VARIETIES | SOURCE |
|---|---|---|
| 1 | FARO 12 | NCRI |
| 2 | FARO 13 | NCRI |
| 3 | FARO 14 | NCRI |
| 4 | FARO 15 | NCRI |
| 5 | FARO 16 | NCRI |
| 6 | FARO 17 | NCRI |
| 7 | FARO 18 | NCRI |
| 8 | FARO 19 | NCRI |
| 9 | FARO 20 | NCRI |
| 10 | FARO 21 | NCRI |
| 11 | FARO 22 | NCRI |
| 12 | FARO 24 | NCRI |
| 13 | FARO 26 | NCRI |
| 14 | FARO 27 | NCRI |
| 15 | FARO 28 | NCRI |
| 16 | FARO 29 | NCRI |
| 17 | FARO 30 | NCRI |
| 18 | FARO 31 | NCRI |
| 19 | FARO 32 | NCRI |
| 20 | FARO 33 | NCRI |
| 21 | FARO 34 | NCRI |
| 22 | FARO 35 | NCRI |
| 23 | FARO 36 | NCRI |
| 24 | FARO 37 | NCRI |
| 25 | FARO 38 | NCRI |
| 26 | FARO 4 | NCRI |
| 27 | FARO 44 | NCRI |
| 28 | FARO 50 | NCRI |
| 29 | FARO 51 | NCRI |
| 30 | FARO 52 | NCRI |
| 31 | FARO 53 | NCRI |
| 32 | FARO 54 | NCRI |
| 33 | FARO 55 | NCRI |
| 34 | FARO 56 | NCRI |
| 35 | FARO 57 | NCRI |
| 36 | FARO 60 | NCRI |
| 37 | FARO 61 | NCRI |
| 38 | FARO 62 | NCRI |
| 39 | FARO 66 | NCRI |
| 40 | FARO 67 | NCRI |
| 41 | IR 72 | AWR |
| 42 | NERICA 38 | AWR |
| 43 | NICRO 48 | AWR |
| 44 | NICRO 49 | AWR |
| 45 | NIL 27 | AWR |
| 46 | NIL 54 | AWR |
| 47 | RASA | AWR |
| 48 | ROK 5 | AWR |
| 59 | SWANA | AWR |
| 50 | WAT121 | AWR |
| 51 | ZX | AWR |

NCRI: National Cereal Research Institute
AWR: Africa World Rice

**Results**

## Screening for Flood Tolerance

### Survival of different varieties to flooding for 1st year screening in freshwater habitat

The survival of different varieties to flooding for 1st year screening in freshwater habitat is presented in Tables 2 and 3. There was significant variation in germination % among the varieties screened in freshwater habitat. Most of the varieties exhibited good germination % almost throughout the seedling nursery period. Varieties like Swana Sub 1, Faro 4, Faro 17, Faro 66, Faro 67 and Faro 24 had a good germination % of 96.67%, 85.00%, 83.33%, 87.33%, 93.33% and 73.93% respectively while varieties like Faro 12, Faro 14, Faro 31, Faro 34, Faro 35, Faro 53, and Faro 56 had a poor germination % of 26.67%, 23.33%, 26.67%, 26.67%, 30.00%, 26.67% and 30.00% respectively. Elongation ranged from 0.40 cm per day to 1.79 cm per day for varieties screened in freshwater habitat. The highest elongation was produced by Faro 4 (1.26cm) and Swana sub1 (1.79cm) elongation per day. The least elongation per number of day was recorded for Faro 38, Faro 32, Faro 31, Faro 30, and Faro 21 per day respectively. Elongation % ranged from 5.45% to 39.33% for varieties screened in freshwater. The minimum elongation% was shown by Faro 32 (15.84%). Varieties like, Faro 17 (26.20%), Faro 24 (26.34%), Faro 4 (27.00%), NIL54 (22.34%) and Swana sub 1 (25.33%) had highest elongation %, while the least elongation% was observed in Faro 30 (9.73%).These following lowland rice varieties namely; Swana sub 1, Faro 66 , Faro 67 and Faro 4 exhibited very good survival capabilities at the rate of 87.61%, 75.85%, 79.98% and 76.10 % respectively, while the following varieties namely; Faro 12. Faro 28, Faro 29, Faro 31, Faro 35, Faro 36, Faro 55 and Faro 56 exhibited least survival% of 33.39%,32.73%, 38.71%, 22.77%, 31.63%, 38.60%, 35.17% and 38.71% respectively. The elongation per day was taken at every three days interval.
There was significant difference at ($P< 0.05$) correlation between germination x germination at 0.49 for 1st year under freshwater habitat with the phenotypic parameters measured (Table 3). There was also a significant correlation between survival x survival (0.59), elongation per day (0.55), plant height before submergence (0.89) and plant height after submergence (0.56). All phenotypic parameters also showed strong positive correlation with one another.

**Table 2: Survival of different varieties to flooding for 1st year screening under freshwater habitat**

| S/N | Varieties | Germination (%) | Plant height before submergence (cm) | Plant height after submergence (cm) | Elongation (%) | Elongation/day (cm) | Survival (%) |
|---|---|---|---|---|---|---|---|
| 1 | FARO 12 | 26.67 | 21.00 | 30.67 | 17.43 | 0.70 | 33.39 |
| 2 | FARO 13 | 40.00 | 27.00 | 34.33 | 18.98 | 0.72 | 48.35 |
| 3 | FARO 14 | 23.33 | 27.00 | 36.33 | 10.83 | 0.56 | 40.02 |
| 4 | FARO 15 | 40.00 | 29.67 | 37.00 | 16.60 | 0.71 | 53.01 |
| 5 | FARO 16 | 50.00 | 32.33 | 43.33 | 13.70 | 0.66 | 72.36 |
| 6 | FARO 17 | 73.33 | 34.33 | 45.33 | 26.20 | 0.85 | 75.22 |
| 7 | FARO 18 | 66.67 | 26.00 | 34.67 | 21.40 | 0.74 | 63.91 |
| 8 | FARO 19 | 50.00 | 29.33 | 37.33 | 18.17 | 0.71 | 63.71 |
| 9 | FARO 20 | 33.33 | 30.00 | 37.00 | 15.13 | 0.62 | 59.04 |
| 10 | FARO 21 | 47.89 | 31.89 | 46.29 | 10.52 | 0.57 | 53.35 |
| 11 | FARO 22 | 50.00 | 25.00 | 35.33 | 14.84 | 0.60 | 76.24 |
| 12 | FARO 24 | 73.93 | 35.05 | 41.74 | 26.34 | 0.80 | 81.62 |
| 13 | FARO 26 | 53.33 | 25.00 | 34.00 | 13.87 | 0.68 | 74.23 |
| 14 | FARO 27 | 36.67 | 26.00 | 35.33 | 12.70 | 0.61 | 40.84 |
| 15 | FARO 28 | 30.00 | 30.33 | 37.67 | 13.47 | 0.65 | 32.73 |
| 16 | FARO 29 | 20.00 | 25.67 | 31.67 | 12.50 | 0.68 | 38.71 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 17 | FARO 30 | 50.00 | 25.33 | 32.67 | 9.73 | 0.40 | 49.54 |
| 18 | FARO 31 | 26.67 | 25.33 | 34.33 | 13.80 | 0.62 | 22.77 |
| 19 | FARO 32 | 36.67 | 22.33 | 32.00 | 15.84 | 0.54 | 63.52 |
| 20 | FARO 33 | 53.33 | 28.67 | 37.00 | 16.20 | 0.61 | 65.34 |
| 21 | FARO 34 | 26.67 | 22.33 | 31.33 | 13.13 | 0.65 | 40.84 |
| 22 | FARO 35 | 30.00 | 28.00 | 35.33 | 15.03 | 0.67 | 31.63 |
| 23 | FARO 36 | 33.33 | 25.00 | 34.00 | 14.67 | 0.71 | 38.60 |
| 24 | FARO 37 | 60.00 | 33.00 | 43.00 | 24.70 | 0.63 | 79.22 |
| 25 | FARO 38 | 56.67 | 25.67 | 34.67 | 10.23 | 0.50 | 51.61 |
| 26 | FARO 4 | 70.00 | 33.33 | 46.67 | 27.00 | 1.26 | 76.10 |
| 27 | FARO 44 | 66.67 | 28.33 | 37.33 | 13.67 | 0.63 | 53.94 |
| 28 | FARO 50 | 46.67 | 24.33 | 35.33 | 12.60 | 0.61 | 61.25 |
| 29 | FARO 51 | 33.33 | 26.33 | 33.33 | 13.53 | 0.64 | 37.64 |
| 30 | FARO 52 | 70.00 | 35.00 | 46.33 | 20.63 | 0.78 | 79.59 |
| 31 | FARO 53 | 26.67 | 25.33 | 32.67 | 12.43 | 0.58 | 44.02 |
| 32 | FARO 54 | 50.00 | 28.00 | 38.67 | 17.83 | 0.66 | 63.03 |
| 33 | FARO 55 | 40.00 | 27.67 | 34.67 | 12.03 | 0.54 | 35.17 |
| 34 | FARO 56 | 30.00 | 29.00 | 38.67 | 12.30 | 0.65 | 38.71 |
| 35 | FARO 57 | 60.00 | 28.33 | 43.33 | 21.97 | 0.82 | 79.44 |
| 36 | FARO 60 | 36.67 | 25.33 | 33.00 | 14.37 | 0.62 | 45.23 |
| 37 | FARO 61 | 53.33 | 26.67 | 36.33 | 11.05 | 0.59 | 59.33 |
| 38 | FARO 62 | 33.33 | 29.33 | 38.00 | 16.38 | 0.67 | 63.37 |
| 39 | FARO 66 | 63.33 | 26.33 | 35.33 | 17.03 | 0.71 | 76.85 |
| 40 | FARO 67 | 53.33 | 33.33 | 42.00 | 18.03 | 0.80 | 79.98 |
| 41 | IR 72 | 56.67 | 31.00 | 45.67 | 16.33 | 0.77 | 59.09 |
| 42 | NERICA 38 | 46.67 | 27.67 | 35.00 | 18.93 | 0.81 | 53.40 |
| 43 | NICRO 48 | 60.00 | 24.33 | 35.33 | 20.23 | 0.84 | 69.35 |
| 44 | NICRO 49 | 60.00 | 29.33 | 37.00 | 14.50 | 0.72 | 67.54 |
| 45 | NIL 27 | 46.67 | 24.00 | 35.00 | 18.90 | 0.67 | 48.78 |
| 46 | NIL 54 | 40.00 | 24.67 | 34.33 | 22.37 | 0.80 | 49.03 |
| 47 | RASA | 60.00 | 31.00 | 41.00 | 19.23 | 0.63 | 73.66 |
| 48 | ROK 5 | 56.67 | 27.00 | 37.00 | 15.00 | 0.66 | 65.98 |
| 49 | SWANA | 96.67 | 38.33 | 53.00 | 25.33 | 1.79 | 97.61 |
| 50 | WAT121 | 72.15 | 32.91 | 40.51 | 14.11 | 0.58 | 66.18 |
| 51 | ZX | 50.00 | 35.67 | 41.67 | 14.53 | 0.65 | 50.85 |
| | LSD (0.05%) | 0.59 | 0.89 | 0.56 | 0.55 | 0.72 | 0.79 |
| | CV% | 56.76 | 17.89 | 23.30 | 26.80 | 31.20 | 71.10 |

**Table 3. Phenotypic correlation of different varieties to flood tolerance for 1st year under freshwater habitat**

| | Germination (%) | Plant height before submergence (cm) | Plant height after submergence (cm) | Elongation /day (cm) | Elongation (%) | Survival (%) |
|---|---|---|---|---|---|---|
| **Germination (% )** | 0.49* | | | | | |
| **Plant height before submergence (cm)** | 0.58* | 0.89* | | | | |
| **Plant height after submergence (cm)** | 0.68* | 0.89* | 0.56* | | | |
| **Elongation /day(cm)** | 0.47* | 0.44* | 0.56* | 0.55* | | |
| **Elongation (%)** | 0.58* | 0.46* | 0.55* | 0.77* | 0.42* | |
| **Survival (%)** | 0.79* | 0.52* | 0.59* | 0.42* | 0.58* | 0.59* |

*= significant at P<0.05

**Survival of different varieties to flooding for 1st year screening under estuarine habitat**

Survival of different varieties to flooding for 1st year screening under estuarine habitat is presented in Tables 4and 5. Germination and seedling growth were significantly influenced by the flood stress in estuarine habitat. The rate of germination decreased as the flooding stress increased. Swana sub1 (93.83%), Faro 4 (75.33%), Faro 66 ( 80.00%), Faro 67 (86.67%) and Faro 52 (83.33%) had best germination rates respectively while varieties like Faro 12, Faro 13,Faro 14 and Faro 15 had the least germination rates of 46.7%, 50.67%, 53.33% and 41.67% respectively. Elongation ranged from 0.38cm to 1.24cm. The following varieties namely; Faro 16 (0.47cm), Faro 21 (0.49cm), Faro 62 (0.47cm) and Faro 15 (0.38cm) recorded least elongation per day, while maximum elongation per day was shown by Swana sub 1(1.24cm), Faro 12 (1.03cm) and Faro 52 (1.50cm). Elongation % was recorded between 9.80% per day to 22.15% per day. Three genotypes namely; Faro 4, Faro 31, and Faro 52 exhibited maximum elongation % of 22.15%, 21.27% and 20.63% respectively. While varieties like Faro 15 and Faro 21 showed the least elongation % of 9.80% and 9.97%. A good number of the varieties exhibited good survival ability before they were submerged in drums. The following varieties namely; Faro 66, Faro 67, Nil 54, Swana sub 1, Faro 24, Faro 17, Faro 18, Faro 32, Faro 34 and Faro 4 exhibited highest survival % of 81.30%, 75.80%, 80.23%, 92.87%, 77.93%, 84.23%, 75.80%, 79.57%, 80.03% and 89.87% respectively. While varieties like Nil 27, Nerica 38, Faro 61, Faro 62 Faro 12 and ZX exhibited least survival % of 32.97%, 35.00%, 35.43%, 35.05%, 38.63% and 19.95% respectively. There was significant difference at ($P < 0.05$) correlation between germination x germination (%) at 0.58 for 1st year under freshwater habitat with the phenotypic parameters measured (Table 3).There was a also a significant correlation between survival x survival (0.59), elongation per day (0.55), plant height before submergence (0.89) and plant height after submergence (0.56). All phenotypic parameters also showed strong positive correlation with one another.

**Table 4: Survival of different varieties to flooding for the 1st year screening under estuarine habitat**

| S/No | Varieties | Germination (cm) | Plant height before submergence (cm) | Plant height after submergence (cm) | Elongation (%) | Elongation/day (cm) | Survival ( %) |
|---|---|---|---|---|---|---|---|
| 1 | FARO 12 | 46.67 | 37.33 | 46.00 | 1.03 | 15.53 | 38.63 |
| 2 | FARO 13 | 50.67 | 28.33 | 37.67 | 0.63 | 14.50 | 63.43 |
| 3 | FARO 14 | 53.33 | 27.00 | 35.00 | 0.62 | 12.60 | 61.67 |
| 4 | FARO 15 | 41.67 | 28.33 | 37.33 | 0.38 | 9.80 | 64.70 |
| 5 | FARO 16 | 63.33 | 31.33 | 38.33 | 0.47 | 10.33 | 63.80 |
| 6 | FARO 17 | 63.33 | 31.00 | 40.00 | 0.62 | 13.00 | 84.23 |
| 7 | FARO 18 | 63.33 | 30.00 | 37.33 | 0.68 | 11.43 | 75.80 |
| 8 | FARO 19 | 60.00 | 28.33 | 36.33 | 0.62 | 13.27 | 50.20 |
| 9 | FARO 20 | 53.33 | 24.67 | 34.67 | 0.58 | 12.77 | 46.90 |
| 10 | FARO 21 | 33.33 | 26.67 | 36.00 | 0.49 | 9.97 | 66.40 |
| 11 | FARO 22 | 56.67 | 25.00 | 36.67 | 0.72 | 15.37 | 68.63 |
| 12 | FARO 24 | 66.67 | 29.33 | 35.67 | 0.91 | 22.15 | 77.93 |
| 13 | FARO 26 | 66.67 | 32.00 | 38.33 | 0.82 | 18.27 | 66.03 |
| 14 | FARO 27 | 53.33 | 29.00 | 38.00 | 0.65 | 16.00 | 78.60 |
| 15 | FARO 28 | 60.00 | 30.67 | 38.00 | 0.70 | 15.87 | 56.90 |
| 16 | FARO 29 | 46.67 | 27.67 | 36.33 | 0.60 | 15.40 | 56.13 |
| 17 | FARO 30 | 60.00 | 25.00 | 32.67 | 0.62 | 13.07 | 68.57 |
| 18 | FARO 31 | 80.00 | 29.33 | 37.00 | 0.91 | 21.27 | 81.43 |
| 19 | FARO 32 | 73.33 | 26.33 | 37.00 | 0.65 | 16.27 | 79.57 |
| 20 | FARO 33 | 73.33 | 32.00 | 42.00 | 0.57 | 14.40 | 59.33 |
| 21 | FARO 34 | 63.33 | 25.33 | 34.67 | 0.68 | 15.83 | 80.03 |
| 22 | FARO 35 | 70.00 | 28.00 | 36.33 | 0.80 | 17.67 | 77.87 |
| 23 | FARO 36 | 63.33 | 28.00 | 36.67 | 0.64 | 13.80 | 76.83 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 24 | FARO 37 | 66.67 | 28.67 | 38.33 | 0.70 | 17.13 | 80.80 |
| 25 | FARO 38 | 60.00 | 28.00 | 37.33 | 0.60 | 15.87 | 64.80 |
| 26 | FARO 4 | 75.33 | 26.33 | 36.67 | 0.62 | 14.47 | 89.87 |
| 27 | FARO 44 | 46.67 | 26.00 | 35.00 | 0.55 | 12.67 | 73.00 |
| 28 | FARO 50 | 46.67 | 26.67 | 34.33 | 0.72 | 17.00 | 53.20 |
| 29 | FARO 51 | 50.00 | 23.00 | 31.67 | 0.60 | 13.17 | 49.53 |
| 30 | FARO 52 | 83.33 | 29.00 | 34.33 | 1.50 | 20.63 | 77.23 |
| 31 | FARO 53 | 46.67 | 23.33 | 31.00 | 0.74 | 16.13 | 59.13 |
| 32 | FARO 54 | 80.00 | 22.33 | 32.33 | 0.64 | 13.40 | 41.23 |
| 33 | FARO 55 | 30.00 | 26.33 | 36.33 | 0.56 | 12.80 | 78.23 |
| 34 | FARO 56 | 60.00 | 28.00 | 35.67 | 0.73 | 18.37 | 63.60 |
| 35 | FARO 57 | 50.00 | 28.67 | 36.67 | 0.57 | 12.93 | 45.57 |
| 36 | FARO 60 | 30.00 | 22.00 | 29.67 | 0.55 | 11.47 | 49.87 |
| 37 | FARO 61 | 69.00 | 23.00 | 30.67 | 0.68 | 14.87 | 35.43 |
| 38 | FARO 62 | 16.67 | 24.67 | 33.33 | 0.47 | 12.00 | 35.05 |
| 39 | FARO 66 | 80.00 | 22.00 | 32.33 | 0.58 | 13.03 | 81.30 |
| 40 | FARO 67 | 86.67 | 23.00 | 32.33 | 0.67 | 14.17 | 75.80 |
| 41 | IR 72 | 60.00 | 22.67 | 33.00 | 0.58 | 13.70 | 40.37 |
| 42 | NERICA38 | 26.67 | 25.00 | 34.00 | 0.52 | 11.10 | 35.00 |
| 43 | NICRO 48 | 66.67 | 28.33 | 36.00 | 0.67 | 12.53 | 56.17 |
| 44 | NICRO 49 | 33.33 | 25.33 | 34.00 | 0.65 | 15.10 | 32.97 |
| 45 | NIL 27 | 43.33 | 26.33 | 36.00 | 0.63 | 13.00 | 30.27 |
| 46 | NIL 54 | 60.00 | 28.33 | 36.00 | 0.65 | 15.67 | 80.23 |
| 47 | RASA | 56.67 | 30.67 | 39.33 | 0.63 | 15.97 | 75.17 |
| 48 | ROK 5 | 63.33 | 27.33 | 34.33 | 0.63 | 13.87 | 76.83 |
| 49 | SWANA | 93.83 | 28.33 | 37.67 | 0.58 | 17.30 | 92.87 |
| 50 | WAT121 | 38.34 | 13.23 | 13.05 | 1.24 | 12.65 | 40.99 |
| 51 | ZX | 21.86 | 14.45 | 10.82 | 0.56 | 15.72 | 19.95 |
| | LSD (0.05%) | 0.55 | 0.75 | 0.91 | 0.29 | 0.43 | 0.56 |
| | CV% | 46.67 | 28.33 | 37.67 | 0.63 | 14.50 | 63.43 |

**Table 5: Phenotypic correlation of different varieties to flood tolerance for 1st year under estuarine habitat**

| | Germination (%) | Plant height before submergence (cm) | Plant height after submergence (cm) | Elongation /day (cm) | Elongation (%) | Survival (%) |
|---|---|---|---|---|---|---|
| **Germination ( % )** | 0.58* | | | | | |
| **Plant height before submergence (cm)** | 0.75* | 0.68* | | | | |
| **Plant height after submergence (cm)** | 0.70* | 0.91* | 0.39* | | | |
| **Elongation /day (cm)** | 0.60* | 0.36* | 0.29* | 0.26* | | |
| **Elongation (%)** | 0.61* | 0.43* | 0.91* | 0.43* | 0.57* | |
| **Survival( %)** | 0.80* | 0.65* | 0.63* | 0.35* | 0.43* | 0.56* |

*= significant at P<0.05

## Survival of different varieties to flooding for 2nd year screening under freshwater habitat

Survival of different varieties to flooding for 2nd year screening under freshwater habitat is presented in Tables 6 and7. Germination and seedling growth was of the rice seeds were significantly influenced due to susceptibility of the varieties to flood stress in freshwater habitat. The rate of germination decreased as the flooding stress increased. Swana sub1, Faro 4, Faro 66, Faro 67 , Faro 52, Faro 17, Faro 18, Faro 24, Faro 20 and Faro 16 had best germination rates of

98.67%, 85.56%, 76.89%, 85.87%, 75.60%, 79.47%, 87.00%, 76.10%, 86.69% and 78.19% respectively while varieties like Faro 12, Faro 13 ,Faro 21, Nicro 49, and Nerica 38, had the least germination rates of 36.67%, 46.67%, 33.33%, 33.33% and 26.67%. There was good variation among the varieties for elongation per day for varieties screened in freshwater habitat. Elongation ranged between 9.80 cm to 25.53cm. The minimum elongation was shown by Faro 12 (15.53cm), Faro 13 (14.50cm), Faro 14 (12.80cm) and Faro 16 (10.33cm) while maximum elongation per day was shown by Swana sub 1(25.53cm), Faro 4 (22.56cm) , Faro 52(22.63cm) and the least elongation per day was recorded by Faro 15(9.80cm) . Elongation % ranges from 0.47 cm per day to 2.58 cm per day. These following varieties namely; Faro 4, Faro 17, and Swana sub 1 exhibited maximum elongation % of 1.96cm, 1.62cm, and 2.58cm respectively. Faro 62 showed the least elongation 0.47cm%. Most of the varieties survived during and after their subjection in water in the screening drums. These following varieties namely; Swana sub 1, Faro 66, Faro 67, Faro 52, Faro 57, Faro 37, Faro 18, Faro 24, Faro 20 and Faro 16 showed an outstanding survival percentage of 94.73%, 76.50%, and 83.80%, 85.00%, 75.00%, 84.50%, 77.00%, 75.90%, 76.20% and 80.48% respectively. There was significant difference at ($P< 0.05$) correlation between germination x germination (%) at 0.75 for 2nd year under freshwater habitat with the phenotypic parameters measured (Table 7).There was a also a significant correlation between survival x survival % (0.52), elongation per day (cm) 0.45, plant height before submergence (0.45) and plant height after submergence (0.37). All phenotypic parameters showed strong positive correlation with one another.

**Table 6: Survival of different varieties to flooding for 2nd year screening under freshwater habitat**

| S/No | Varieties | Germination % | Plant height before submergence (cm) | Plant height after submergence (cm) | Elongation % | Elongation /day Cm | Survival % |
|---|---|---|---|---|---|---|---|
| 1 | FARO 12 | 36.67 | 27.33 | 36.00 | 1.03 | 25.53 | 58.63 |
| 2 | FARO 13 | 46.67 | 28.33 | 37.67 | 0.63 | 14.50 | 63.43 |
| 3 | FARO 14 | 53.33 | 27.00 | 35.00 | 0.62 | 12.60 | 61.67 |
| 4 | FARO 15 | 46.67 | 28.33 | 37.33 | 0.38 | 9.80 | 64.70 |
| 5 | FARO 16 | 63.33 | 31.33 | 38.33 | 0.47 | 10.33 | 63.80 |
| 6 | FARO 17 | 63.33 | 31.00 | 40.00 | 0.62 | 13.00 | 64.23 |
| 7 | FARO 18 | 63.33 | 30.00 | 37.33 | 0.68 | 11.43 | 64.80 |
| 8 | FARO 19 | 60.00 | 28.33 | 36.33 | 0.62 | 13.27 | 70.20 |
| 9 | FARO 20 | 53.33 | 24.67 | 34.67 | 0.58 | 12.77 | 76.90 |
| 10 | FARO 21 | 33.33 | 26.67 | 36.00 | 0.49 | 9.97 | 66.40 |
| 11 | FARO 22 | 56.67 | 25.00 | 36.67 | 0.72 | 15.37 | 68.63 |
| 12 | FARO 24 | 66.67 | 29.33 | 35.67 | 0.91 | 20.17 | 77.93 |
| 13 | FARO 26 | 66.67 | 32.00 | 38.33 | 0.82 | 18.27 | 66.03 |
| 14 | FARO 27 | 53.33 | 29.00 | 38.00 | 0.65 | 16.00 | 78.60 |
| 15 | FARO 28 | 60.00 | 30.67 | 38.00 | 0.70 | 15.87 | 56.90 |
| 16 | FARO 29 | 46.67 | 27.67 | 36.33 | 0.60 | 15.40 | 56.13 |
| 17 | FARO 30 | 60.00 | 25.00 | 32.67 | 0.62 | 13.07 | 68.57 |
| 18 | FARO 31 | 80.00 | 29.33 | 37.00 | 0.91 | 21.27 | 81.43 |
| 19 | FARO 32 | 73.33 | 26.33 | 37.00 | 0.65 | 16.27 | 79.57 |
| 20 | FARO 33 | 73.33 | 32.00 | 42.00 | 0.57 | 14.40 | 89.33 |
| 21 | FARO 34 | 63.33 | 25.33 | 34.67 | 0.68 | 15.83 | 80.03 |
| 22 | FARO 35 | 70.00 | 28.00 | 36.33 | 0.80 | 19.67 | 77.87 |
| 23 | FARO 36 | 63.33 | 28.00 | 36.67 | 0.64 | 13.80 | 76.83 |
| 24 | FARO 37 | 66.67 | 28.67 | 38.33 | 0.70 | 17.13 | 80.80 |
| 25 | FARO 38 | 60.00 | 28.00 | 37.33 | 0.60 | 15.87 | 64.80 |
| 26 | FARO 4 | 53.33 | 26.33 | 36.67 | 1.62 | 14.47 | 51.87 |
| 27 | FARO 44 | 46.67 | 26.00 | 35.00 | 0.55 | 12.67 | 73.00 |
| 28 | FARO 50 | 46.67 | 26.67 | 34.33 | 0.72 | 17.00 | 53.20 |
| 29 | FARO 51 | 40.00 | 23.00 | 31.67 | 0.60 | 13.17 | 39.53 |
| 30 | FARO 52 | 53.33 | 29.00 | 34.33 | 0.50 | 12.63 | 77.23 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 31 | FARO 53 | 46.67 | 23.33 | 31.00 | 0.74 | 16.13 | 59.13 |
| 32 | FARO 54 | 30.00 | 22.33 | 32.33 | 0.64 | 13.40 | 41.23 |
| 33 | FARO 55 | 30.00 | 26.33 | 36.33 | 0.56 | 12.80 | 48.23 |
| 34 | FARO 56 | 60.00 | 28.00 | 35.67 | 0.73 | 18.37 | 63.60 |
| 35 | FARO 57 | 50.00 | 28.67 | 36.67 | 0.57 | 19.93 | 75.57 |
| 36 | FARO 60 | 30.00 | 22.00 | 29.67 | 0.55 | 17.47 | 49.87 |
| 37 | FARO 61 | 40.00 | 23.00 | 30.67 | 0.68 | 14.87 | 75.43 |
| 38 | FARO 62 | 16.67 | 24.67 | 33.33 | 0.47 | 12.00 | 35.05 |
| 39 | FARO 66 | 30.00 | 22.00 | 32.33 | 1.58 | 13.03 | 78.30 |
| 40 | FARO 67 | 36.67 | 23.00 | 32.33 | 0.67 | 14.17 | 75.80 |
| 41 | IR 72 | 30.00 | 22.67 | 33.00 | 0.58 | 13.70 | 40.37 |
| 42 | NERICA 38 | 26.67 | 25.00 | 34.00 | 0.52 | 11.10 | 35.00 |
| 43 | NICRO 48 | 66.67 | 28.33 | 36.00 | 0.67 | 13.53 | 56.17 |
| 44 | NICRO 49 | 33.33 | 25.33 | 34.00 | 0.65 | 13.10 | 32.97 |
| 45 | NIL 27 | 43.33 | 26.33 | 36.00 | 0.63 | 13.00 | 30.27 |
| 46 | NIL 54 | 60.00 | 28.33 | 36.00 | 0.65 | 15.67 | 80.23 |
| 47 | RASA | 56.67 | 30.67 | 39.33 | 0.63 | 15.97 | 75.17 |
| 48 | ROK 5 | 63.33 | 27.33 | 34.33 | 0.63 | 13.87 | 66.83 |
| 49 | SWANA | 96.67 | 28.33 | 37.67 | 1.98 | 18.30 | 98.87 |
| 50 | WAT121 | 53.33 | 37.33 | 46.00 | 1.03 | 25.53 | 68.63 |
| 51 | ZX | 46.67 | 28.33 | 37.67 | 0.63 | 14.50 | 63.43 |
| | LSD (0.05%) | 0.05 | 0.83 | 0.55 | 0.07 | 0.65 | 0.05 |
| | CV% | 51.86 | 14.45 | 20.82 | 25.72 | 26.16 | 79.95 |

**Table 7: Phenotypic Correlations of different varieties to flood tolerance for 2nd year under freshwater habitat**

| | Germination (%) | Plant height before submergence (cm) | Plant height after submergence (cm) | Elongation/day (cm) | Elongation (%) | Survival (%) |
|---|---|---|---|---|---|---|
| **Germination (%)** | 0.75* | | | | | |
| **Plant height before submergence (cm)** | 0.65* | 0.45* | | | | |
| **Plant height after submergence (cm)** | 0.68* | 0.91* | 0.37* | | | |
| **Elongation /day (cm)** | 0.60* | 0.34* | 0.29* | 0.45* | | |
| **Elongation (%)** | 0.60* | 0.46* | 0.46* | 0.86* | 0.38* | |
| **Survival (%)** | 0.79* | 0.65* | 0.67* | 0.42* | 0.43* | 0.52* |

*= significant at P<0.05

## Survival of different varieties to flooding 2nd year screening under estuarine habitat

Survival of different varieties to flooding 2nd year screening under estuarine habitat are presented in Tables 8 and 9. Varieties like Swana Sub 1, Faro 4, Faro 17, Faro 66, Faro 67 and Faro 24 had outstanding germination % of 96.67%, 85.00%, 83.33%, 87.33%, 93.33% and 73.93% respectively while varieties like Faro 12, Faro 14, Faro 31, Faro 34, Faro 35, Faro 53, and Faro 56 had a poor germination % of 26.67%, 23.33%, 26.67%, 26.67%, 30.00%, 26.67% and 30.00% respectively.

Elongation ranged from 0.40 cm per day to 1.79 cm per day for varieties screened in freshwater habitat. Elongation per day was recorded at every three day interval. The highest elongation was shown by Faro 4 (1.26cm) and Swana sub1 (1.79cm) elongation per day. The least elongation per day was recorded for Faro 38, Faro 32, Faro 31, Faro 30, and Faro 21 per day respectively.

Elongation % ranged from 5.45% to 39.33% for varieties screened in freshwater. The minimum elongation% was shown by Faro 32 (15.84%). Varieties like, Faro 17 (26.20%), Faro 24 (26.34%), Faro 4 (27.00%), NIL54 (22.34%) and Swana sub 1 (25.33%) had highest elongation %, while the least elongation% was Faro 30 (9.73%). These following rice varieties namely; Swanasub1, Faro 66 , Faro 67 and Faro 4 exhibited best survival capabilities at the rate of 87.61%, 75.85%, 79.98% and 76.10 % survival respectively, while the following varieties namely; Faro 12. Faro 28, Faro 29, Faro 31, Faro 35, Faro 36, Faro 55, and Faro56 exhibited least survival % of 33.39%,32.73%, 38.71%, 22.77%, 31.63%, 38.60 %, 35.17% and 38.71% respectively. There was significant difference at (P< 0.05) correlation between germination x germination was 0.57 for 2nd year under estuarine habitat with the phenotypic parameters measured (Table 9). There was also a significant correlation between survival x survival (0.47), elongation per day (0.27), plant height before submergence (0.46) and plant height after submergence (0.58). All phenotypic parameters also showed strong positive correlation with one another.

**Table 8: Survival of different varieties to flooding 2nd year screening under estuarine habitat**

| S/No | Varieties | Germination (%) | Plant height before submergence (cm) | Plant height after submergence (cm) | Elongation % | Elongation/day (cm) | Survival % |
|---|---|---|---|---|---|---|---|
| 1 | FARO 12 | 33.62 | 29.33 | 40.33 | 0.78 | 18.37 | 24.57 |
| 2 | FARO 13 | 30.00 | 21.00 | 28.00 | 0.80 | 17.43 | 27.60 |
| 3 | FARO 14 | 20.13 | 22.67 | 33.67 | 0.68 | 11.90 | 18.67 |
| 4 | FARO 15 | 35.50 | 27.00 | 38.67 | 0.48 | 13.23 | 18.13 |
| 5 | FARO 16 | 50.00 | 27.00 | 36.33 | 0.69 | 14.00 | 41.67 |
| 6 | FARO 17 | 83.33 | 24.00 | 32.00 | 0.90 | 20.10 | 87.60 |
| 7 | FARO 18 | 73.33 | 20.33 | 32.33 | 0.81 | 18.93 | 78.43 |
| 8 | FARO 19 | 50.00 | 22.00 | 35.00 | 0.61 | 12.97 | 40.80 |
| 9 | FARO 20 | 70.00 | 26.67 | 38.00 | 0.63 | 18.90 | 78.47 |
| 10 | FARO 21 | 46.67 | 23.67 | 31.67 | 0.63 | 12.33 | 57.90 |
| 11 | FARO 22 | 53.33 | 24.33 | 35.33 | 0.51 | 13.30 | 77.10 |
| 12 | FARO 24 | 79.33 | 23.00 | 33.33 | 0.90 | 24.03 | 71.37 |
| 13 | FARO 26 | 73.33 | 26.00 | 31.33 | 0.68 | 14.13 | 69.87 |
| 14 | FARO 27 | 70.00 | 22.67 | 33.67 | 0.82 | 16.43 | 61.43 |
| 15 | FARO 28 | 50.00 | 22.33 | 31.00 | 0.58 | 14.50 | 56.93 |
| 16 | FARO 29 | 50.00 | 22.33 | 34.33 | 0.35 | 9.67 | 35.00 |
| 17 | FARO 30 | 56.67 | 27.33 | 38.67 | 0.39 | 10.54 | 37.10 |
| 18 | FARO 31 | 56.67 | 25.00 | 34.00 | 0.52 | 12.87 | 47.23 |
| 19 | FARO 32 | 70.00 | 21.67 | 31.67 | 0.72 | 17.47 | 59.30 |
| 20 | FARO 33 | 73.33 | 24.67 | 36.67 | 0.88 | 10.37 | 49.93 |
| 21 | FARO 34 | 66.67 | 23.00 | 33.33 | 0.69 | 16.97 | 63.07 |
| 22 | FARO 35 | 70.67 | 24.67 | 35.00 | 0.69 | 17.97 | 59.73 |
| 23 | FARO 36 | 66.67 | 23.33 | 31.67 | 0.87 | 11.87 | 77.47 |
| 24 | FARO 37 | 66.67 | 20.33 | 29.67 | 0.78 | 16.90 | 58.10 |
| 25 | FARO 38 | 73.33 | 22.67 | 31.33 | 0.66 | 16.10 | 54.50 |
| 26 | FARO 4 | 85.00 | 22.33 | 32.67 | 1.40 | 26.94 | 84.73 |
| 27 | FARO 44 | 76.67 | 24.67 | 36.00 | 0.42 | 11.43 | 69.17 |
| 28 | FARO 50 | 63.33 | 22.67 | 33.67 | 0.75 | 17.30 | 52.23 |
| 29 | FARO 51 | 50.00 | 24.67 | 34.67 | 0.41 | 10.27 | 60.47 |
| 30 | FARO 52 | 73.33 | 19.00 | 30.00 | 1.58 | 13.73 | 54.13 |
| 31 | FARO 53 | 60.00 | 23.67 | 34.00 | 0.45 | 11.53 | 48.13 |
| 32 | FARO 54 | 60.00 | 22.67 | 31.67 | 0.48 | 11.54 | 46.27 |
| 33 | FARO 55 | 26.67 | 22.67 | 31.33 | 0.52 | 12.73 | 50.37 |
| 34 | FARO 56 | 63.33 | 22.33 | 30.33 | 0.70 | 14.60 | 73.93 |
| 35 | FARO 57 | 33.33 | 22.33 | 31.67 | 0.44 | 11.08 | 51.83 |
| 36 | FARO 60 | 43.33 | 21.33 | 29.33 | 0.54 | 12.80 | 47.40 |
| 37 | FARO 61 | 43.33 | 24.00 | 31.67 | 0.54 | 13.07 | 64.07 |
| 38 | FARO 62 | 26.67 | 24.33 | 32.00 | 0.41 | 9.07 | 43.10 |
| 39 | FARO 66 | 83.15 | 22.00 | 29.67 | 0.93 | 10.17 | 88.07 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 40 | FARO 67 | 76.67 | 24.00 | 31.67 | 0.64 | 19.47 | 75.50 |
| 41 | IR 72 | 26.67 | 21.33 | 31.67 | 1.54 | 14.30 | 51.37 |
| 42 | NERICA38 | 36.67 | 23.67 | 31.00 | 0.51 | 12.20 | 34.73 |
| 43 | NICRO 48 | 73.33 | 23.67 | 34.33 | 0.51 | 12.50 | 83.93 |
| 44 | NICRO 49 | 26.67 | 21.00 | 30.33 | 0.33 | 8.80 | 34.50 |
| 45 | NIL 27 | 23.33 | 20.33 | 29.67 | 0.59 | 14.53 | 29.27 |
| 46 | NIL 54 | 63.33 | 21.00 | 32.67 | 0.84 | 15.90 | 53.30 |
| 47 | RASA | 76.67 | 21.00 | 30.00 | 0.64 | 12.33 | 64.13 |
| 48 | ROK 5 | 75.00 | 24.67 | 33.00 | 0.82 | 19.67 | 71.70 |
| 49 | SWANA | 96.50 | 26.00 | 38.00 | 0.77 | 16.87 | 95.43 |
| 50 | WAT121 | 56.67 | 29.33 | 40.33 | 0.62 | 18.37 | 64.57 |
| 51 | ZX | 60.00 | 21.00 | 28.00 | 0.80 | 17.43 | 57.60 |
| | LSD (0.05%) | 0.55 | 0.67 | 0.49 | 0.27 | 0.61 | 0.05 |
| | CV% | 64.79 | 13.43 | 28.42 | 21.13 | 23.37 | 78.95 |

**Table 9: Phenotypic correlation of different varieties to flood tolerance for 2nd year under estuarine habitat**

| | **Germination %** | **Plant height before submergence (cm)** | **Plant height after submergence (cm)** | **Elongation /day (cm)** | **Elongation (% )** | **Survival (%)** |
|---|---|---|---|---|---|---|
| **Germination (cm)** | 0.57* | | | | | |
| **Plant height before submergence (cm)** | 0.39* | 0.46* | | | | |
| **Plant height after submergence (cm)** | 0.48* | 0.79* | 0.58* | | | |
| **Elongation /day (cm)** | 0.69* | 0.05* | 0.08 | 0.27* | | |
| **Elongation (%)** | 0.65* | 0.28* | 0.28* | 0.88* | 0.33* | |
| **Survival (%)** | 0.53* | 0.41* | 0.44* | 0.55* | 0.58* | 0.47* |

*= significant at P<0.05

**Discussion**

Flood is a serious constraint to rice plant growth and survival especially in rainfed lowland and flood prone areas. The various traits that was used in screening for flood tolerance in this study includes; germination percentage, plant height before submergence, plant height after submergence, elongation ability and survival percentage. As these traits under submergence is the ultimate criterion or indices used for assessing flood tolerance. The result in this work showed that varieties which recorded highest percentage survival after the submergence trial, could have genes other than Sub 1 for submergence tolerance and this result is in line with the findings of Des *et al.,* (2001); Sarkar *et al. (*2006); Bailey-Serres and Voesenek (2008) who also reported that the ability of Swana sub-1 to maintain high survival percentages could be because of the presence of the Sub-1 gene which has been introgressed into it. Sarkar *et al.,* (2009); Singh *et al.* (2009) and Akinwale *et al.* (2012) reported that flood tolerance is associated with higher survival rate, higher number of tillers and higher number of panicles which will ultimately lead to increase in grain yield. Fukao and Bailey-Serres (2008) stated flood tolerance conferred by Sub1A gene is related to suppression of elongation thereby enhancing survival. Voesenek *et al.* (2004) stated that varieties with continuously elongation during flooding will not be idea for long duration flood regime. Singh *et al*. (2001) and Das *et al.* (2005) also mentioned that limited stem elongation is associated with variety's ability to survive submergence as energy required for maintenance process are made readily available, not used for stem elongation. It then means that an idea genotype will device a means of conserving energy for use in growth recovery after de-submergence. Bailey-Serres *et al.,* 2010 in supporting this position mentioned that rainfed lowland rice genotypes respond to transient or partial flooding by moderate elongation of leaves and the portion of stems that are underwater. It is therefore normal for flood tolerant varieties to exhibit limited stem elongation. A strong positive correlation was found between survival % and all the phenotypic correlation parameters measured, and this result is in line with the findings according to Mohanty *et al*, 2000, who stated that submergence tolerance by which certain rice genotypes survive submergence of 10 days or more particularly in shallow water depth up to 40 cm (as per the classification followed in India) and up to 50 cm (as per the classification followed at the International Rice Research Institute). Setter *et al.,* 1997 also stated that flood are highly unpredictable and may occur at any growth stage of the rice crop and the yield loss may be anywhere between less than 10 and 100% depending on factors such as water depth, duration of submergence, temperature, turbidity of water, rate of nitrogen fertilization, light intensity and age of the crop. Survival Percentages before submergence was strongly dependent on non-structural carbohydrate reserves remaining in the shoot after submergence, which is in turn equally dependent on the initial carbohydrate content before submergence as well as on the extent of stem elongation during submergence (Das *et al.,* 2005). Survival of seedling is positively correlated with stem starch along with chlorophyll concentration both before and after submergence (Ella and Ismail, 2006). Plant height did not increase much in some varieties like Faro 33, Faro 37, Faro 12 and Faro 13. This was as a result of significantly lower elongation in some varieties as compared to some other varieties according to (Sarkar and Bhattacharjee, 2011). The result of elongation per day in this work, was in cognizance with Singh *et al*. (2009) research work have shown that survival is positively associated with limited elongation.

## Conclusion

The devastating effects of flooding on rice plant remains a major concerns for farmers around the world. The climatic change and effect of flood in recent times in Nigeria has caused serious negative impacts on rice farming. This research work was to screen 51 lowland rice (*Oryza spp)* varieties for flood tolerance in freshwater and estuarine environments in Delta State. Because of natural disasters caused by heavy rain, rice production in Nigeria is often unstable, whereas rice is an important food crop. Reports of flooding damage to rice plants have been increasing with the expansion of rainfed lowland rice cultivation. The effect of the flood on the survival of the varieties was between (22.77% – 100%), during the flood tolerance trial. tolerant rice varieties showed higher percentage survival by exhibiting higher percentage survival. In Nigeria approximately 70% of rainfed lowland rice farms are prone to seasonal flooding, which has led to rice yield loss. In this research, fifty one varieties were screened in pots and drums. At the end of the two years screening exercise, twenty one best varieties ( Faro 66 Faro 15, Faro 16 ,Faro 17, Faro 18 ,Faro 19, Faro 20 , Faro 22, Faro 24, Faro 26 , Faro 33, Faro 37, Faro 4 , Faro 50, Faro 52 , Faro 57 , Faro 44 , Faro 67 Nicro 49, Rasa, Swana Sub 1) were selected based on their growth response and percentage survival. After which these 21 best varieties were planted in the field to ascertain their stability in four environments. Results obtained in this work clearly indicate that these twenty one varieties showed great potentials for flood tolerance. It therefore implies that these varieties can be considered as candidate's in future breeding programme for flood tolerant varieties.

**References**

Akinwale, M.G., Akinyele, B.O., Odiyi, A.C., Nwilene, F., Gregorio, G.B. and Oyetunji, O.E.(2012).Phenotypic Screening of Nigerian Rainfed Lowland Mega Rice Genotypes for Submergence Tolerance". In: Proceedings of the World Congress on Engineering. Volume I. WCE 2012, July 4 -6, 2012, London, U.K. ISBN: 978-988-19251-3-8.

Anugwara, B., and Emakpe, G. (2013). Rice Production Systems. WARDER-NISER, Nigeria, pp. 95-94.

Bailey-Serres, J. and Voesenek, L.A.C.J. (2010). Life in the balance: a signalling network controlling survival of flooding. Plant Biol. 13: 489–494.

Bailey-Serres, J. and Voesenek, L.A.C.J. (2008).Flooding stress: acclimations and genetic diversity. Annual Review of Plant Biology, **59**, pp.313–339.

Das, K. K., Sarkar, R. K. and Ismail, A. M. (2005). Elongation ability and non-structural carbohydrate levels in relation to submergence tolerance in rice. Plant Sci. 168: pp.131–136.

Das, K.K., Sarkar, R.K. and Ismail, A.M. (2001). Elongation ability and non-structural carbohydrate levels in relation to submergence tolerance in rice. Plant Science, 168, pp.131–136.

Ella E.S. and Ismail A.M. (2006). Seedling Nutrient Status before Submergence Affects Survival after Submergence in Rice. Crop sci. 46: pp.1673-1681.

Erenstein, O., Frederic, L., Akande, S.O., Titilola, S.O., Akpokodje, G. and Ogundele, O.O. (2014). Nigeria - Rice production systems. WARDER-NISER, Nigeria, pp. 95.

Food and Agriculture Organization (2016).FAOSTAT Data. Available at: http://faostat3.fao.org/browse/FB/CC/E.

Food and Agriculture Organization. (2019). World agriculture: towards 2015/2030. http://www.fao.org/htm. Retrieved 19/12/2016.

Fukao, T., and Bailey-Serres, J. (2010).Plant responses to hypoxia—is survival a balancing act? *Trends in Plant Science*, **9**, pp. 449–456.

Mohanty, H. K., Mallik, S. and Grover, A. (2000). Prospects of improving flooding tolerance in lowland rice varieties by conventional breeding and genetic engineering. Curr. Sci. 78: pp.132–137.

NIMET, (2021), Seasonal Rainfall Prediction and its Socio Economic Implications in Nigeria.

Sarkar, K.R and Bhattacharjee, B. (2011). Rice Genotypes with SUB1 QTL Differ in Submergence Tolerance, Elongation Ability during Submergence and Re-generation Growth at Re-emergence. Rice.pp.5- 7.

Sarkar, R.K. and Panda, D. (2006). Distinction and characterization of submergence tolerant and sensitive rice cultivars, probed by the fluorescence OJIP rise kinetics. *Functional Plant Biology*, **36**, pp. 222–233.

Setter, T.L., Ellis, M., Laureles, E.V., Ella, E.S., Senadhira, D., Mishra, S.B., Sarkarung, S. and Datta, S. (1997). Physiology and Genetics of Submergence Tolerance in Rice. Annals of Botany. 79: pp. 67-77.

Singh, H.P., Singh, B.B. and Ram, P.C. (2001). "Submergence tolerance of rainfed lowland rice: Search for physiological marker traits." *Journal of Plant Physiology*, 158, pp.883–889.

Singh, S., Mackill, D.J. and Ismail, A.M. (2009). Responses of Sub1 rice introgression lines to submergence in the field: yield and grain quality. *Field Crop Research,* 113, pp. 12–23.

Singh, R.K. and Chandhury, B.D. (2014).*Biometrical methods in quantitative genetic analysis*. Kalyni Publishers, New Delhi, India.pp.318.

United States Department of Agriculture (2018).World Rice Production, Consumption, and Stocks. United States Department of Agriculture. Foreign Agricultural Service. Available at: https://apps.fas.usda.gov/psdonline/circulars/grainrice.

Voesenek, L.A.C.J., Rijnders, J.H.G.M., Peeters, A.J.M., van de Steeg, H.M. and de Kroon, H. (2008). Plant hormones regulate fast shoot elongation underwater: from genes to communities. *Ecology*, 85, pp.16–27.