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Effects of different flood depths on the growth and yield of some lowland rice varieties

EU. Uwuigbe[*1], FO. Oroka[2], SO. Akparobi[3]

[1]*Department of Crop Science, Faculty of Agriculture, Dennis Osadebay University, Asaba, Delta State, Nigeria*

[2,3]*Department of Agronomy, Faculty of Agriculture, Delta State University, Abraka, Delta State, Nigeria*

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Abstract

This study was conducted to examine the effect of different flood depths on the growth and yield of some lowland rice varieties. The experiment was a 3 × 3 × 5 factorial experiment laid out in Completely Randomized Design with three replications. The factors considered were the effect of different flood depth levels (40cm, 60cm and 80cm) on the different growth stages (vegetative, reproductive and ripening) of five varieties of rice. Parameters assessed includes; Germination%, Elongation per day, Elongation%, Survival%, Plant height (cm), Number of tillers, and Leaf diameter (cm), Days to 50% flowering, Days to 50% maturity, Number of panicle/plant, Number of grain/panicle, 1000 seed weight (g), Seed yields/plant(g), Seed yield/m² (g). Data collected were subjected to analysis of variance. Swana sub 1 was observed to be best variety as it recorded the highest seed yield (g) values of 35.2g, 33.6g and 21.8g for maturity growth stage at 40cm, 60cm and 80cm flood depths respectively while the least seed yield (g) values of 29.8g, 22.6g and 10.4g was recorded by Faro 37 at 40 , 60 and 80cm flood depths. The study concluded also 40cm flood depth as the best for optimum growth and survival of rice. Swana sub 1 is hereby recommended to farmers due to their high yield and ability to withstand flood stress.

***Corresponding Author:** EU. Uwuigbe ✉ edith.uwuigbe@dou.edu.ng

Introduction

Rice belongs to the family *Gramineae* and genus *Oryza*. World rice production in 2013 accounts for 496.6 million tonnes of milled rice (FAO, 2014). Many millions of people across the globe have benefited economically, culturally, and via their nutrition attributable to rice (USDA, 2018). Yield loss due to floods ranges from (10 to 100%) depending on flood duration, depth and floodwater conditions (Singh *et al.,* 2017). Consequently, flooding is normally expected in most lowland rice producing areas of coastal and freshwater environments. Rice grows well when under water, but if the flood levels are high or submerge the whole field, then the rice plant will not survive. One of the significant threats to agricultural production in sub-Sahara Africa is climate. In Nigeria, crop production within the rainforest ecological zone is mainly rain-fed and mostly dependent on nature. Crop farmers are generally exposed to variability in climate and risks associated with weather fluctuations and climatic variability also affects growth and yield of cereal crop such as maize (Oroka, 2016). The study of Akparobi *et al.* (2003) also confirms that genotypic variation occurs for early tuberization irrespective of ecology in which it is cultivated, in lowlands and mid altitudes. Almost all varieties of rice are keenly susceptible to flooding and get easily affected or damaged at the time of germination (Yamauchi *et al.,* 1993, Ismail *et al.*, 2009, Angaji *et al.,* 2010, Lee *et al.,* 2014, Singh *et al.,* 2017). The prevailing flood problem which is almost becoming a recurrent global phenomenon and the subsequent climate change impact on the environment has led to reduction in rice production mostly in flood prone areas. Therefore, this study could bridge the gap by providing information on the flood tolerance of some lowland rice varieties. Hence, the objective is to assess the effects of different flood depths on the different growth stages of rice in Delta State.

Materials and methods

Area of study

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 and 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 rainfall amount of 2969mm; a mean temperature of 26.3 - 33.5°C and relative humidity varies from 61-89% (NIMET, 2021).

Experimental design and Planting

The experimental design was a 3×3×5 factorial experiment laid out in Completely Randomized Design with three replications. Five tolerant varieties were used for this experiment and they were transplanted directly into pits measuring three different flood depths (40cm, 60cm and 80cm) at 3 different growth stages (vegetative, reproductive and ripening) making it a total of 135 plots. The different flood water depths for each of the growth stage were maintained throughout the experiment with the aid of a meter rule. A standard Control set up (of 20cm flood depth) was put in place as a check and this experiment was carried out in the fresh water environment only. Well-drained fertile nursery bed exposed to full sunlight and conveniently located in the area close to the main plot was used.

The seed bed was ploughed, harrowed and well watered every morning and evening. The seed bed measured 1 to 1.5 m wide, 10 m long, and 4 to 6cm above the ground surface and well leveled. The seedling was allowed to grow for 21 days before they were transplanted to the field.

Data collection

Vegetative growth stage

i. Plant height (cm): This was measured from soil level to the tip of the flag leaf with the aid of a meter rule at 2, 4, 6, 8, 10, 12 weeks after transplanting.
ii. Tiller number: numbers of tillers per variety were counted at 2, 4, 6, 8, 10, 12 weeks after transplanting.
iii. Number of leaves per plant: numbers of leaves on each variety were counted at 2, 4, 6, 8, 10, 12 weeks after transplanting.

iv. Number of tillers/plant: The tiller number of the selected five plants was counted and their mean was computed at 2, 4, 6, 8, 10, 12 weeks after transplanting.
v. Number of panicles/plant: The number of panicles was counted for each of the selected plants and their mean was calculated at 8, 10 and 12 weeks after transplanting.
vi. Number of grains/ panicles: Number of filled grains of five was randomly selected panicle from each of the selected plant was taken and their mean was calculated at 8, 10 and 12 weeks after transplanting.
vii. Length of the panicle: Length of five selected panicle for each of the selected plant was taken incm and their mean was calculated at 8, 10 and 12 weeks after transplanting. .

Reproduction stage

i. Data pertaining to reproductive phase was recorded as described by Gomez (1972); Wopereis (2009) as shown below.
ii. Days to 50% plants heading was determined by counting the number of days from planting to 50% of plants reach heading stage.
iii. Days to 50% flowering were determined by counting number of days from planting to day when 50% of the plants in the plot had flowered.
iv. Leaf area index (LAI) was determined by taking randomly 10 plants from the middle of plot and determining the variable as follows: Total leaf area (cm^2) / Total ground area (cm^2).
v. Leaf area was determined as length of the leaf (cm) x width of the leaf (cm) x 0.75 as recommended by Gomez (1972).

Ripening stage

Data on flowering stage to maturity stage was collected as described by Gomez (1972) as indicated below:

i. Panicle number was obtained by counting all developed panicles from randomly selected 10 panicles from the center of each plot and the average computed.
ii. Panicle length (cm) was measured from the middle panicle using a meter rule
iii. Total number of spikelet was determined from randomly selected middle panicle and the average was computed.
iv. The 1000 seed weight (g) was weighed using electric balance and weight recorded.
v. Grain yield weight (g) was obtained by harvesting rice from one meter square area in the middle of each plot and threshed accordingly. The paddy will then adjusted at 14% moisture content using the formula that follows, and then the grain weights for each plot was recorded and converted in tokg/ha as described by Gomez (1972).

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.

Results

Effect of Different Depth Levels on the Different Growth Stages of Rice for 2019-2020

The five tolerant varieties namely; Swana sub 1, Faro 44, Faro 37, Faro 66 and Faro 67 which had outstanding growth and yield performance at the end of the field trial were planted into three different dunged pits measuring (40cm, 60cm and 80cm) in freshwater environment only. A control set up of 20cm flood depth was also established for this experiment

Vegetative growth stage

The vegetative phase begins with germination and ends with panicle initiation. At this stage, the tillers have completed and it takes about 45 to 52 days, which signals the end of the stage**.** The effects of different flood depths on the vegetative stage of rice are presented in Table 1. Significant difference at $P < 0.05$ was observed in plant height among the different varieties at the different stages of growth. The different flood depths also showed various degrees of impact on the growth of these varieties. There was also significant difference observed at $P < 0.01$ in plant height for varieties planted in 40, 60 and 80cm flood depth at the vegetative growth stage.

But significant difference at (P < 0.01) was observed in plant height among varieties planted in 20cm flood depth which is the control. Maximum plant height of 39.5cm was measured in 80cm flood depth by Swana sub 1 while the least plant height value of 22.7cm was recorded by Faro 37.

Table 1. Effect of different flood depths and Growth Stages on Plant height (cm) of Rice for 2019-2020.

	Control Flood Depths			
Varieties	20cm	40cm	60cm	80cm
Vegetative				
Swana Sub 1	47.2	32.6	37.5	39.5
Faro 44	39.4	28.4	22.7	19.0
Faro 37	36.7	24.8	22.4	22.7
Faro 66	29.3	27.5	33.2	32.5
Faro 67	32.0	26.8	35.5	33.5
Mean	30.1	23.4	34.7	23.4
Reproductive				
Swana Sub 1	88.5	82.9	78,5	75.3
Faro 44	58.9	42.6	39.2	55.4
Faro 37	46.8	37.8	31.9	51.8
Faro 66	81.6	78.2	73.8	72.8
Faro 67	74.3	78.5	70.6	74.6
Mean	84.7	79.6	58.9	67.6
Maturity				
Swana Sub 1	153	146	147	146
Faro 44	93.3	94.8	73.7	79.8
Faro 37	72.0	89.7	66.8	72.2
Faro 66	145	132	135	139
Faro 67	162	158	146	153
Mean	135	126	133	139
Growth stages × Flood depth	**	*	**	**
Flood depth × Varieties	**	*	*	**
Growth stages × Varieties	**	**	*	**
Flood depth ×Growth stages × Varieties	*	**	**	**

Where **= (P<0.01), *= (P<0.05)

At reproductive stage of plant height, Faro 44 and Faro 37 recorded a plant height of 39.2cm and 31.9cm at 60cm flood depth, compared to Swana Sub 1, Faro 66 and Faro 67 which recorded 78.5cm, 73.8cm and 70.6cm respectively at the same growth stage and flood depth, which shows a significant decrease in plant height as the flood depth increases. At maturity stage of plant height, Faro 67 also recorded the highest plant height of 158cm and 153cm at 40cm and 80cm flood depth, followed by Swana Sub 1 at 146cm and 151cm at the same flood depth, while the least value of 89.7cm and 72.2cm was recorded by Faro 37 also under the same flood depth. Similarly at this stage, maximum plant height of 147cm was observed by Swana sub 1 in 60cm flood depth, while the least plant height value of 68.8cm was also recorded by Faro 37 at 60cm flood depth.

There was no significant difference observed in the number of tiller for all the varieties planted in 20cm and 40cm flood depths at the vegetative growth stage (Table 2). But significant difference was observed in number of tillers of varieties grown in 60cm and 80cm flood depths. Swarna sub1 had highest number of tillers above other varieties at these flood depths by recording the values of 14.2 and 14.7 respectively. Faro 37 showed the least value for number of tillers of 08.4 and 06.8 in 60 and 80cm flood depth, followed by Faro 44 which recorded 09.1 and 07.4 at the same flood depths.

Table 2. Effect of Flood Depths on Number of Tillers of Rice for 2019-2020.

Varieties	Flood depths			
	20cm control	40cm	60cm	80cm
Swana Sub 1	15.6	16.7	14.2	14.7
Faro 44	15.9	15.6	09.1	07.4
Faro 37	16.1	14.8	08.4	06.8
Faro 66	15.6	16.2	11.0	12.5
Faro 67	15.0	16.6	11.5	11.3
Mean	15.9	16.6	11.9	11.6
Growth stages × Flood depth	Ns	Ns	**	**
Flood depth × Varieties	Ns	Ns	**	**
Growth stages × Varieties	Ns	Ns	**	**
Flood depth ×Growth stages × Varieties	Ns	Ns	**	**

Where **= (P<0.01), *= (P<0.05) and ns= Not significant.

Reproductive stage

The reproductive stage includes booting and heading stages and it takes about 35 days, counting from the end of vegetative growth stage. There were significant differences at P < 0.05 among the varieties in the different flood depths at this growth stage and the result is presented in (Table 3). The mean values of days to maturity and flowering were the same for all the varieties planted under the control 20cm and also for 40cm flood depth. Swana sub 1 and Faro 66 showed the earliest days to maturity of (116.0 and

112.0) and (115.0 and 119.0) under 40cm and 80cm flood depth. Faro 37 had delayed days to maturity value of 149.0 and 152.0 followed by Faro 44 at 133.0 and 145.0 days at the same flood depths. Faro 44 also exhibited least number of days to flowering at 103 days in 40cm flood depth. Under 60cm and 80cm flood depths, Swana sub 1 was first to flower at 84.0 and 94.0 days, while Faro 37 was least to flower at 116 and 112 days under the same flood depths. Faro 37 also recorded the least number of spikelets/ panicle and number of panicle/plant of 11.2 and 15.2 at 40cm flood depth. Swana sub 1 had highest number of spikelets /panicle of 19.9 and 18.0 under 60cm and 80cm flood depths, while the least values of 11.1 and 13.1 was by Faro 37 under the same flood depths. Panicle length of Faro 44 was least in value of 21.1 under 60cm flood depth, while Swana sub 1 recorded highest panicle length value of 29.5 under the same 60cm flood depth. Swarna-Sub1 had significantly number of panicle/plant of 18.2 than Faro 37 which had (05.1) under 80cm flood depth.

Table 3. Effect of floods depths on Reproductive Growth Stage of Rice for 2019-2020.

Varieties	Days to maturity	Days to flowering	Spikelet panicle	Panicle length (cm)	No. of Panicle/plant
20cm Flood depth (control)					
Swana sub 1	130.0	84.0	17.6	28.2	28.6
Faro 44	142.0	110	08.7	27.7	17.2
Faro 37	138.0	102	08.2	28.0	14.2
Faro 66	125.0	85.0	15.8	28.7	26.2
Faro 67	122.0	98.0	12.9	29.6	26.9
Mean	125.0	98.0	10.8	28.1	24.2
40cm Flood depth					
Swana sub 1	116.0	82.0	16.1	49.4	25.9
Faro 44	133.0	109	15.8	26.7	11.2
Faro 37	129.0	103	11.2	21.0	15.2
Faro 66	112.0	87.0	14.6	41.1	19.5
Faro 67	128.0	97.0	15.2	32.2	23.3
Mean	124.0	97.0	12.8	34.8	17.7
60cm Flood depth					
Swarna-Sub 1	137.0	84.0	19.9	29.5	23.2
Faro 44	133.0	110	19.5	21.1	09.5
Faro 37	148.0	116	11.1	24.7	07.1
Faro 66	135.0	91.0	13.9	26.1	20.2
Faro 67	136.0	98.0	19.9	22.5	16.1
Mean	133.0	105	15.6	22.1	16.7
80cm Flood depth					
Swana sub 1	115.0	94.0	18.0	28.8	18.2
Faro 44	145.0	114	15.5	25.8	07.1
Faro 37	152.0	112	13.1	24.7	05.1
Fao 66	119.0	99.0	14.9	26.1	13.7
Faro 67	133.0	106	19.9	26.0	11.8
Mean	139.0	94.0	14.8	23.0	11.9
Growth stages × Flood depth	**	*	**	**	**
Flood depth × Varieties	Ns	Ns	*	**	**
Growth stages × Varieties	*	**	**	**	**
Flood depth ×Growth stages × Varieties	**	**	**	**	**

Where **= (P<0.01), *= (P<0.05) and Ns= Not significant.

Maturity

The maturity stage is also known as the grain filling of ripening phase and it usually takes between 35 days, counting from the end of the reproductive growth stage. The result of the effect of different flood depths on the maturity stage of rice varieties is presented in (Table 4). Significant difference at $P < 0.05$ was observed in yield of the varieties under 20, 40, 60 and 80cm flood depths. The highest value for 1000 grain weight (g) was recorded by Swana sub 1 (19.2 g), followed by Faro 66 (18.6 g) and then Faro 66 (15.2 g) at 80cm flood depth. The least value of 1000 grain weight was recorded by Faro 37 (12.6 g) at this same flood depth. Faro 66 and Faro 67 also recorded highest value for 1000 grain weight of (25.6 g) and (25.2 g) under 60cm flood depth. Swana sub 1, Faro 67 and Faro 66 also recorded the highest values of 1000 seed grain weight of (28.5g), (27.5g) and (24.6g) respectively under 40cm flood depth. The least number of grain/panicle was recorded by Faro 44 (118) and Faro 37 (98) under 40cm flood depth, while Swana sub 1 recorded the highest value for number of grain/panicle of 166 under the same flood depth. The value for number of grain/panicle under 20cm flood depth which is the control, had Swana sub 1 recording the highest value of 216, followed by Faro 66 (185), while the least value was recorded in Faro 37 (159). Faro 66 and Faro 67 also recorded an outstanding value of 126 and 129 for number of grain/panicle respectively in 80cm flood depth.

Table 4. Effect of different flood depths on the Maturity stage of rice varieties.

Varieties	No. of Panicle/ Plant	No. of Grain/panicle	Panicle length (cm)	1000-grain weight (g)	Seed yield/plant (g/m²)
20cm (control)					
Swana sub 1	25.2	216	29.9	28.5	33.8
Faro 44	21.6	174	26.8	20.6	22.7
Faro 37	20.3	159	25.7	23.4	24.7
Faro 66	18.4	185	18.4	24.6	36.8
Faro 67	16.9	178	22.1	27.5	22.6
Mean	22.8	188	28.1	21.3	21.7
40cm Flood Depth					
Swana sub 1	24.5	166	20.8	24.6	34.2
Faro 44	18.8	118	17.5	22.8	23.8
Faro 37	20.6	98	15.1	19.2	28.3
Faro 66	20.8	141	17.4	21.5	33.8
Faro 67	10.5	152	18.6	27.6	30.2
Mean	16.5	145	16.7	22.4	30.7
60cm Flood Depth					
Swarna-Sub 1	17.3	130	18.8	22.9	28.2
Faro 44	17.3	118	15.5	18.6	22.6
Faro 37	16.3	128	18.9	18.6	23.4
Faro 66	11.3	102	15.2	25.2	25.4
Faro 67	13.7	136	22.7	25.6	26.6
Mean	14.6	130	15.2	26.8	22.2
80cm Flood Depth					
Swana sub 1	21.4	128	20.5	19.2	20.8
Faro 44	18.7	86	15.7	14.8	10.4
Faro 37	10.9	83	18.6	12.6	12.5
Fao 66	13.2	126	17.2	18.6	22.3
Faro 67	13.6	129	18.5	15.2	23.0
Mean	12.9	118	16.3	11.9	20.2
Flood depth × Growth stages	**	*	**	**	**
Flood depth × Varieties	*	Ns	Ns	**	**
Growth stages × Varieties	*	**	**	**	**
Flood depth ×Growth stages × Varieties	**	*	**	**	**

Where **= (P<0.01), *= (P<0.05) and ns= Not significant.

The highest number of seed yield/panicle (g/m²) was recorded in Faro 37 (34.2), followed by Faro 66 (33.8), while the least was recorded by Faro 44 (23.8) in 40cm flood depth. Faro 67 and Faro 66 also recorded the highest value for seed yield/panicle (g/m²) of (23.0) and (22.3) respectively under 80cm flood depth. Swana sub 1 recorded the highest number for panicle/plant with a value of (21.4) in 80cm flood depth while the least number of panicle/plant value of 10.7 was recorded by Faro 37. Swana sub 1, Faro 66 and Faro 67 had the longest panicle length of 20.8, 17.4 and 18.6 respectively under 40cm flood depth, while the least panicle length of 15.7 was recorded by Faro 44 under 80cm flood depth.

Discussion

Effects of Different Flood Depths on the Growth Stages of Rice

The survival and grain yield of 5 lowland varieties planted at different flood depths of (40cm, 60cm and 80cm).

Three varieties namely; Swana sub1, Faro 66 and Faro 67 had outstanding growth and grain yield/m² (g). This result is in line with the findings of (Venuprasad, 2017). Who stated that Faro 66 and Faro 67 are the two high-yielding flood-tolerant rice cultivars and they were chosen on the basis of farmer rankings and the outcomes of on-station, on-farm experiments and multi-location in collaboration with the National Rice and Maize Center and the National Cereals Research Institute. Survival of the varieties was strongly affected by the inherent ability of the individual variety to withstand the different levels of the flood water.

From this study, it was observed that those varieties that survived and performed best in the shallower depth (20cm and 40cm), also survived and performed exceptionally well in deeper flood depths (60cm and 80cm) and this findings agrees with (Das *et al.*, 2005) research work, who reported that the survival of varieties is strongly dependent on the ability and the flood tolerant trait of the variety to withstand intense flood stress. Ella *et al.* (2003); Sarkar *et al. (*2006); Bailey-Serres and Voesenek, (2008) 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) also reported that flood tolerance is associated with higher survival rate, plant height , higher number of tillers and higher number of panicles which will ultimately lead to increase in grain yield, hence these varieties that survived under these flood depths must have flood tolerant traits.

Vegetative stage

There was significant difference at ($P < 0.05$) observed among the different varieties at this stage of growth. The plant height of Faro 44 and Faro 37 decreased significantly at 60cm flood depth, unlike Swana Sub 1, Faro 66 and Faro 67 that performed so well at this growth stage at the three different growth stages. Flood stress is one of the most limiting factors to the growth of rice, especially during this vegetative growth stage where the seedlings are just getting established in the soil after transplanting, where the tillers are still shooting out. In this study, it was observed that the 60cn and 80cm flood depths had effect on the elongation of the tillers and on plant height .This in turn resulted to lodging and death of some of the seedlings few days after transplanting at this depth. This finding agrees with Mohanty *et al.* (2000), who stated that flood tolerance for some certain varieties takes between 10 days or more particularly in shallow water depth up to 40cm or deep water depth of up to 50cm and in such case, the variety is considered to have the ability of withstanding adverse flood effects. Plant height was influenced and reduced as observed in this study as a result of the effect of flood stress as well as elongation and their survival under deeper flood depth. This result is in line with Kawano *et al.* (2002) observed that shoot elongation during flooding utilises energy from stored carbohydrate. Singh *et al.* (2014) observed that shoot elongation increases proportionately with flooding and *Sub1*-introgressed genotypes showed slower shoot elongation rates compared to intolerant genotypes. Thus, rice varieties having slower elongation growth under water are preferred for cultivation in the areas affected with flash flooding, and the genotypes having faster elongation capacity are considered appropriate for deep water as well as partially deep-water areas (Sarkar and Bhattacharjee, 2011, Vergara *et al.,* 2014).

Reproductive stage

There was significant differences at ($P < 0.05$) in days to flowering observed under 40cm, 60cm and 80cm flood depths and the mean values of days to flowering for all varieties at flowering were similar under 20cm and 40cm flood depths, but decreased by almost 40% under 60cm and 80cm flood depths. Among the varieties, Swarna-Sub1and Faro 66 showed the earliest days to flowering of (81.0 and 84.0) and (78.0 and 89.0) under 40cm and 80cm flood depths. Swana sub 1 had the earliest values of days to maturity of 136.0 and 132.0, for 40cm and 60cm flood depths, while Faro 37, Faro 66, Faro 67 and Faro 44 exhibited delay in days to maturity at 80cm flood depth. The result indicates that there was variation in the yield related characteristics. This finding is in line with Hagos and Fetien (2011) and Yahaya (2014), who stated that early maturing varieties are important for less flood stress areas while late maturing varieties are for flooded areas.

Maturity stage

The seed yield/plant (g) of the five varieties namely; Swana sub 1, Faro 44, Faro 37, Faro 66 and Faro 67 were high at 40cm flood depth but decreased gradually under 60cm flood depth and then recorded a more lesser values under more severe stress flood depth conditions of 80cm (Fig. 1). This result is in cognizance with Mackill *et al.* (1986) findings who reported that seed yield decreases due to floods stress by 10 to 100% as the flood depth level became deeper and severe. Some varieties still predominate in flood-prone lowland farms and rice yield is low, ranging from 0.5 to 2.0 t ha, less than half that of irrigated rice (Mackill *et al.,* 1986).

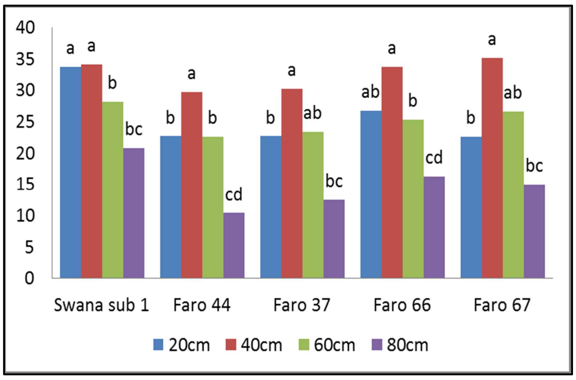

Fig. 1. Seed yield/plant (g). Means with the same letter are not significantly different.

At this maturity stage, varieties like Faro 66, Faro 67, and Swana sub 1 performed well under 60cm and 80cm flood depths, while Faro 44 and Faro 37 showed the lesser reduction in grain yield of about 50% due to the severity of the flood stress. Grain yields of Swarna-sub1 were excellent throughout for all the three different flood depth at this growth stages. The greatest reduction in number of yield/plant (g) was in Faro 37 (63%); followed by Faro 44 (53%),with relatively lower reductions in Faro 67 (48%) and Faro 66 (46%) under 60cm and 80cm flood depths.

The effect of the different flood depths on development of spikelet and grain yield showed that the higher the flood depth, the lower the growth and yield response of the varieties. The maximum Panicle length 29.9cm and 20.8cm was achieved in 20cm and 40cm flood depths while a reduced values of 18.8cm and 12.2cm was obtained in 60cm and 80cm flood depths for Swana sub 1. Similarly the number of spikelet's grown under 20cm and 40cm flood depths were higher in number (23 and 26) respectively, when compared to number of spikelet's grown in 60 and 80cm which reduced by 14 and 12 respectively. Weight of 1000 grains was measured as 24.85 g at 20cm depth, followed by 1.46, 7.85 and 10.96% reduction at 40, 60 and 80cm respectively. This shows that deeper water depth has adverse effects on spike characteristics and weight of grains than that of shallower water depth and this is in agreement with Anbumozhi *et al.* (1998) who reported that shallower ponding water depth have relatively lesser yield reductions, compared to deeper ponding water depth with reference to the optimum water depth of 9cm. De Datta (1981) also emphasized that extremely deep water results in poor growth and yield of rice. Panda *et al.* (1997) also reported that higher yields were obtained by subjecting the crop to submergence of 5 ± 2cm during tillering and reproductive stages with 7cm irrigation a day after disappearance of ponded water during the rest of the period. Swana sub 1 was outstanding in growth and yield followed by Faro 66 and Faro 67 in the three flood depths, unlike the other two varieties Faro 44 and Faro 37 which showed a drastic reduction in growth and grain yield. A reduction in all yield attributes was noticeable under 60 and 80cm flood depths for these two varieties, while Faro 66 and Faro 67 showed better growth and yield response in this same flood depth.

Conclusion

Five varieties namely: Swana sub 1, Faro 66, Faro 67, Faro 44, and Faro 37 were used. The experiment was on the effects of three different flood depths (40cm, 60cm, and 80cm), on the yield and different growth stages of rice, clearly suggest that varieties such as Swana sub1, Faro 66 and Faro 67 were more tolerant and performed best in the three different flood depths. There was significant effect at ($P < 0.05$) observed on the different growth stages on all the varieties under the three different flood depths. Swana sub 1, Faro 66 and Faro 67 also exhibited consistent higher yield performance under 40cm flood depth, followed by 60cm flood depth, and the least yield was observed in 80cm flood depths. Therefore, 40cm flood depth with the following varieties; Swana sub 1, Faro 66 and Faro 67 is here by recommended to farmers as this flood depth will not affect growth and yield.

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