**EVALUATION OF THE EFFECTS OF FLOODING ON THREE VARIETIES OF RICE**

**(A CASE STUDY OF ABAKALIKI, EBONYI STATE)**

**DEPARTMENT OF AGRICULTURAL ENGINEERING TECHNOLOGY**

**ABSTRACT**

 Flooding has been described as one of the most important environmental factors determining the distribution of salt marsh plants. We studied the impact of five water levels on the germination and establishment of the invasive cord-grass spartina deniflora. Plant house experiment was carried out to determine the effects of time and depth of flooding on the survival and growth of rice. Data showed that time and depth of flooding had significant effects on the survival and growth of rice.

 The germination rate was decrease gradually with depth. There was no seedling emergence from depth deeper than 4cm; however seedling at 8cm depth all died. Plant rooted at 4cm presented the highest quantum efficiency of photo-system 11 with slightly lower maximum net photosynthesis rate than other plants over 4cm depth reflecting high photo-protection levels, together with low nitrogen and pigments contents.

 Water level depth reduced shoot relative growth rate (RGR). The results could be useful to fight S, densiflora invasion because artificial inundation of invaded marshes to a water depth of 8cm would prevent its establishment from seed bank.

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**CHAPTER ONE**

**1.0 INTRODUCTION**

**1.1 Background of the Study**

The damaging effects of flooding remain as major sources of concerns among millions of rice farmers worldwide. The weather change due to various reasons causing unexpected and sudden flood recently in Nigeria has negative impacts on rice farming and people’s life. This research project is to evaluate the effect of flooding on the growth of three varieties of rice grown in Abakaliki Ebonyi State and to see how it influences people and agriculture.

The extent of the damage of flooding on rice is related to at least three factors. The temperature of the water, the amount of water motion and the duration of the flood. Temperature affects the speed of respiration. The faster the respiration, the quicker the oxygen is depleted and the sooner fermentation begins. Warm water speeds respiration, oxygen use and cell death. The faster water moves the greater the degree of turbulence. This water turbulence oxygenates the water slightly. Increasing oxygen content of the water slightly decrease’s the impact of flooding on plants. Duration of the flood is important because many of the effects of low oxygen on plants are reversible of the duration is not too long. Long durations allow for increased oxygen depletion and build up of harmful chemicals. Although local conditions influence the effects, 36 to 48 hours is often the tolerable limit.

In general rice cannot tolerate flooding better than other plants. But, if flooding occurs in the spring, the rice growing point is near the soil surface (below or above) making it likely to be submersed longer. Soil water logging and submergence (collectively termed flooding) are abiotic stresses that influence species composition and productivity in various type of rice, worldwide.

In rice farming, flooding species are manipulated (e.g. Ofada, upland and Nerica rice) or are accommodated by genotype selection. There have also been recent advances towards developing cultivators for low land areas prone to short-duration flash flooding. For most of this rice, excess water is a constraint to growth and productivity in many regions and this adversely affecting the growth of various types of rice.

Finally, rice are often damaged and thus, more susceptible to disease organisms. Disease symptoms may not appear until several weeks or even months after the flood event.

**1.2 Objectives of the Study**

The main objective of the study is to evaluate the effect of flooding on the growth of three varsities of rice grown in Abakaliki Ebonyi State.

Specifically the objectives or aim of this project are:-

1. To determine the effect of flooding on three varieties of Rice. (Oryza Sativa)
2. To examine three varieties of Rice on a flooded land and Non-flooded conditions.
3. To know the nutritional evaluation of the effect of flooding on three varieties of Rice.
4. To study the flooding characteristics of various varieties of Rice.
5. Provide strategies on handling the effects of adverse flooding.
6. To make recommendations and profound solutions to the problems.

**1.3 Justification of the Study**

The main purpose of this research work is to determine weather flooding affect the growth of three varieties of rice (A case study of Abakaliki Ebonyi State). Recent heavy rains in some parts of Nigeria have promoted injuries of flooding and its effects.

The extent to which flooding injures rice is determined by several factors, including plant stage of development when flooding occurs, the duration of flooding, and air/soil temperatures, rice can survive only 2-4 days of flooded conditions. Once rice has reached the silking stage shallow depths of flooding usually cause a noticeable amounts of damage.

If excess moisture in the early growth stages retards rice development, rice may be subject to greater injury during a dry summer because root systems are not sufficiently developed to access available subsoil water. Seed treatments are usually effective but can provide protection only so long; if seedling development is slowed or delayed 2-3 weeks. There is limited resistance to these diseases and predicting damage is difficult because symptoms do not appear until later in the growing season. Rice should be cultivated in a favourable climatic condition for increasing its rice production and rapidly moving to self-sufficiency in rice.

 This study has thoroughly discussed and offered clear indications of priority among these challenges as well as pointers to their solution.

**CHAPTER TWO**

**2.0 LITERATURE REVIEW**

**2.1 Overview of Rice Cropping**

Floods have benefits but also cause multiple problems. Floods occur worldwide, often after heavy rains in an area. Once the flood waters clear away, it leave behind a variety of different effects on the land, animals and people. While many people view flooding as having a solely negative effect, positive things can also result in aftermath of a flood. Flooding causes structural and environmental damage to landscape (Akoroda, 2004). Floods erode soil, often on a large scale bases. This displacement of soil leads to the weakening of structures like houses and bridges. Ebisemiju (2008), opines that the most significant impact of flooding arises from urbanization, because it involves deforestation, landuse changes, precipitation, temperature modification of soil physical properties and structures and the exposure of bare soil surfaces especially of construction sites all of which bring about changes in the morphological and hydrological state of water. Flood waters can destroy farms and business; disrupt road, rail and communication lines, and rain crops and agricultural land. Floods also disrupt in drainage and sewage systems, presenting a serious health hazard resulting from pollution and water borne-disease. Flooding of river is a natural phenomenon. The damage caused by flooding however has increased due to decreasing space for rivers and growing population pressure on valley grounds and wetlands (Olaniran; 2007). It is now generally accepted that increasing urban coverage and development have led to a worldwide increase in both the risk and economic burden of floods (Mudetsee, 2003). The spectre of climate change is also causing international concern. Although no studies have conclusively shown how climate change have been a significant contributor to flood events to date (Douglas, 2008), future prediction suggest that the frequency of severe weather occurrences, including high-intensity and long-duration of rainfall events, is likely to increase. There is also a perception that agricultural intensification and other changes in land management practices may have increased the risk of flooding (Printer, 2009). The researcher has observed that, flooding in Nigeria is a direct consequence of unbridled urbanization characterized by absence of a well-articulated and comprehensive planning and development control or due to climate changes. Urbanization influences all phases of hydrological cycle from precipitation to infiltration rates and the hydraulics of overland flow.

Finally, due to flooding harvests have been delayed, crops and pastures have been submerged and killed, and farm produce destroyed. Whenever soil is removed from actively propped lands, the fertilizer that has been applied by the farmer is equally washed away. These attributes are slow to replace and ultimately reduce crops yield unless higher levels of input are applied, particularly in the short term. Flooding and excessive rainfall have caused massive erosion, landslides and loss of nutrient rich top soil, this have caused the rich red clay soils in some area to be more acidic with increased depth. As the more neutral surface soil is lost through erosions, and flooding farmers may need to apply extra lime and nutrients before new crops can be riceed.

 Flooding is a complex stress that imposes several often-concurrent challenges to normal rice functioning. Dominant is starvation of oxygen and carbon dioxide that is imposed by extremely slow rates of diffusion through the floodwater compared to that in air. Many papers deal directly or indirectly with the impact of oxygen deficiency at various levels of organization, ranging from the initial sensing of oxygen shortage to whole-rice processes involving escape from total inundation, and to the interaction of these basic characteristics of rices with environment to create vigorous riparian ecosystems.

**2.2 Effects of Flooding on Rice Growth**

Effects from flooding may last long after floodwaters recede. Rice may turn yellow because oxygen for nodule function had been reduced. The nitrogen deficiency should be temporary. Rice may suffer from N loss through de-nitrification. Unless more N is supplied, permanent yield reduction is possible. Sometimes floodwaters deposit silt and residue on leaves. Photosynthesis will be reduced until the soil and residue are washed from the leaves by subsequent rain.

The primary damage to rice (other than lodging) from flooding or ponding is oxygen deprivation. The oxygen content of water is much lower than air — even air within the soil. Water in soil (water-logging) or above the soil surface (flooding) means there is much less oxygen available to rice. Living rice tissues, including roots, require oxygen for respiration from which high energy compounds are made. Low oxygen availability means that the entire process of respiration slows. If oxygen levels decrease too much, rice respiration changes to a pathway similar to fermentation. While some life-sustaining energy is produced during fermentation, energy production is reduced by up to 95 percent. So, one effect of low oxygen is drastically reduced metabolism, which can sharply reduce rice growth and, if long enough in duration, cause death to some or the entire rice.

Finally roots are often damaged, and thus, more susceptible to disease organisms. Disease symptoms may not appear until several weeks or even months after the flood event.

**2.3 Types of Rice Grown**

It is helpful to know what types of rice the farmer is growing in Abakaliki. A preference of one type over the other will determine the focus or direction for both formal research and extension. These are the African rice, Oryza glaberrima; ofada, upland and Nerica rice.

**2.4 Techniques of Flood Control**

Despite many rice weeds being well adapted to lowland conditions, flooding has a major suppressive effect on the emergence of most rice weeds and has long been used as an effective measure for weed control, as in transplanted and water-seeded rice. The need to allow the rice to establish aerobically in direct-seeded systems makes early flooding ineffective, and gives opportunities for weeds to establish.

Some species such as F. miliacea *and* E. colona, show little or no innate or induced dormancy and germinate rapidly on the surface of saturated soils but can be suppressed by shallow water. Likewise, germination of the invasive grass weed Leptochloa chinensis is strongly suppressed by standing water and establishment was found to be prohibited by water depths. Others, such as C. difformis*,* exhibit polymorphism in germination responses to flooding, which is possibly a ‘bet-hedging’ survival tactic against unpredictable flooding events.

**2.5 Additional Traits Probably Involved in the Survival of Anaerobic System.**

Rapid cell expansion is necessary for fast growth of rice under flooding and low-oxygen stress in germinating of rice. Expansins are a group of non-enzymatic proteins known to regulate cell wall expansion. These proteins are encoded by a gene super family with at least two major groups: a-expansins and b-expansins. Their role in cell extensibility has been reported in many crops, including rice. Transcript expression patterns of genes were often highly correlated with elongation. Transcript profiling of anoxia-grown rice seedlings revealed that they are likely to be involved in rice coleoptiles elongation under anoxia. Another group of proteins known to be involved in regulating cell wall expansion are the peroxidases. These enzymes are responsible for the assembly of lignins and proteins in the cell wall and for the binding of ferulic acid to the cell wall by subsequently reducing wall extensibility and restricting cell elongation. Higher peroxidase activity is closely associated with reduced elongation in plants such as rice.

**2.6 Rice Adaptation to Anaerobic System**

Despite being a semi-aquatic species, rice is sensitive to various types of flooding stress and this sensitivity varies with the genotype, stage of development, duration and depth of flooding, and floodwater conditions. Even shallow flooding of the soil caused by heavy rainfall soon after seeding can reduce germination and result in poor crop establishment, since rice is sensitive to flooding during germination. During vegetative growth of rice, the most common and damaging type of flooding is short-term complete inundation (up to 2 weeks), also referred to as flash floods. This type of flooding currently affects more than 20 thousand ha of rice-growing in Abakaliki, and can result in severe damage and plant mortality if it is sustained for longer than a week. The extent of damage caused by complete submergence during the vegetative stage is largely modulated by environmental conditions, with higher temperatures, greater water turbidity and lower solar radiation worsening the severity of the stress. Rice genotypes tolerant of complete submergence at the vegetative stage, such as the Indian land rice, were identified that can survive submergence for over 2 weeks, and a single gene responsible for tolerance was cloned and its role in conferring tolerance established.

Furthermore, a marker-assisted backcrossing system was developed and used to transfer into several popular rice varieties, and some of them have already been released for commercial use in several countries.

**2.7 Genetic Variation in Flooding Tolerance during Germination and Early Growth in Rice.**

 Breeding for better germination, greater seedling vigor and higher tolerance of water logging in rice has been attempted before but with limited success because genotypes with sufficient tolerance were not available in a quest for submergence tolerance at the seedling stage, screened 258 accessions from the International Rice Research Institute (IRRI) gene bank and 404 from the International Network for the Genetic Evaluation of Rice (INGER), using seeds pre-germinated for 2 days and then sown at 25-mm soil depth and submerged with 20–50 mm of water. Using this system, 12 genotypes were identified as tolerant, with emergence in the range of 54–78 %, compared with 7–19 % for the sensitive genotypes. Furthermore, these authors observed that tolerant genotypes produce longer coleoptiles under hypoxia, in a manner independent of O2 and ethylene than those of sensitive genotypes.

**2.8 Mobilization of Stored Carbohydrates**

Generally, seeds with carbohydrate reserves, such as rice, are known to be more tolerant of hypoxia during germination than seeds with fatty acid reserves Moreover, several studies investigated the processes of starch breakdown under aerobic conditions, yet the importance of activities and levels of expression of starch-degrading enzymes under low-oxygen stress has not been sufficiently established. Amylases are believed to play a major role in starch breakdown in cereal seeds and rice seeds retain their ability to break down starch into readily fermentable carbohydrates when germinating under hypoxic or even anoxic conditions. Rice seed has the complete set of enzymes needed for degradation of starch and its use for growth and maintenance of the growing embryo; however, the activities of these enzymes are affected by oxygen availability.

Furthermore, genetic variation in the ability to breakdown starch into usable soluble sugars was also reported within rice. Genotypes that are more tolerant of flooding during germination seem to have better capabilities for breaking starch into simple sugars, as demonstrated by faster depletion of starch in their germinating seeds compared with sensitive genotypes. Tolerant genotypes also showed greater total amylase activity in germinating seeds, with a progressive increase in activity from sowing to reach several-fold at 3 days after seeding in flooded soil. The higher amylase activity was also associated with maintenance of higher soluble sugar concentrations in germinating seeds, greater starch depletion, better shoot and root growth and higher seedling survival. The variations in a amylase activity under air, hypoxia is a complex control mechanism that is regulated differently in tolerant and in tolerant rice cultivars. Understanding the allelic variation in the structural and regulatory mechanisms of this gene family could help in exploiting its use for breeding to enhance rice seed germination in flooded soils.

 **2.9 Role of Rice Hormones under Flooded Conditions**

The plant hormone ethylene promotes rice seedling growth under flooded conditions through effects mediated and this flooding induced elongation is one of the escape mechanisms that help submerged plants regain contact with air. This elongation is beneficial in early growth as elongation of the coleoptiles and mesocotyls, but a disadvantage for seedlings if the duration of flooding is short because of the tendency of elongating plants to fall over after the water recedes. Excessive shoot elongation with failure to reach the water surface can also lead to exhaustion of carbohydrate reserves, leading to rice death. The elongation promoting effect of thylene in rice is not only on the coleoptiles and mesocotyl of young seedlings and internodes of older plants, but also on other plant parts such as leave and roots. However, the effects of these plant hormones are hard to predict and sometimes contentious, probably because of various environmental factors and floodwater characteristics that could alter these responses. Therefore the extent of growth becomes dependent on the relative concentrations of endogenous. Moreover, ethylene was reported to enhance sucrose transport from the scutellum to the growing coleoptile in germinating rice seeds.

**2.10 Adaptation of Rice to Flooding during Establishment**

Weeds have a major economic importance for rice production in Nigeria, and their control constitutes up to

30 % of the total production cost. Relatively few of these are considered pan-tropical, with those tolerant of flooding regimes commonly found in upland rice. Of the grass weeds affecting rice .This species is likely to have attracted the particular attention of researchers due to its wide distribution, lack of effective control measures and the considerable crop losses that its infestations can cause. Other species probably have adaptive mechanisms, but these have not been adequately studied yet. Wetland areas tend to show greater commonality across geographical areas than dry land systems. Further, in wetlands, it is usual for moist, saturated and flooded conditions are not unlike those found in many lowland rice fields and this may help to explain the widespread distribution of many lowland rice weeds, as well as the range of ecotypes that exist. As a likely result, several of the widespread weeds of rice are among those described as being the world’s worst weeds.

**2.11 Farmer’s coping Strategies to flood**

 The flash caused dead plants leading to increase cost of seeds and labours for re-planting and reduce benefit from rice production. Coping by building boundary by farmers themselves is not easy in some cases because the soil is so soft and difficult to solid soil for strong boundary. Farmers can only build semi-boundary themselves, they get soils around to build within their farm as well as at the common place for few fields to prevent inflow of water. They cope with flood by pumping water out through their own building boundary. Thus, farmers need the rice varieties, which are tolerant to flood and acid sulfate soil with all good characteristics.

**CHAPTER THREE**

**3.0 MATERIALS AND METHOD**

**3.1 Area of study**

This research work was carried out at Abakaliki, Abakaliki is located in the South-Eastern part of Nigeria (7°N, 3°E). The city is one of food producing state in southeast with an estimated population of about 4 million people

**3.2 Materials**

The experiment was conducted on three varieties of Rice ofada, upland and Nerica Rice) at Abakaliki Ebonyi State, they were used to screen for flooding tolerance.

**3.3 Germination Determination**

Flooding has been described as one of the most important environmental factors determining the distribution of salt marsh plants. Slow seed germination and delayed seedling establishment will become a major problem for rice production in flood-prone lowland areas as sowing method shifts from transplanting to direct seedling. Piece plants are known to be adapted to flood conditions, many rice cultivars are sensitive to low oxygen levels during the germination period which is frequently caused by flooding

**3.4 Yield of various Varieties**

Rice is rich in genetic diversity, with thousands of verities grown throughout the world and its economic importance related to agro-ecological adaptation, household food, security, ceremonies, nutritional diversification, income generation and employment. Remarkable deepwater varieties of O. glabberima exist which are specific to the usual flood conditions that occur in the inland Niger Delta, the Sokoto - Rima valley and other flood plains of extreme north of Nigeria. The O. glabberima verities have certain negative features with respect to O. Sativa e.g. the seed shatters easily the grain is brittle and difficult to mill and most importantly, the yields are lower.

**3.5 Land preparation and Agronomic practices**

The land was cleared and grasses burnt in order to kill any rice contaminants that may be present in the piece of land under cultivation, after burning, the land was ploughed and harrowing manually.

 The experiment layout was randomized complete block design (RCBD) and the cultivars were randomly allocated to each experimental plot measuring 1.0 x 1.0m. there seeds were initially sow per hole at a plant spacing of 20x20cm with an inter-plot spacing of 40cm created to aid easy movement between the plots.

**3.6 Method**

The secondary data and qualitative information were collected from various farmers in Abakaliki as well as from the printed materials and the internet. The primary data in two special sites Izee and Ikwo Ebonyi central senatorial zone provinces in the flood prone area for the information on flood and flash flood events in relation to the rice farming were gathered through household baseline survey, focus group discussions (FGDs), and keep informant interviews.

**CHAPTER FOUR**

**4.0 RESULTS AND DISCUSSION**

**4.1 Results**

Rice genotypes with a greater ability to germinate and establish in flooded soils were identified, providing opportunities to develop varieties suitable for direct seeding in flooded soils. Tolerance of flooding in these genotypes was mostly attributed to traits associated with better ability to mobilize stored carbohydrates and anaerobic metabolism. The injury results from rice inability to grow in these environments during flooding. While specific information on how long small grains can survive under water has not been widely reported, most indications are that rice can withstand water logged soils for up to 24 hours without excessive damage. Although direct seedling is advantageous over transplanting in terms of labour requirement, many prime quality and high yielding rice cultivators are not good performances in direct seedling resulting in slow development and direct seeding technology in flood-prone area. Depending on the condition rice can probably survive saturated conditions for up to two days. Flood affects rice generally there by reducing the alkalinity, calinity and acidity.

**Table 4.1 shows the effect of flood on Different Rice varieties.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S/N** | **Varieties of Rice**  | **Plant Area**  | **Germination Count**  | **Plant Height**  | **Grain yield**  |
| 1 | OFADA | Flooded Non-flooded  | 85.1 62.3 | 71.334.5 | 1.240.70 |
| 2 | UPLAND | FloodedNon-flooded  | 95.251.1 | 84.520.2 | 2.210.95 |
| 3 | NERICA | FloodedNon-flooded  | 93.554.2 | 72.240.3 | 1.741.16 |

From the table above Ofada Rice grown on flooded area with germination count 85.1 and plant height of 71.3, grain yield 1.24 was affected by flood and germination count of 62. 3, plant height of 34.5 grain yield 0.07 was not affected by flood. Upland Rice was grown on flooded area with germination count of 95.2 plant height 84.5 and grain yield 2.21 was affected by flood and germination count of 51.1 with plant height of 20.2 and grain yield of 0.95 was not affected by flood. Nerica Rice was planted on flooded area with germination count of 93.5 plant height 72.2 and grain yield of 1.74 was affected by flood, the germination count of 54.2 with plant height of 40.3 and grain yield of 1.6 was not affected by flood. This is to indicate that flood affect the growth of rice and also the areas affected was much than the area not affected, it also shows that time and depth of flooding had significant affects on the survival and growth of rice and its quantity and quality of Rice grown.

**4.2 Discussion**

Being located in the monsoon tropic humid area, Abakaliki was not only affected by diversified climate changes and plentiful resources but also suffers many natural disasters, especially flood. In this research, it was observed that among three rice cultivators including plant area, plant height, germination count and grain yield, upland rice was the tallest among the three varieties studied and the other were short, not as tall as the upland rice and the germination count on flooded area for upland rice is the highest. This is to say that flood affect the upland rice than the other varieties. Generally flood affect the growth of rice plant thereby reducing the germination percentage, plant height, the yield and also reducing the alkalinity, calimty and acidity, depositing parents materials thereby increasing the soil fertility Due to flood, there were tremendous damages on the farm, this disasters also made Abakaliki farming population and Nigeria face hunger. Abakaliki is easily affected by high tidal water from the river and it plays as a basin of the flood, the rains made the ground being saturated and ponds and lakes are already overflowing their bank, low tropical pressure, heavy rains, high tides and outbreak of pests are challenges to both farmers and agricultural activities.

**CHAPTER FIVE**

**5.0 CONCLUSION AND RECOMMENDATION**

**5.1 Conclusion**

The nature of flood and the consequence of anthropogenic activities have made floods an inherent environmental problem, which can only be controlled rather than eradicated in man’s environment. Agricultural land use potentially has an important part to play in flood risk management in as much as runoff and subsurface drainage from farmlands acts as pathway causing flooding in downstream receptors areas. Because of flood the total production will not be enough to feed the nation, the rice yield has to be increased without delay by making use of the available technologies thereby improving drainage.

**5.2 Recommendation**

In order to fulfill this challenge, research an integrated effort of researchers, extension workers, administrators and planners is needed to this solve and to ensure proper crop growth in these area recommendation such as improving drainage and aeration is critical, avoidance of loose organic materials.

**-Research: -** In the flood prone area in the south there is the need of rice varieties that are to lerant to both flash flood (sudden flood lasts for less than 3 weeks) and stagnant flood. Thus, the breeding goal in rice research should target to this concern.

**-Farmers: -** Both male and female farmers in the flood prone area should form in community or group to receive and apply appropriate technologies, support knowledge and learning each other the measures to cope with the problems of flash flood and stagnant flood.

**-Institutions and network:** **-** The research institutions, extension agencies and farmer’s association and social clubs should form a network to develop and disseminate the suitable and adaptable rice technologies for the flood prone area.

**-Policy:** **-** Government should financially and materially support farmer community in the areas where are vulnerable to both stagnant and sudden flash flood to consolidate the dikes/boundaries to protect the rice plants in both dry and wet season. The agricultural information of flash flood and submergence tolerant rice varieties.

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