International Journal of Food, Agriculture and Veterinary Sciences ISSN: 2277-209X (Online)
An Online International Journal Available at http://www.cibtech.org/jfav.htm
2013 Vol. 3 (1) January-April, pp. 58-62/Ogbodo

Research Article

UNDERSTANDING THE CAUSES OF RICE GROWTH DISORDERS AT IKWO, EBONYI STATE, SOUTHEAST NIGERIA

***E. N. Ogbodo**
Department of Soil Science and Environmental Management,
Ebonyi State University, P.M.B. 053 Abakaliki, Nigeria
**Author for Correspondence*

ABSTRACT
A survey was conducted as part of the efforts to clarify the causes of rice growth disorders; a contributor to low rice yields, and the possible countermeasures for improved and effective rice production at Ikwo area of Ebonyi state, Nigeria. The study took place at the paddy fields of the Ebonyi state World Bank rice project, Ikwo. Five hundred soil samples were collected from the five locations of Item, Obegu, Ndiagu, Enyibichiri and Ekpanwudele. The samples were subjected to physical and chemical analyses, and the data statistically analyzed. Rice plant samples were also taken from the fields and investigated for deformities. The rice plants growth disorders observed were short and bunched roots, low tillering, short plant length, narrow-short-vertical leaf blade, and very dark green leaves. Some of the old leaves were brown and dead, whereas brown spots usually appeared on some old leaves of rice plants. The soils were observed to be acidic, low in organic matter, and suffer multiple nutrient deficiencies. The soils also had indication of excessive concentration of iron (Fe^{2+}) and Manganese (Mn^{2+}). The rice growth disorders were attributed to severe deformities which were indicative of injurious uptake of Fe^{2+}, Mn^{2+} and associated reductive substances.

Key Words: *Rice, Growth Disorders, Iron Toxicity, Manganese Toxicity*

INTRODUCTION
The main inhibiting factors to high rice yields in Ebonyi State of Nigeria reported earlier centered on soil physical and chemical constraints (Ogbodo and Nnabude, 2004; ogbodo *et al.*, 2009; Ogbodo and Chukwu, 2012 and Ogbodo and Ekpe, 2011). Other apparent causes of low crop productivity in the area include inappropriate input combination (ogbodo *et al.*, 2011), poor leveling of rice fields, unsuitable water management (water-logging), cropping of mixed varieties, lack of appropriate and adequate fertilizer application, weed interference, and insect pest attack.
It has however become obvious that apart from the aforementioned constraints, rice growth disorder could be an important cause of low rice yields in the area, which has been overlooked. This investigation therefore is directed towards understanding further constraints to rice growth at Ikwo area, which is a major rice producing area in Nigeria, their causes and the possible countermeasures. The report could provide a dependable data base for the overall improvement in rice yields and future management of rice production in the area.

MATERIALS AND METHODS
Location
The study was carried out in the 2012 farming season at Ebonyi state rice project Ikwo, located within latitude 800 151 E and longitude 6 01 N in the derived savanna zone of Southeast Nigeria. The project is spread across Item, Obegu, Ndiagu, Enyibichiri and Ekpanwudele farming communities. This area is representative of the rice producing areas of Ikwo, where the bulk of rice production in Ebonyi state is concentrated. The underlying soil is made of shale parent material, of shallow depth, predisposing the soils to poor-drainage.

Field Work:

The study was conducted in fifty plots in the main fields from five major rice fields at Item, Obegu, Ndiagu, Enyibichiri and Ekpanwudele farming sub-stations of the project. Ten soil samples were taken at 0-40 cm depth from each of ten plots having varied topographic features in each of the substations, and corresponding with the major rice varieties cropped in the project, (Faro-15, Faro-16, IR-8 and IR-5). Hence five hundred soil samples were collected from the plots in the paddy fields, studied and analyzed. The values for the 100 samples from each sub-station were used to draw inferences as representative of the entire area. Six soil core samples were also randomly collected from each of the ten plots in each sub-station, and used to determine the soils bulk density and porosity. The samples of the rice varieties were collected from the rice fields at the booting stage and each variety from each location packaged in a sealed envelope. Envelopes containing the rice varieties were properly labeled, giving information about the variety, date, and place of collection. The names of the varieties were as used by the breeders.

Laboratory study

Soil texture was determined by the hydrometer method and classified with the textural triangle. Bulk density was determined by the method of Blake and Hartge, (1980). Measurements of soil chemical characteristics included routine soil analysis and measurements of Fe^{2+} and Mn^{2+} in soil samples, using the method of Novozamsky *et al.*, (1983).

RESULTS AND DISCUSSION

Rice Plant Disorders

The principal growth disorder observed in the paddy fields was severe uneven growth of rice plants. Some of the characteristics of the rice plants growth disorders were low tillering, short plant length, narrow-short-vertical leaf blade, and very dark green leaves. Some of the old leaves were brown and dead, whereas brown spots usually appeared on some old leaves of rice plants resulting to a phenomenon called bronzing. The other growth disorders observed on the plant samples were short and bunched roots.

The rice growth disorders in the farms were estimated to be caused by nutrient deficiency and reductive injury. In this area, rice yield level is around 2t/ha, as against 5t/ha target. The low rice yield is a semblance of the average yield of 1.9t/ha reported by Ogbodo *et al (*2012) within the same ecology, and with similar traditional rice production processes. Even in the face of the observed soil nutrient deficiency, fertilizer application by the farmers is mainly basal (N-P_20_5-K_30, 15-15-15, each nutrient 30Kg/ha). The farmers do not even apply lime and compost, which had been shown to have very sound structural and chemical influence on the properties of soils representing the area (Ogbodo 2009a, b and Ogbodo *et al*, 2010). The appearances of some of the rice growth disorders closely resembled the symptoms of excess iron and manganese. The result of the soil analysis also equally suggests that there is excessive iron and manganese in soil; and this confirmed these disorders observed.

Soil Characteristics

Soil color was yellowish brown. Soil texture in the sampled plots was clayey, ranging from clay to silt clay (Table 1). Soil below 20cm depth has higher content of clay, and dense. Gravels and humus were low at all the locations. Mottlings of iron were observed in whole layers, while Gley horizon was observed below 30 cm depth in all the plots. Top soils were compact and plasticity was strong.

Table 2 shows the results of soil chemical analysis. The pH is slightly lower than the adequate pH range of 5.5—6.5 for sustainable crop production in the area reported by Ogbodo and Chukwu, (2012). Phosphorus deficiency is severe and across the entire substations. Deficiencies of Nitrogen, Sodium and calcium are also pronounced, whereas Potassium is slightly deficient. Electric conductivity (EC) is adequate whereas the soils are generally endowed with magnesium. The concentrations of Iron seem generally too high for crop production purposes. Also the possibility of excess manganese level was observed. Both iron and manganese showed higher concentrations in the upper soil layer, and this indicates that water movement was upward within the period.

The concentration of Fe^{2+} in the soils is at the levels that normally induce iron toxicity. Measurements ranging from 300 mg/g are detrimental to crop production (Alloway, 1995). Though the concentrations of Fe^{2+} and Mn^{2+} in the soils were high, these may not be estimated to be the only causes of the rice growth disorders. The possibility of other causes leading to the problems was estimated, bordering on; decreased root activity due to the deficiency of major nutrients, principally phosphorus, calcium and potassium, and also the presence of harmful metabolic intermediates of organic matter such as organic acid which were naturally estimated. These have contributed to the decrease of the rice roots activity leading to low respiration and nutrient uptake. On the other hand, as the roots become inactive, excess absorption of harmful substances such as Fe^{2+} occurs. It was also obvious that the fields have little water permeability, so the reductive harmful substances stay long in the soil. The part of field where the water depth is high is always flooded, so the reductive harmful substances cannot get oxidative decomposition. All these culminate in the rice crops taking up harmful substances reflecting in the growth disorders observed.

The rice growth disorders become even severe as the water depth increases resulting from the capillary movement of water detected. Fertilizers also dissolve more as the water depth increases, so the mixing ratio to the soil also decreases resulting in low fertilizer use efficiency. When the fertilized soil surge, due to the rough puddling of soil prevalent in the area, the available nutrients also decreases. On the other hand, the reports of the Federal Department of Agricultural Land Resources (FDALR, 1985) and Anikwe, 2001 showed that soil and atmospheric temperatures are usually high in this area, so the respiration of the rice crops should also be high. Besides the rice cultivated is Indica type, which the need for oxygen is high. Since there was no water control structures in the area, as the water depth increases, the quantity of oxygen available decreases resulting in oxygen starvation of the crops. These conditions could have retarded the growth of the rice crops.

Countermeasures

The soils require increased and adequate fertilizer application, particularly the primary nutrients (N.P.K.), and Ca and Na. The levels are grossly deficient in the soils and higher doses of these elements through fertilizer application could go a long way to counter the growth disorders and improve crop performance. Recommend adequate quantity of fertilizers reported by, Ogbodo *et al.*, (2009) and Ogbodo *et al.*, (2011) should be adopted to boost the growth and grain yield of the rice crops.

The level of the soil humus should be increased by the adoption of the use of organic manure (straw) in the crop production. The research concerning the quality and quantity of organic manure had been carried out and reported in Ogbodo (2009b). The aapplication of rice straw at equivalent of 10 t/ha as recommended also in Ogbodo and Nnabude (2012a, b) should be adopted instead of the practice where the farmers usually burned their rice straws. Lime application ($CaC0_3$) should be practiced, since iron and manganese toxicity are known to be prevalent in acidic soils.

There is the need to adopt appropriate tillage methods. Leveling of the fields should be conducted with tractors to make the soil fertility uniform and water management easy. Ogbodo (2010) and Ogbodo and Nnabude (2012a, b) had recommended plowing and harrowing the soil and a combination of plowing and harrowing, with the application of crop residues for improved soil structure and productivity, and optimum rice yields. Appropriate tillage will improve infiltration, and if the soil permeability increases, the harmful substances can be leached down and removed from the root zone. However excessive permeability may aid loss of the nutrients. In order to avert this situation, it is recommended that plowing should be carried out after rainy season and just after harvesting when the soil is dry and before the following rainy season in order to cut the capillary connection. This will also suppress the excessive drying of soil and reduce the upward movement of harmful substances.

CONCLUSION

The rice crops showed severe signs of toxicities of Fe^{2+} and Mn^{2+}; which actually predominate under low soil pH as obtained in the soils of the study area. Since the soils were acidic, the presence of excessive iron and manganese became toxic to the rice plants. Conclusively, the reducing conditions and low pH produced toxic levels of Fe^{2+} and Mn^{2+}; and under reducing conditions there is less availability of oxygen, all of which had adverse effects on the rice crops growth. There was also obvious multiple nutrient deficiencies, and the signs indicative of unfavorable rhizosphere; caused by poor soil structure owing to high bulk density and low porosity, which may have in part contributed to low growth and development of the crops.

Table 1: Soil chemical properties

Location	Bulk Density(g/cm^3)	Porosity (%)	Sand (%)	Silt (%)	Clay (%)	Textural Class
Item	1.36	49	41	6	43	Clay
Ndiagu	1.46	45	53	5	42	Silt Clay
Obegu	1.40	47	43	5	52	Clay
Enyibichiri	1.36	48	41	5	54	Clay
Ekpanwudele	1.42	49	49	5	46	Silt Clay

Table 2: The soil chemical Properties

Location.	**Layer (cm)**	**P^H (H_2O)**	**EC (1: 5, S/cm^3)**	**N (%)**	**P_2O_5**	**K**	**C_a** Cmol/Kg	**Mg**	**Na**	**Fe (mg/g)**	**Mn (mg/g)**
Item	0 −20	4.8	0.08	0.10.	19.17	15	6. 50	20	0.005	400	40
	20−40	5.4	0.05	0.08	11.32	5	5.00	50	0.005	100	10
Ndiagu	0−20	4.7	0.08	0.08	15.80	20	5.00	50	0.005	400	30
	20−40	5.1	0.05	0.06	4.70	5	2.20	10	0.005	140	20
Obegu	0−20	4.9	0.07	0.11	16.00	10	5.0	50	0.005	350	80
	20-40	5.6	0.05	0.07	6. 10	7	3.50	30	0.015	180	30
Enyibichiri	0−20	5.0	0.05	0.08	15.5	15	3.54	20	0.005	370	20
	20−40	5.2	0.05	o.05	7.25	10	2.63	25	0.005	170	7
Ekpanwudele.	0−20	5.1	0.05	0.02	16.82	15	4.6	50	0.005	340	100
	20−40	5.2	0.03	0.01	5.90	5	4.0	50	0.005	110	40

REFERENCES

Alloway BJ (1995). Heavy metals in soils 2nd Edition. *Chapman and Hall Glasgow* **34**.

Anikwe MAN (2000). Amelioration of heavy Clay Loam soil with rice husk dust and its effects on soil physical properties and Maize yield. *Bioresource Technology* **7** 160-173.

BLAKE GR and HARTGE KH (1986). Bulk density. In:Methods of Soil Analysis, Part 1: Physical and Minerological methods, 2nd Edition. Soil Science Society of America, Madison USA 365-375.

FDALR (Federal Department of Agriculture and Land Resources) (1985). The reconnaissance soil survey of Anambra State soil report. *Federal Department of Agriculture and Land Recourses. Lagos-Nigeria.*

Novozamsky 1, Houba VIG, Van Eck R and Van Verk W (1983). A novel digestion Technique for multiple-element plant and soil. *Communiqué in Soil Science and Plant Analysis* **14** 239-248.

Ogbodo EN and Nnabude PA (2004). Evaluation of the performance of three varieties of upland rice in degraded acid soil in Abakaliki, Ebonyi State. *Journal of Technology and Education in Nigeria* **9** 1-7.

Ogbodo EN, EkpeII and Utobo EB (2009). Use of Organic Amendments to Improve Chemical Properties and Crop Yield in Degraded Typic Haplustult in South Eastern Nigeria. *American-Eurasian Journal of Sustainable Agriculture* **3**(3) 609-614.

Ogbodo EN (2009a). Changes in the Properties of an Acid Soil Amended with Burnt Rice Husk and the Effect on the Growth and Yield of Pepper at Abakaliki South Eastern Nigeria. *American-Eurasian Journal of Sustainable Agriculture* **3**(3) 579-586.

Ogbodo EN (2009b). Effect of Crop Residue on Soil Chemical Properties and Rice Yields on an Ultisol at Abakaliki, Southeastern Nigeria. *American-Eurasian Journal of Sustainable Agriculture* **3**(3) 422-447.

Ogbodo EN (2010). Effect of Crop Residue on Soil Physical Properties and Rice Yield on an Acid Ultisol at Abakaliki, Southeastern Nigeria. *Research Journal of Agriculture and Biological Sciencies* **6**(5) 647-652.

Ogbodo EN, Ekpe II, Utobo EB and Ogah EO (2010). Effect of Plant Spacing and N Rates on the Growth and Yields of Rice at Abakaliki Ebonyi State, Southeast Nigeria. *Research Journal of Agriculture and Biological Sciencies* **6**(5) 653-658.

Ogbodo EN (2011). Effect of Tillage Methods on some Soil Properties and Rice Yields on Acid Utisol at Abakaliki, Southeastern Nigeria. *Nigeria Journal of Soil Science* **21**(1) 47-57.

Ogbodo EN and Ekpe II (2011). Identification of Some Major Soil Properties That Influence Rice Grain Yield In The Lowland Soils Of Ebonyi State. *Nigeria Agricultural Science Journal* **42** 225-232.

Ogbodo EN, Okereke CO, Chukwu VA and Nwite JC (2012). The Contribution of a new input Combination package to rice production in Ebonyi state, Nigeria. *Nigeria Agricultural Science Journal* **43** 19-26.

Ogbodo EN and Chukwu GO (2012). Soil Fertility Evaluation of Selected Aquic Haplustalf in Ebonyi State, Southeast Nigeria. *Nigeria Journal of Soil Science* **22**(1) 97-107.

Ogbodo EN and Nnabude PA (2012a). Effect of Tillage and Crop Residue on Soil Physical Properties and Rice Yield on an acid Ultisol at Abakaliki, Southeastern Nigeria. *Nigeria Journal of Soil Science* **22**(1) 86-96.

Ogbodo EN and Nnabude PA (2012b). Effect of Tillage and Crop Residue on Soil Chemical Properties and Rice Yields on an Acid Ultisol at Abakaliki Southeastern Nigeria. *Nigeria Journal of Soil Science* **22**(1) 73-85**.**