International Journal of Plant Breeding and Genetics ISSN 2756-3847 Vol. 8 (1), pp. 001-003, May, 2021. Available online at www.internationalscholarsjournals.com © International Scholars Journals

Short Communication

Edaphic factors and survival of a red mangrove species in two mangrove swamp soils

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Accepted 13 May, 2021

The effects of two Niger Delta Mangrove Swamp Soils on growth and growth components of *Rhizophora mangle* were studied. The mud flats had higher manganese, organic carbon, lower sodium, higher phosphorus, lower pH and no sand particle compared with peaty clays. The mud flats also had very low cation exchange capacity (CEC) and these qualities affected adversely the plant height, survival, disease index and stability of the plants compared with those grown in peaty clays. Recommendations for improvement of the mud flats for mangrove swamp re-vegetation are made.

Key words: Red mangrove species, mangrove swamp soil, survival rate.

INTRODUCTION

In the Niger Delta region of Nigeria, mangrove plants cover approximately, 600 km^2 between the fresh water alluvial zone and the belt of beach-ridges which form the seaward boundary (Elf Nigeria Limited, 1996; Anderson, 1997). The three red mangrove species in the Niger Delta: *Rhizophora mangle, Rhizophora harrisonii* and *Rhizophora racemosa* are found in the three soil types within the mangrove system. These soils are silty clays, peaty clays ("Chikoko") and saline sands (Hartoungh, 1996). The silty clays support tall *R. racemosa* which grows less vigorously in peaty clays. In peaty clays, *R. racemosa* is associated with *R. mangle* and *R. harrisonii*. The saline sands rather support sparse growth of scrubby *R. racemosa* with occasional stands of *R. harrisonii*. Field observations indicate that the mud flats at the banks bear no vegetation. Similarly, other researches have indicated that the survival rates of the three red mangroves were least in *R. racemosa* and highest in *R. mangle* (Zuofa and Onuegbu, 1996). It is therefore important to invest-tigate the factors responsible for bare vegetation in the mud flats using the red mangrove with higher survival rate (*R. mangle*) as the test crop. This research therefore aims at investigating the factors responsible for bare vegetation in the mud flats. It is hoped that knowledge of the factors responsible for the bare vegetation would contribute in remediating the soils and boosting red mangrove production.

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MATERIAL AND METHODS

The experiments were sited at Eagle Island Mangrove Swamp, Port Harcourt (Latitude 4^o 42' E and 4^o 48'W and Longitude 6^o 15'N and 7^o 25'S with an annual rainfall of 250 mm and mean annual tempe-rature of 28^{o}C). The red mangrove species used to test the effect of the soil type on survival of the plants was *R. mangle*. Peaty clays ("Chikoko") served as the control.

Three different sites of mud flats in the study area were selected. Soil samples were collected at 0 - 15 cm and 15 - 30 cm depths at five points per site and composed. They were taken to the labo-ratory for physico-chemical analysis. Organic carbon was deter-mined by Walkley and Black Wet Oxidation Method (1934); total Nitrogen by Micro-Kjeldhl methods as described by Bremmer and Mulvany (1982); available phosphorus by Bray and Kurtz No. 1 extraction method as described by Olsen and Somners (1982); Cation exchange capacity by the method described by Chapman and Pratt (1961); exchangeable cations by ammonium extraction method as modified by Grant (1982); pH by the method described by Allen et al (1974); and textural analysis by the method described by Day (1965).

The seedlings used in transplanting were first raised in the nursery to ensure uniform age of the transplants. At the end of the third month in the nursery, the seedlings were transplanted into the field. Each site, 20 x 30 m, giving a total of 60 x 90 m for the three sites, was dug with holes, 30 cm depth each, at a distance of 2 m apart. The polythene bags were carefully removed and the ball of soil and plants put into the holes already prepared. The soils around the holes were gathered around the seedlings and compacted. Each site contained 150 plants such that a total of 450 plants were tested.

Table 1. Physio-chemical analysis of the soils obtained at Eagle island mangrove swamp, Port Harcourt.

Parameters	Soil Depth (cm)	Flat Muds	Peaty Clays ("Chikoko"
	0-15	4.2	6.6
pH	15-30	4	6.5
	0-5	23	16.5
Organic carbon (%)	15-30	24	13.7
	0-15	44.69	40
C/N Ratio	15-30	45	53
	0-15	98	1
Available P (ppm)	15-30	101	2
	0-15	2.45	8.4
Ca (meq)	15-30	2.4	7.5
	0-15	0.87	0.74
K (meq)	15-30	0.83	0.28
		5	18.3
	0-15	4.47	17
Mg (meq)	15-30	0.58	20
	0-15	0.52	23
Na (meq)	15-30	21.87	39
	0-15	20.77	30.7
CEC (meq)	15-13	0.48	0.33
	0-5	0.47	0.28
Mn (meq)	15-30	0	25
	Sand	0	25
Mechanical Analysis (%)	Silt	70	32
	Clay	30	44

The seedlings were monitored for six months at one month interval and the following parameters were analyzed from 100 randomly selected plants: plant height, survival rate, disease index and instability index per plant. Plant height was esti-mated by means of metre rule while survival rate was estimated by the number of survival plants in relation to the total plants assessed multiplied by 100. Disease index was calculated by the Method of Zuofa and Onuegbu (1996). Instability Index (1.1) was estimated using the following ratings.

0 =No. seedling lodged
1 =1 - 10 seedlings lodged
2 =11 - 20 seedlings lodged
3 =21 - 30 seedlings lodged
5 = 31 - 40 seedlings lodged

Instability Index therefore ranged from zero to 5 in which zero represented no lodging of the seedlings (high stability) while 5 represented very high instability of the seedlings resulting from lodging. The entire experiment was repeated for peaty clays ("Chikoko").

RESULTS AND DISCUSSION

The results of the soil analysis are shown in Table 1. The results show that the C/N ratio of the mud flats and quan-tity of potassium, manganese, available phosphorus and organic carbon were far higher than in the peaty clays. However, the peaty clays had more calcium, magnesium cation exchange capacity, higher sodium and higher pH in the mud flats. Similarly, the mud flats had very high silt and clay contents and no sand compared with the peaty clays. The implications of high silt and clay contents are high consistency and poor capillarity. The plants grown in the mud flats had shorter height, lower survival rate, higher disease and instability indices compared with those grown in the peaty clays. At the sixth month only 5.30% of the plants survived in the mud flats and 89.40% in the peat clays. Such adverse effects in the mud flats may have resulted from impaired metabolic activities as a result of lack of oxygen from the root system, or by carbon dioxide accumulation or indirectly by the toxic pro-ducts such as manganese and flooded soil (Bergman, 1999; Ivemy, 1966; Kinako and Onuegbu, 1993). The analysis of the soils indicated a higher quality of manga-nese in the mud flats than in peaty clays. Similarly, high silt and clay contents in the mud flats might have caused poor capillarity, which might have resulted in greater oxy-gen demand with decreased respiration rate (Veneten-nikov, 1968). The greater oxygen demand could have resulted in reduced metabolic functions of the plants in

Table 2. Effects two types of Niger Delta mangrove soils on some growth and growth components of a red mangrove species, *Rhizophora mangle*.

Soil	Map*	Mean plant height (cm)	Survival rate (%)	Disease Index	Instability Index
Peaty clays ("Chikoko")	1	9.87	65.26	0.00	1
	2	21.08	73.45	0.01	1
	3	33.60	85.10	0.25	0
	4	35.92	86.30	0.32	0
	5	38.06	88.25	0.43	0
	6	44.20	89.40	0.45	0
Mud flats	1	7.60	58.50	0.01	4
	2	15.45	43.60	0.32	5
	3	28.70	27.40	0.43	5
	4	30.65	12.50	1.50	5
	5	33.70	7.10	1.60	5
	6	37.5	5.30	1.80	5
LSD (0.05)		2.74	5.83	0.15	2.51

the mud flats. Reduced metabolic activities in the mud flats resulted in reduced growth and development. Kinako and Onuegbu (1993) and Onuegbu (2002) attributed such adverse effects to the reduced level of metabolic activities in flooded plants. The findings of the present study agree with theirs. The higher disease index of plants in the mud flats was as a result of increased susceptibility to pathogens. Lorio (1998) and Zak (2001) reported increased susceptibility of flooded plants to pathogenic infection. Even though, red mangroves are halophytes, the conditions in the mud flats were unfavou-rable. Similarly, the instability index of plants in the mud flats was higher as a result of lack of sand particles for proper, firmer anchorage. This research indicates that the mud flats had no sand particle and had low pH (very acidic). Odu (2004) reported that low pH supported the growth of pathogenic micro-organisms. The low pH observed in this study must have supported microbial growth and therefore death of the plants as a result of infection.

Conclusion

This research shows that the mud flats compared with the peaty clays had higher organic carbon, higher phos-phorus, among others. However, higher silt and clays and other qualities made it almost unstable for plant growth. If the desired qualities of the soil type were to be harnessed for mangrove swamp revegetation, some quantities of sand and wood ash should be included to it so as to improve its qualities of capillarity, reduce consistency and acidity, respectively.

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