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Research Paper

Survival And Tolerance of Banbusa Vulgaris in Crude Oil Contaminated Coastal Wetlands/Soil of The Niger Delta, Nigeria

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Abstract
There are no much knowledge on the survival and tolerance of plants species in the Niger Delta to the highly polluted crude oil environment. This study focused on the survival and tolerance of Bambusa vulgaris to crude oil contamination using soil treatment in polythene bags. Soil treated with 25, 50, and 75mls of crude oil were introduced in to a poly bag containing measured quantity of soil in kg. Bambusa vulgaris cultivated under normal environmental conditions and in an unpolluted soil were transplanted to the polypots containing the treatment. Findings revealed that survival of bambusa vulgaris was recorded at 80% given normal soil condition and 58% after treatment or in contaminated soils through the tolerance level was measured to be adequate with an increase from 92% to over 100% across samples with very low pollutants level (25ml) while sample 50ml to 75ml exposure had a decline in their tolerance level but stabilized overtime as measured by surface and sub surface biomass level for branches and sub branches there is an increase in tolerance level across samples with 25ml exposure and a decline and subsequent increase for samples of 60ml to 75ml. It is therefore recommended that the economic potential of bambusa vulgaris can be of advantage in crude oil contaminated wet lands of Niger Delta.

Keywords: *Environment, Pollution, Bambusa vulgaris, Contamination, Treatment*

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I. Introduction

The Niger Delta region is a tropical rainforest harboring diverse plant and animal species both in the terrestrial and aquatic ecosystem (Ayuba, 2012). It is ranked among the world largest wetlands (SPDC, 1999). Crude oil production in the region amounting to approximately 13 million barrels have been spilled into the Niger Delta environment in the past 50 years (FME 2006), making it one of the worlds five most oil spill impacted wetland environment (Ayuba, 2012). The high cost and low efficacy of the usual physicochemical remediation techniques have necessitated the creation of alternative options for *in situ* applications, particularly remediation techniques that are dependent on the activities of microorganisms and plants (Snigh and Chaudhry *et al*., 2005). This is known as bioremediation, and one of such techniques is rhizoremediation. Rhizoremediation involves the removal of pollutants from a contaminated environment via mutual interaction of plant roots and the associated microorganisms (Shukla *et al*., 2010). Premised on this, intensive selection studies are required to choose the most appropriate plants that can survive oil contaminated soils (Pivetz, 2001). Little is known about plant species from the tropics that can be deployed for this purpose (Ogbo *et al*., 2009). Despite the overwhelming numbers of potential plants, a comparatively small numbers of plants have been studied (Pivetz, 2001) therefore *Bambusa vulgaris* which is is versatile in utilization and one of the fastest-growing non-timber forest products in the Niger Delta was considered for this study. It's versatility in utilization is see on the ground that all plant parts can be used for various purposes. Leaves are used for fodder, shoots for human consumption, culms for biomass, construction, textiles, musical instruments and many bamboos species are used in horticulture (Hunter, 2003). In rural environments, handicrafts such as personal ornaments, utensils, baskets and other containers, bird cages, poultry coops, musical instruments, water pipes, local bridges, house construction and fishing gears are made from bamboo stem. Modern day use of bamboo stem includes pulp and paper production, bamboo blinds and barbeque skewers. The living bamboo provides edible shoots, fences, windbreaks, ornamentals and a means to counter

erosion in some situations. A bamboo stem has an underground part, called the rhizome, and an emergent portion called the culm. The bamboo stem is segmented possessing a series of nodes which appears as rings along the culm, where the sheaths, buds and branches arise. The internal space within the bamboo culm is compartmentalized into a series of hollows by each node bearing a transverse plate. It is this basically hollow cylinder-like structure with crosswalls placed at regular intervals along the culm that gives bamboo its inherent strength and flexibility. Typically, bamboo rhizome turns upwards to continue as a culm and also bears new rhizomes, which again upturn to become culms, and these further bear "daughter rhizomes". In other words, wave-like successions of rhizomes build up as repeating units, which are of successively newer generation. The clumping or "running" habit of bamboos is a consequence of its rhizome growth behaviour. Buds and branches are usually present from at least the middle of the culm upwards and may not form at the lowermost culm nodes.

Bamboo belongs to a large subfamily of the grasses (Poaceae: Bambusoideae with 1662 species in 121 genera). Bamboos have a range of functional forms distributed over numerous biogeographic regions, including dwarf herbaceous species found in temperate climates and giant tropical woody species that can grow up to 20m tall (Bystriakova et al. 2004). It is estimated that 2.5 billion people are directly involved with the production and consumption of bamboo (Scurlock et al. 2000). It possess certain characteristics that differentiates them from other grasses: woody segmented, typically hollow stems (culms), complex system of branching; and flowers that typically have three perianth-like structures (lodicules) each and 3–6 stamens (Soderstrom 1981). Bamboos also share other characteristics with some herbaceous (non-woody) grasses, notably leaf blades that have a distinctive internal organization of the tissues (including "arm cells" and "fusoid cells" not found in other grasses) and which are basally narrowed to form a stalklike connection with the leaf sheath (sometimes called a "pseudostalk"). It is a renewable resources and grows abundantly in both the tropical and sub tropical countries (Fu and Banik, 1996). They possess rapid growth capabilities and hence are capable of reaching maturity within three to five years (Zhou, 1995). Their growth dynamics (fast growth and easy propagation) and rooting system enable their ability to control soil erosion and land degradation due to their soil binding Properties, hence be employed for afforestation, soil conservation and social forestry programmes (Gaur, 1987).

One of the best features of bamboo is its ability to sequester more carbon dioxide than just about any other plant within the first two years after establishment (INBAR, 2010). Typically, bamboo can absorb 12 tons per hectare and releases 35% more oxygen than other plants of the same size and area (INBAR, 2010). As indicated in Zehui's (2001) report, due to bamboo's high nitrogen consumption, it helps mitigate water pollution, as it takes up and transforms nutrient wastes when planted alongside manufacturing zones, intensive livestock farming areas, and sewage treatment facilities. Currently, land degradation has assumed international dimensions due to detrimental impacts it exerts on agriculture and forest lands. According to Bai *et al.* (2008) land degradation is defined as the long-term loss of ecosystem function and productivity caused by disturbances from which the land cannot recover unaided. It is the cumulative result of derivative processes regulated by natural and anthropogenic factors. Pollution of soil from crude oil is a common phenomenon in the Niger Delta region of Nigeria and this event has been very disastrous to the sustainability of the environment. Oil spill is a major soil contaminants and it is a very common event in Nigeria and the world at large. Crude oil contaminated soil can be cleaned up using physico-chemical, thermal and biological treatment methods. The first two methods which include encapsulation, solidification, stabilization, electrokinetics, vitrification, vapour extraction, and soil washing and flushing) have been reported to be expensive, grossly inadequate and ineffective, and may result in further contamination consequently having detrimental effects on the environments. Because of the potential to produce secondary pollution, the increasing controversy about the use of these techniques poses long term threat to the environment. This led to the introduction of biological methods which involves the use of biological or natural agents in breaking down of compounds released as a result of pollution in the soil. Bamboo is one of the species reputed for its extraordinary performance on poor or deficient soils hence it is a suitable candidate species for reclamation of degraded lands. It can be grown under diverse climatic and environmental conditions such as arid, swamps, windy and sloppy lands. This enables it to be used as a pioneer plant in restoring degraded land. The inherent adaptability, as well as the nutrient and water conservation capabilities of bamboo make it a fore-runner plant in the eco-restoration of degraded land. According to Sharma (1980), there are about 75 genera and 1,250 species worldwide and mostly confined to South- East Asia. Fifteen genera and 43 species of bamboo are native to Africa. *Bambusa vulgaris* is one of the important sympodial bamboos widely distributed in Southwest China and elsewhere in the tropics (INBAR, 2006). Biological approach (bioremediation) thus encourages the establishment/reestablishment of plants on polluted soils. It is an environmentally friendly approach because it is achieved via natural processes. Phytoremediation, a cost effective technique is a potential alternative to some of the expensive clean-up technique. This study therefore provide information on the survival and tolerance levels of the *Bambusa vulgaris* in soil contaminated crude oil.

II. MATERIALS AND METHODOLOGY

Study area

This research was carried out at the Forestry Research Institute of Nigeria (FRIN) outstation in Onne, Eleme Local Government Area of Rivers State, Nigeria (See Figure 1). The study area lies between latitudes 4º 43'N and 4º 43' 56''N and longitudes 7°18' E and 7° 18' 55''E. The study location is found in the sub-equatorial region. It has a tropical climate with a mean temperature of 30^0C a relative humidity of 80% - 100%, and a mean yearly rainfall of about 2,300mm. The rainfall is always high but varies with seasons (Mmom and Fred-Nwagwu, 2013). The type of vegetation found in the study area is tropical rainforest. The vegetation represents the most luxuriant, the most complex, and the most diverse terrestrial ecosystem the world has known (Ojeh, 2011).

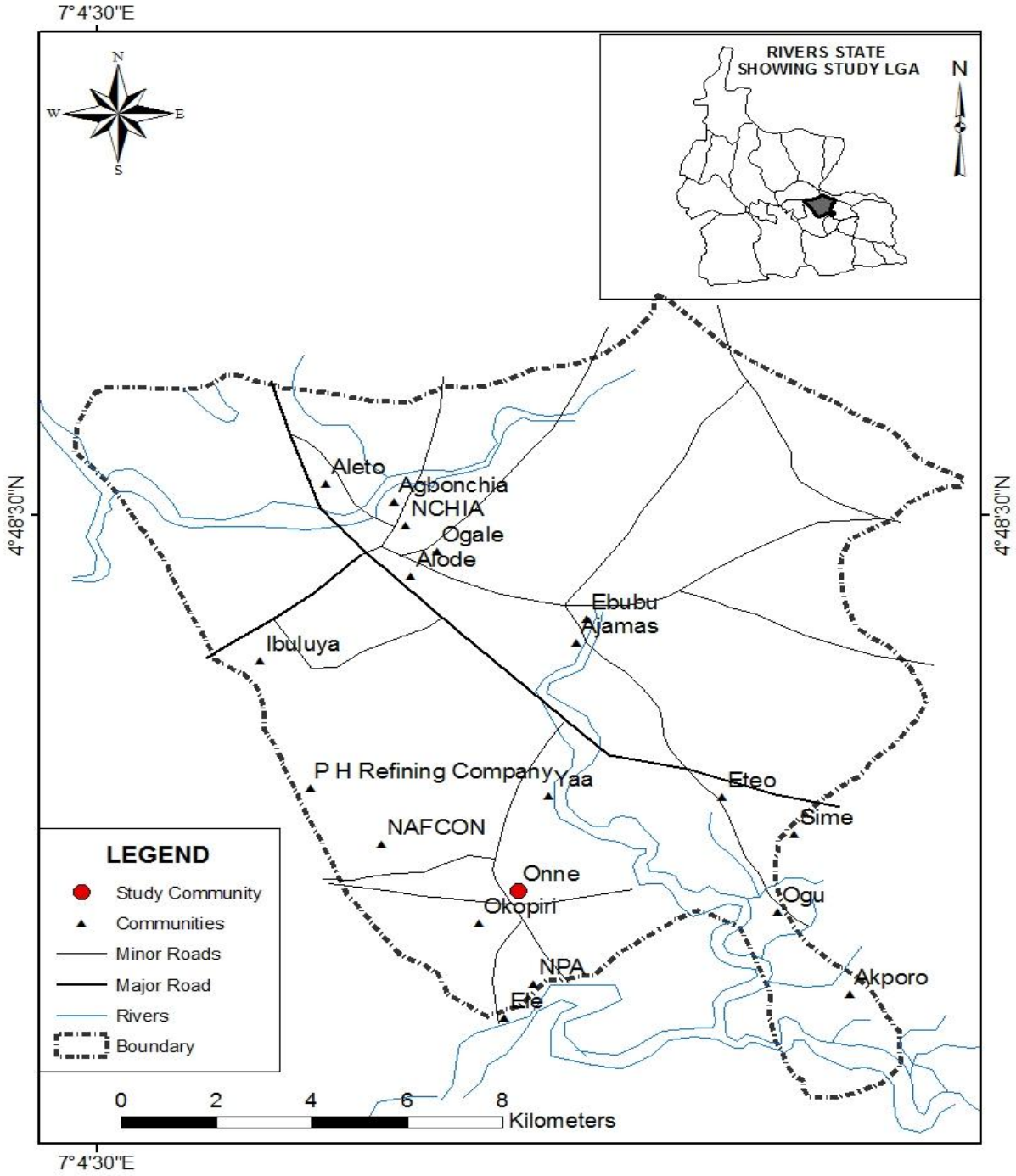


Figure 1: Eleme Local Government Area showing Study Area (Onne)

Seedling Collection and Selected sites

Bambusa vulgaris was sourced within the University of Port Harcourt Campus, Port Harcourt, Rivers State, Nigeria



Plate 1A: Sourcing of Bambusa *vulgaris* from study area environment



Plate 1B: Sourcing of *Bambusa vulgaris* from study area environment

Sourced *Bambusa vulgaris* was vegetatively propagated for 4 months in an Undisturbed/unpolluted fertile land covered with thick black top soils used for productive farming activities within the study area.

Site preparation

The site selected for the study is located in the Forestry Research Institute of Nigeria (FRIN) outstation in Onne, Rivers State, Nigeria (See figure 1) which contains all the necessary macro and micro plants nutrients in sufficient quantities to support vigorous plants growth. The soil has good structure which promotes aeration, root penetration, water percolation with no signs of erosion



Plate 2: A - Undisturbed/Unpolluted Soil where B*ambusa vulgaris was cultivated*



Plate 2: B - Undisturbed/Unpolluted Soil where B*ambusa vulgaris was cultivated*



Plate 3: A - Soil preparation for propagation of B*ambusa vulgaris*



Plate 3: B - Ridge preparation for propagation of B*ambusa vulgaris*



Plate 4: A - Cultivation of B*ambusa vulgaris in the Study Area*



Plate 4: B - Cultivated B*ambusa vulgaris in the Study Area*



Plate 5: A - Watering of Cultivated B*ambusa vulgaris in the Study Area*



Plate 5: B - Watering of Cultivated B*ambusa vulgaris in the Study Area*

The cultivation was vegetatively propagated primarily because Species like B*ambusa vulgaris* flowers rarely and do not produce seeds making propagation absolutely dependent on vegetative means (Naithani and Biswas, 1992; Koshy and Pushpagadan, 1997 and Banik, 2000) implying that conventionally, bamboos have been propagated and cultivated by vegetative means. Culm cuttings are preferred as planting materials for nursery rising of large sized and thick walled bamboo species by vegetative means.

Transplanting of Germinated B*ambusa vulgaris*

Topsoil were sieved and filled into poly bags and weighed crude oil were gradually added into the clean soil in a mechanical mixer to obtain homogeneous soil/pollutant mixture at different ratios/level (25 mL, 50 mL and 75 mL) see plate 6 &7



Plate 6: Extraction of Unpolluted Top soil



Plate 7: Weighing crude oil (Bonny Light) at different levels (0ml, 25ml, 50ml, 75ml) for soil contamination per kg of soil

Soil samples were polluted with crude oil, Bonny Light; at different levels of contamination (0ml, 25ml, 50ml, 75ml) per kg of soil and was thoroughly mixed before filling in poly bags
Forest topsoil were collected and sieved with a 2 mm sieve to remove debris and large stones. Uncontaminated soil, 0 mL served as control. Soil sample, 2 kg per treatment was filled into 20cm by 15 cm polythene pots see plate 8.



Plate 8: Soil sample treatment filled into polythene pots

Four months old uniformly growing seedlings of *Bambusa vulgaris*, were transplanted into polythene pots containing the soil treatments see plate 9& 10.



Plate 9: Uniformly growing seedlings of *Bambusa vulgaris*, transplanted into polythene pots containing the soil treatments



Plate 10: One months old uniformly growing seedlings of *Bambusa vulgaris*, were transplanted into polythene pots containing the soil treatments



Plate 11: Two months old uniformly growing seedlings of *Bambusa vulgaris*, were transplanted into polythene pots containing the soil treatments



Plate 12: Three months old uniformly growing seedlings of *Bambusa vulgaris*, were transplanted into polythene pots containing the soil treatments



Plate 13: Four months old uniformly growing seedlings of *Bambusa vulgaris*, were transplanted into polythene pots containing the soil treatments

The seedlings were watered daily according to the water holding capacity of the pots and monitored for tolerance and survival rate. Survival rate (*S*) - was calculated using the equation below:

Survival rate (*S* %.) $S = \frac{n}{N} \times 100$

Where

n = number of survived plants

N = number of total plants cultivated

Tolerance index = mean growth in treatment /mean growth before treatment x 100/1



Plate 14: Survived and dead Plant in polythene pots containing the soil treatments

III. RESULT AND DISCUSSION

The present investigations were conducted in the year 2021 at the Forestry Research Institute of Nigeria (FRIN) outstation in Onne, Rivers State, Nigeria. Survival was examined at two separate experiments, one without contamination of soil with crude oil and the other on crude oil contaminated soil.

B*ambusa vulgaris* Survival Rate after Planting (Vegetative Propagation)



Plate 15: B*ambusa vulgaris* planted at the ridges/sand beds

Table 1: Uncontaminated Soil condition and Survival Ration of Vegetative propagated B*ambusa vulgaris*

Sample Category	**Soil pH before Treatment**	**Soil Temperature before Treatment**	**Species survival Report**
Sample 1	6.1	26.5	Survived
Sample 2	6.2	26.5	Dead
Sample 3	6.2	26.5	Survived
Sample 4	6.0	26	Dead
Sample 5	6.0	26	Survived
Sample 6	6.1	26	Survived
Sample 7	6.2	27	Survived
Sample 8	6.2	27	Survived
Sample 9	6.3	27	Survived
Sample 10	6.1	27	Survived
Sample 11	6.1	27	Dead
Sample 12	6.1	26.5	Survived
Sample 13	6.3	27	Survived
Sample 14	6.2	27	Dead
Sample 15	6.2	27	Survived
Sample 16	6.2	27	Survived
Sample 17	6.2	27	Survived
Sample 18	6.2	27	Survived
Sample 19	6.2	26.5	Survived
Sample 20	6.2	26.5	Survived
Mean	6.1	26.7	

The cuttings were planted vertically at 10cm depth at a distance of 10cm in sand beds. Observations on sprouting was carried out and findings revealed that survival after sprouting which was calculated as Number of living tress (survived) / number of trees planted (Total cultivated) × 100 =16 / 20 × 100 / 1 = 80%. Hence survival after sprouting was recorded at 80 percent given the soil conditions (pH) before and after treatment as shown table 1.

Table 2: Contaminated Soil Condition of Vegetative propagated B*ambusa vulgaris*

Experiment Category	**Category**	**Soil pH condition after treatment**	**Soil Temperature after Treatment**
25ml	Sample A	4	26.5
	Sample B	4	26.5
	Sample C	4	26.5
50ml	Sample A	4	26
	Sample B	4	26
	Sample C	4	26
75ml	Sample A	4	27
	Sample B	4	27
	Sample C	4	27

Table 3: B*ambusa vulgaris* Survival Rate weeks before and after soil treatment and Planting

Experiment	Category	Before transplant (Height)	At transplant	2 weeks after transplant	4 weeks after transplant	6 weeks after transplant	Root weight
25ml	Sample A	4.5	4.5	4.5	4.5	4.5	1.88
	Sample B	4.5	4.5	4.5	4.5	4.5	141.7
	Sample C	4	4	4	4	4	30.6
50ml	Sample A	4	4	4	4	4	51.8

	Sample B	5.2	5.2	5.2	5.2	5.2	43.6
	Sample C	4.5	4.5	4.5	4.5	4.5	32.4
75ml	Sample A	2.9	2.9	2.9	2.9	2.9	154.4
	Sample B	4	4	4	4	4	87.2
	Sample C	5	5	5	5	5	92.5
0ml	Sample A	5.6	5.6	5.6	5.6	5.6	78.2
	Sample B	3.4	3.4	3.4	3.4	3.4	155.8
	Sample C	3.3	3.3	3.3	3.3	3.3	196.6

B*ambusa vulgaris* Survival Rate after soil treatment and Planting was measured at the Number of transplanted tree (B*ambusa vulgaris)* that survived weeks after treatment / Total number of transplanted tree (B*ambusa vulgaris)* = 9/13 × 100 = 63%

Hence, the survival rate for B*ambusa vulgaris* after transplant in a crude oil contaminated soil is 63 percent which implies a 17 percent lower survival rate for species in a contaminated environment. Therefore survival in contaminated soil is above 50 percent for *Bambusa vulgaris.*

There is no significant growth in the height of species sampled during the period of study across all transplanted sample.

Tolerance Index for Leaves after Treatment

Table 4: Leaf Tolerance of B*ambusa vulgaris* after soil treatment and Planting

Experiment	**Category**	**Leaves before transplant**	**Leaves at transplant**	**2 weeks after transplant**	**Tolerance level**	**4 weeks after transplant**	**Tolerance level**	**6 weeks after transplant**	**Tolerance level**	**Root weight**	**Tolerance level for Root**
25ml	Sample A	38	38	195	127/138* 100/1	120	166/138* 100/1	160	159/138* 100/1 **=115%**	1.88	134/144× 100/1 = **93%**
	Sample B	200	200	147		191		220		141.7	
	Sample C	177	177	38	**= 92%**	140	**= 108%**	97		30.6	
50ml	Sample A	169	169	94	123/198* 100/1 = **62%**	_	0/198*100/1 **=0%**	_	94/320*100/1 **=29%**	51.8	108.6/144× 100 **75 %**
	Sample B	301	301	169		_		_		43.6	
	Sample C	126	126	105		81		94		32.4	
75ml	Sample A	267	267	40	133/149* 100/1 **= 89%**	_	157/149* 100/1 **=69%**	_	0/320*100/1 **=0%**	154.4	111/144 × 100 **77 %**
	Sample B	136	136	196		157		_		87.2	
	Sample C	46	46	163		0		0		92.5	
Control sample											
0ml	Sample A	96	96	_	**Mean Leave count 166 therefore Tolerance Level =84%**	_	**Mean Leave count 225 =72%**	_	**Mean Leave count 320 =19%**	78.2	14/206 × 100 68% tolerance
	Sample B	62	62	83		137		_		155.8	
	Sample C	264	264	249 141		312		320		196.6	

From the study experiment, it was observed that tolerance level for the leaves increased from 92 percent to 108 percent for the species exposed to 25ml contaminated soil. And there was general decline from a mean tolerance level of 115, to 29 and finally 0 percent for 25ml, 50ml, and 75ml exposure to crude oil pollution respectively. Also findings revealed that the tolerance level for 50ml and 75ml exposure declined over the time of the study.



Plate 16: B*ambusa vulgaris* planted on soil treatment contaminated with crude oil

Cuttings taken out from the propagation bed were sufficiently rooted. The cuttings were washed carefully with clean water and then transplanted to polybags containing soil treatment and were immediately transferred to open nursery for data recording. Observations on sprouting was carried out and findings revealed sprouting of leaves in primary branch cuttings was found highest in the treatment of 25ml than the other treatment (50 & 75ml).

Tolerance Index for Branches after Treatment

Table 5: Branches Tolerance level for B*ambusa vulgaris* after soil treatment and Planting

Experiment	Category	Number of branches							
		Before Treatment	At treatment	2 weeks after treatment	Tolerance	4 weeks after treatment	Tolerance	6 weeks after treatment	Tolerance
25ml	Sample A	9	9	17	11/15 × 100 = **73%**		11/16 × 100 = **64%**		11/33 × 100 = **33%**
	Sample B	13	13	16		22			
	Sample C	10	10	13		27		33	
50ml	Sample A	21	21	21	14/15 × 100 = **93%**	_	13/14 × 100 **=93%**	_	14/14 × 100 = **100%**
	Sample B	13	13	13		0			
	Sample C	9	9	11		13		14	
75ml	Sample A	14	14	14	19/23 × 100 = **82%**		19/36× 100 = **52%**		19/0 × 100 = **0%**
	Sample B	26	39	39		36			
	Sample C	16	16	16		0		0	
0ml	Sample A	6	6	18	8/16 × 100 – **50%**	_	8/50 × 100 **16%**	_	8/40 × 100 **=20%**
	Sample B	5	5	11		10		_	
	Sample C	13	13	20		40		40	

Tolerance level for branches after treatment across the samples revealed that there is increase in the level of tolerance for 25ml, 50ml, 75ml and 0ml treatment from 2 to 4 weeks after treatment and thereafter a decline across all treatment except for 50ml this trend is associated with the level stability attained by the sample during the period of study.

Table 6: Sub Branches Tolerance level for B*ambusa vulgaris* after soil treatment and Planting

Experiment	Category	Number of branches							
		Before Treatment	At treatment	2 weeks after treatment	Tolerance	4 weeks after treatment	Tolerance	6 weeks after treatment	Tolerance
25ml	Sample A	1	1	22	18/15*100 =**83%**	_	13/15*100=**87 %**	_	16/15*100 =**106%**
	Sample B	27	27	27		24		_	
	Sample C	18	18	4		14		16	
50ml	Sample A	0	0	0	15/34*100 =**44%**		**6/34*100= 18%**	_	7/34*100 =**21%**
	Sample B	34	34	34		0		_	
	Sample C	70	70	11		17		20	
75ml	Sample A	36	36	36	15/14*100 =**107%**	_	**3/14*100 =21%**	_	**9/14*100 =64%**
	Sample B	1	1	3		4		_	
	Sample C	6	6	6		6		0	
0ml	**Control sample**						**25/17*100**		

					35/17*100 **=205%**		**=147%**		**20/17*100 =117%**
	Sample A	18	18	37		_		_	
	Sample B	8	8	17		23			
	Sample C	26	26	50		53		61	

Sub branches tolerance level was measured during the time of study. Findings reveal that there was also a decline in the sprouting of sub branches across all treatment during the period of 2 to 4 weeks after treatment then subsequent take off for all treatment as observed in an increase in the number of sub branches at the 6th week this implies that their is high survival potential for bambusa vulgaris in crude oil contaminated soils across the sample.

Table 7: Roots (Below Surface Biomass)

Show roots per week

Experiment	Category	2 weeks weight wet in kg	2 weeks dry weight in kg	Biomass	4weeks weight in kg (wet)	4weeks weight in kg (dry)	Biomass	6 weeks weight in kg (wet)	6weeks weight in kg (dry)	Biomass
25ml	Sample A	1.88	1.64	**12.7**	_	_		_	_	
	Sample B				141.7	50.5	**64**			
	Sample C							30.6	5.5	**82**
50ml	Sample A	51.8	13.7	**73.5**	_	_		_	_	
	Sample B				43.6	15.3	**65**			
	Sample C							32.4	11.4	**65**
75ml	Sample A	154.4	55.3	**64.1**	_	_		_	_	
	Sample B				87.2	28.7	**67**		-	
	Sample C							92.5	20.1	**78**
Control sample										
0ml	Sample A	78.2	34.5	**56**	_	_		_	_	
	Sample				155.8	68.8	**56**			
	Sample C							196.6	50.4	**74**

Root development as observed shows an increase in sub surface biomass across the samples in the treatment of 25ml contamination this is revealed given the biomass accumulation of 12.7 for week 1 to 2, 64 for week 3 and 4 and 82 for week 5 and 6. 50ml contamination shows a decline and subsequent stability for week 4 and 5 while 75ml contamination or treatment an increase in week 7 as shown in table 7. This implies survival and stability of bambusa vulgaris in crude oil contaminated soil.

Table 8: Above Surface Biomass

Experiment	Category	2weeks (leaves, stem and branches).			4weeks (leaves, stem and branches)			6weeks (leaves, stem and branches)		
		W	D	Biomes	W	D	Biomes	W	D	Biomes
25ml	Sample A	3.1	2.5	**19**						
	Sample B	_	_		9.9	13.3	**34**	_	_	
	Sample C	_	_		_	_		4.5	4.3	**4.4**
50ml	Sample A	11.8	8.5	**28**						
	Sample B									
	Sample C							8.0	6.8	**15**
75	Sample A	17.0	9.4	**45**						
	Sample B				13.9	9.6	**31**			
	Sample C									
Control sample										
0ml	Sample A	14.6	9.7	**34**						
	Sample B				8.3	5.9	**29**			
	Sample c							14.9	11.8	**21**

The analysis of above surface and sub surface biomass shows decline in surface biomass accumulation across all sample including the control indicating that the trend of decline are as the result of plant strategy to shed their leaves to enable them get nutrients to grow new leaves.

IV. CONCLUSION

In conclusion it was observed that survival of bambusa vulgaris was recorded at 80% given normal soil condition and 63% after treatment or in contaminated soils. The tolerance level was measured to be adequate with an increase from 92% to over 100% across samples treatment with very low pollutants level (25ml) while sample 50ml to 75ml exposure had a decline in their tolerance level but stabilized overtime as measured by surface and sub surface biomass level for branches and sub branches there is an increase in tolerance level across samples with 25ml exposure and a decline and subsequent increase for samples of 60ml to 75ml. Finally survival and tolerance of bambusa vulgaris as measured implies that they can adequately survive in crude oil contaminated soils hence can be seen to be of great economic value or potential for degraded soil. It is therefore recommended that the economic potential of bambusa vulgaris can be of advantage in crude oil contaminated wet lands of Niger Delta.

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