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RESEARCH ARTICLE

IMPACT OF ROAD CONSRUCTION DUST ON PLANTAIN VEGETATION IN PORT HARCOURT RIVERS STATE, NIGERIA

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ABSTRACT

In this study the impact of road construction dust were tested on some of the physicochemical parameters of plantain fluid. Samples of plantain fluid (juice) were taken to examine the characteristics of fluid content upon the influence of road construction dust on the plantain vegetation. These samples were collected on monthly basis over a 12-month period. Sampling of the data was conducted using the acceptable standard. The effect of road construction dust on pH, ion content (Fe^{2+}), total hardness, chloride, sulphate, acidity, alkalinity and total suspended solute was examined under two scenarios: dry and wet seasons.

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INTRODUCTION

Road otherwise called pathway has always been there ever since, as long as history can ever remember. Just as road is not new to mankind, so also is the eminent hazard associated with constructing roads. Road is a path established over land for the passage of vehicles, people and animals. Roads provide dependable pathways for moving people and goods from one place to another. There are different types of roads, there are roads otherwise called foot-path just for pedestrian, restricted from any kind of carriage, horse or whatsoever that is not human. There are also roads meant for all types of vehicles, carriage, trucks, etc, we also have flyovers, track roads, foot bridges, major bridge (peculiar to areas covered by water), high ways, etc. Although what is been considered here is the kind of road which were first constructed and developed in the 18th century. This road construction requires the creation of continuous right-of-way, overcoming geographic obstacles and having grades low enough to permit vehicles or foot travelers on the construction site. The process is often begun with the removal of earth and rock by digging or blasting, construction of embankments, bridges and tunnel, and removal of vegetations (this may involve deforestation) and followed by the laying of pavement materials. Pavements are designed for expected service life or design life. In some countries the standard design life is 40 years for new bitumen concrete pavement. Innovations of the time in such type of roads include water proof surface and better drainage systems. Modern engineers make use of a variety of materials and construction techniques to build roads that can handle the high volumes and stresses of modern automobiles and trucks traffic. Dust is considered to be any particle suspended within the atmosphere. Particles can range in size from as small as a few nanometers to 100 microns (µm) and can become airborne through the action of wind turbulence, by mechanical disturbance of fine materials or through the release of particulate rich gaseous emissions. Most mine originated dust is chemically inert, however there is the potential for more harmful and persistent particulate contamination to occur from mining ore containing or associated with certain products, such as asbestos, radioactive materials or heavy metals. Emissions from operating machinery not included as greenhouse gasses can also be classed as dust particulates. Dust is measured using a variety of methods, the most common being Total Suspended Particulates (TSP), which nominally measures up to 50µm, and PM10 or PM2.5 (particulate matter less than 10µm or 2.5µm in size, respectively). Deposited matter measures the mass of any particulate falling out of suspension expressed in mass per area per time, and is the least commonly used in determining dust concentrations (Environment Australia, 1998). In areas where the construction of roads of this magnitude is proposed an initial site inspection should be carried out to determine the most effective road construction design. There should be a review of environmental factors and an environmental management plan. This is to help reduce the negative effects that may erupt as a result of the equipment, machines, and materials used in the event of construction of these roads. Prominent amongst the toxic substance that is likely to affect humans and plants alike during construction of roads of this importance is dust, which is most likely to be stirred by movement of heavy duty trucks and machines used in the construction as well as the movement of workers on site.

Dust is a general name for minute soil particles with diameters less than 20 thousand (500 micrometer). The dust under consideration is that which is usually stirred within and around the construction site as a result of the movement of workers (human) and the various sophisticated equipments used for the construction. There is no doubt that these dust which is likely to be mixed with other chemicals and materials used in the event of road construction ranging from asphalt, asbestos, coal, ash, crushed concrete, waste and granulated blast furnace where necessary is certain to visit its effect, on the living organisms in and around the construction site. The impact of road construction dust has change soil density, soil, water content and temperature. The road construction dust has brought about many diseases in plants and living organism located around the areas where constructions of roads are being done. The dust from the road can cause harm to the workers and to animals including plants. The road construction dusts on living organisms and the resultant effect cannot be over-emphasized especially on vegetations around that areas which is been constructed. In view of the above, especially with the overwhelming importance of road in the development and transportation of man and goods there is need to identify the possible means of reducing the resultant effect of road construction dust, since we cannot prevent it completely.

The problems of construction dust around the environment may make up 33% of air pollutions. Road dust consists of deposition of vehicle exhaust and industrial exhaust, tire and brake wears, dust from pave roads or potholes and dust from construction. Dust keeps vegetation disturbed in all areas, and can induce potential soil erosion and the spread of weeds. Also road construction materials within the roadsides often reserved, leads to soil compaction which will damage plants and promotes weed invasion into an area. The cost of earthworks and re-vegetation to mitigate soil erosion can be very expensive. Roads and their associated traffic can affect an ecosystem by affecting its structure, its functioning, or both. Roads directly affect ecosystem structure if they cause changes in an organism's behavior, physiology, fecundity, or risk of death. Obvious examples are disturbances to birds and mammals caused by traffic noise (reviewed in Kaseloo and Tyson, 2004), deaths and injuries to animals caused by collisions, and deaths and injuries to roadside plants and animals caused by pollutants originating from the road or its associated traffic. Roads also directly affect ecosystem processes and thereby ecosystem functioning. For example, primary production is reduced by the extent to which the roadbed footprint eliminates vegetation. However, an off-setting increase in the productivity of roadside vegetation is often observed in deserts (reviewed in the next section). A more subtle effect on functioning is road dust settling on plant leaves where it causes a reduction in photosynthetic rates (Farmer, 1993). Road dust washed from plants or deposited directly on soil surfaces can affect soil chemistry (Grantz and others, 2003) and potentially could clog soil pores and reduce infiltration rates, thereby altering hydrological processes. An elevated roadbed acts as a windbreak and can result in unnatural accumulations of snow or leaf litter on the leeward side of the road (fig. 2). All roads act as firebreaks. Many researchers consider the most detrimental consequence of roads to be the reduction they cause in landscape connectivity (Andrews, 1990; Schonewald-Cox and Buechner, 1992), the structural attribute associated with the movement of organisms (including seeds and other propagules), materials (for example, surface water), or natural processes (for example, fire) across the landscape. As connectivity declines, so does the likelihood that abiotic processes and intra- and interspecific interactions in the landscape will continue to occur in their normal manner (Riley et al 2006). Loss of connectivity stems from fragmentation of landscape elements (habitats) and the associated reduction in size and increased isolation of remaining habitat fragments. Isolated habitat fragments are subject to loss of species (and thus declining biodiversity). Species are lost when fragmentation disconnects an isolated population from their original environment.

According to Anderson (2007) terrestrial hydrologic processes include precipitation, condensation, overland and stream flow, infiltration, evapotranspiration, subsurface percolation and flow, and the transport of solutes, nutrients, and particles by surface and subsurface flows. Roads can affect all of these processes, but direct effects on precipitation and condensation typically are minor and of little ecological importance in rural settings. Important ecological effects results from the capacity of roads to (1) modify local infiltration rates and thereby alter local surface-water and ground-water Supplies, (2) obstruct surface flows in natural watercourses and thereby alter the pattern of surface and subsurface flows, (3) collect and store or reroute runoff, and (4) obstruct shallow ground-water flows and thereby alter the pattern of surface and subsurface flows. Roads also alter evapotranspiration rates, but its ecological significance may be secondary to other effects. Forman and Alexander (1998) reviewed road effects on hydrology using studies drawn largely from mesic areas featuring hilly or mountainous terrain. The authors report effects extending 50100 m upslope and 200-1000 m down slope of the road, and sediment affecting streams more than 1 km downstream of the road. There is no mention of hydrological effects in low-relief landscapes nor does the review discuss the potential effect of fine particulates from unpaved roads (dust) on hydrology; for example, by clogging soil pores and thereby reducing infiltration capacity (Anderson 2007 and Ukpaka,2004,2005). The part of the road where compaction has made the ground surface impervious will generate more runoff than would the area in the absence of the road. Some accounts suggest that all roads are essentially impervious, and thus the type of road will not matter as much as its width in determining the amount of runoff generated. Road design manuals stress that water should be kept off of, out of, and away from roads—at least while subject to traffic. Roads intended for use in all weather conditions are indeed made as impervious as possible and to readily drain, in order to minimize water uptake and retention. Some infiltration likely occurs, albeit at a reduced rate, on unimproved roads (defined in table 2) and graded dirt roads intended for use solely when dry or frozen; the presence of rooted plants on a road surface indicates that some infiltration is possible. Regardless of infiltration rate, the area occupied by roads is an important determinant of their hydrological effect because it directly determines the amount of runoff generated (Anderson, 2007 and Ukpaka, 2006, 2010).

The runoff produced by a road surface may infiltrate into roadside soil and thereby alter the vegetation there. Johnson and others (1975) documented increased plant productivity along road margins in the Mojave Desert and attributed the increase to the extra water delivered to the margin by the road surface and, to a lesser extent, the road acting as a dam to collect runoff from upslope drainage systems. Standing crop biomass was enhanced along roads relative to off-road sites even when the bare road surface was included as part of the measured area. Similar findings were documented in semiarid New Mexico by Lightfoot and Whitford (1991). Roads with a ditch on the upslope side will also affect the amount of water flowing in natural channels by intercepting runoff originating on the upslope side of the road and rerouting it to a pond or a road-drainage structure (for example, a culvert or rolling (Anderson 2007) through which it can pass to a pond or channel on the down slope side of the road. Greater road density, wider roads, and longer contributing ditch lengths (*Anderson 2007*) each contribute to higher discharge levels, which in turn can produce greater erosive force ("stream power") and more sediment (detached soil particles) being generated and transported. Coe's (2004) review cites Wemple and others (1996) and Croke and Mockler (2001) as providing evidence that roads often facilitate gully development below road-drainage structures such as ditch relief culverts, water bars, or rolling dips. Jones and others (2000) produced a conceptual model of the effects of roads on hydrology in mesic, hilly terrain (Oregon's Cascade Mountains). They argued that roads are hydrological connected to the stream network and affect the manner in which incoming precipitation is routed through a basin to produce a flood. They suggested that roads can increase the frequency and intensity of flood peaks in natural channels and that road also affect the frequency and extent of debris flows. The latter, which typically originate as landslides on steep slopes, are considered to be a more significant form of disturbance in stream (Ukpaka, 2010a).

Meanwhile, mineral dust generated by both natural and anthropogenic processes has long been recognized as potential sources of diseases in humans. For example, industrial exposures to asbestos and silica have been recognized for decades as triggers for diseases, just as dusts containing elevated trace metals or pathogens. In spite of many years of research, numerous unanswered questions remain about the exact links between dusts and diseases. Unpaved roads deteriorate by degradation of crushed rocks generating fine-grained materials that is the major source of dust created by moving vehicles. Dow chemical company estimated in 1993 that the average untreated road loses 300 tons of aggregate per mile per year and, in a survey by better roads in the mid 1990s those who responded to the questionnaire listed dust control as their worst unpaved road maintenance problem. This research examines the impact of road construction on plantain vegetation located in and around the construction site in developing countries with Nigeria as a case study. The purpose of this research is to determine the amount/concentration of road construction dust around the area under construction and its impact/effect on the plantains (vegetations) in and around the construction site and its environs. Road dust is often considered only on as a nuisance or minor safety hazard by many practitioners. However, it has been shown that millions of tons of dust are generated on unsealed road networks every year. Although much of this dust falls back, regenerated by the next vehicles, studies have shown that at least a third of it's permanently lost in the form of deposits away from the road with losses increasing under crosswind conditions. Apart from the obvious consequence of reduced quality of life and increased safety hazard for road users, pedestrians, works and plantain vegetations located around the site. The loss of fines from the road deterioration of the riding quantity of the road required more frequent grader maintenance. Other consequences which are serious and often overlooked includes: it reduces agricultural and forestry yields that are attributed to retarded plant growth, with increase in insect activity, crop blemishing and reduce palatability of pasture and associated with yield in terms of dairy production. It also affects environmental consequences in terms of air and water pollution and associated health hazards are primarily linked to respiratory diseases.

Road construction differs markedly from the more customary subjects of life cycle. As the loadings caused by maintenance as well as construction are significant, a sufficiently long service life, of at least 40-50 years should be selected. The biological ecosystem impacted by this project consists by commercial and residential development. The projects will result in the loss of habitat to birds and other small organisms. However, given the highly developed nature of surrounding area, and this loss will result to poor vegetation on plants and environment. The high maintenance cost in terms of aggregate replacement, with increased public awareness of pollution problems and increased road users cost has lead highway agencies to have a renewed interest in dust control measures. The road dust is determined primarily by the amount of speed of traffic on the unpaved road. These conditions can be aggravated by long dry spells, softer road aggregates and initially excessive soil binder in the road surface. This project research work is to adopt purpose for the construction dust on vegetation. The problems of road dust have generated a lot of interest of late around the globe. Traffic on unpaved roads has been reported to produce about 35% of atmosphere pollution worldwide out of the 35% of atmosphere pollution 28% is from dust while 77% is from exhaust flames. Some unpaved.

MATERIALS AND METHOD

The test section on this construction site is being constructed with all types of materials and chemicals. But the research is being carried out with rent types of chemicals which is used to test for the plantain which is being affected most of which is not affected. The plantain is collected at a 'stance from each other. The materials that was used for the project is a plantain farm which s planted around the area where the construction is going on. There were several or different reactions that was observed during the work. The plantains that was used for analysis was done on different season. And the samples collected from each plantain have different colors and some of the samples have dust inside. The dusts on the plantain where reddish brown on the construction site. All the plants and human being (workers) around the area are all covered with dust. The materials used were ten (10) samples of plantain fluid, field tape, beakers, Pipette; Measuring Cylinders retort stand, oven, filter paper and electronic weight balance. While the chemicals used for the tests are potassium dichromate, sliver nitrate, potassium, calcium, barium chloride, hydrochloric acid, ammonia buffer, erichrom black indicator, sodium hydroxide, phenoiphiolene, methyl orange. The materials with the chemicals were all that was needed for the project and the research. This were subjected to thorough analysis, to determine the following parameters they are as follows Ph values, total hardness, level of acidic, total suspended solid TSS,total dissolved solid TDS

RESULTS AND DISCUSSION

Table 1 the result of the research works are presented in Tables and Figures Experimental Determination of pH value Readings for Dry Season with Buffer Solution of 6.61

Table 1. Experimental analysis of P^H values for different sample location

Samples	Readings
A	5.87
B	5.86
C	5.76

Table 2. Experimental analysis on evaluation of ion content (Fe^{2+}) values

	SAMPLE A	SAMPLE B	SAMPLE C
FINAL	0.94	1.7	2.8
INITIAL	0	0.94	1.7
TOTAL	0.94	0.76	1.1

Table 3. Experimental analysis on Evaluation of Total hydrocarbon (TH) values

	SAMPLE D	SAMPLE E
FINAL	3.54	4.38
INITIAL	3.2	3.54
TOTAL	0.34	0.84

Table 4. Experimental analysis on Evaluation of chloride values

	SAMPLE A	SAMPLE B
FINAL	1.14	2.72
INITIAL	0	1.14
TOTAL	1.14	1.58

Table 5. Experimental analysis on Evaluation of Sulphate SO_4 values

	SAMPLE A	SAMPLE B	SAMPLE C
FINAL	0.9466	1.1396	1.034
INITIAL	0.7487	0.8491	0.7016
TOTAL	0.1979	0.2905	0.3324

Table 6. Experimental analysis on Evaluation of Sulphate SO_4 values

	SAMPLE D	SAMPLE E
FINAL	0.8012	0.7350
INITIAL	0.6845	0.6266
TOTAL	0.1167	0.1084

Table 6. Experimental analysis on Evaluation of acidity values for dry season

	SAMPLE A	SAMPLE B	SAMPLE C
FINAL	0.08	1.14	1.52
INITIAL	0.00	0.08	1.14
TOTAL	0.08	106	0.38

Table 7 Experimental analysis on Evaluation of acidity values for wet season

	SAMPLE D	SAMPLE E
FINAL	1.05	2.66
INITIAL	0.00	1.05
TOTAL	1.05	1.61

Table 8. Experimental analysis on **Evaluation of Alkalinity**

	SAMPLE A	SAMPLE B	SAMPLE C
FINAL	1.18	1.98	2.20
INITIAL	0.00	1.18	1.98
TOTAL	1.18	0.8	0.22

Table 9. Results of Total Suspended Solute (TSS) values

	SAMPLE 0	SAMPLE E
FINAL	1.02	2.02
INITIAL	0.00	1.02
TOTAL	0.02	1.00

Table 10 Experimental analysis on Evaluation of Total Dissolved Solute (TDS) values

	SAMPLE A	SAMPLE B	SAMPLE C
FINAL	410	538	564
INITIAL	615	807	846

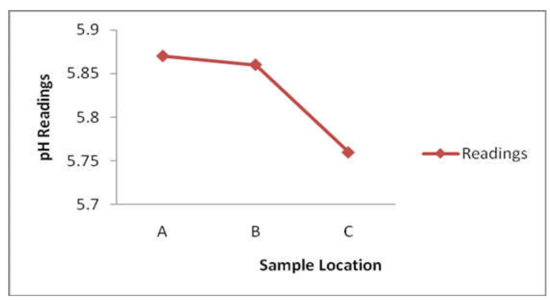


Fig.1. Sample 1Graph of pH reading: values against sample location

From Figure1 it is seen that increase in sample location points yielded increase in pH values, the above represent the pH Value reading for samples A-C which is the fluid samples of three (3) different plantain trees within particular plantain vegetation taken during the dry season. The above values deduced using buffer solution of 6.61 as reagent, with the aid of a beaker and model 2030 pH meter.

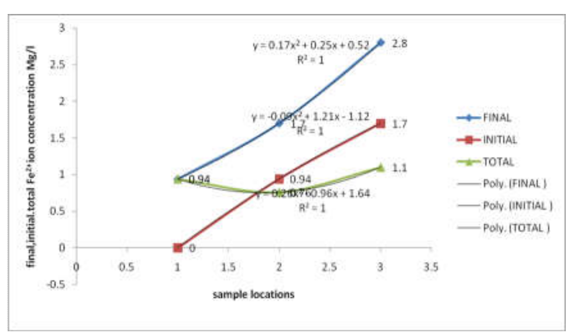


Fig. 2. Sample Graph of ion content against sample location

Figure illustrates the total ion (Fe2+) concentration at different sample locations. The variation in the total ion (Fe2+) concentration can be attributed to the variation in sample location distance.

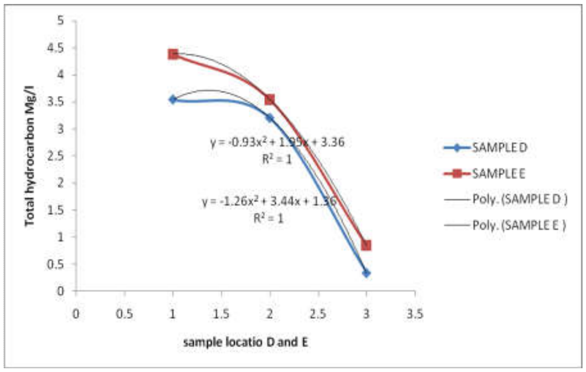


Fig. 3. Sample Graph of Total hydrocarbon concentration against sample location for D and E

The total hydrocarbon concentration decreases with increase in sample location (distance) from the reference point as shown in Figure 3. The variation in the total hydrocarbon concentration can be attributed to the variation in the sample location (distance). The polynomial expressions of the best fit line equation are shown in Figure 3.

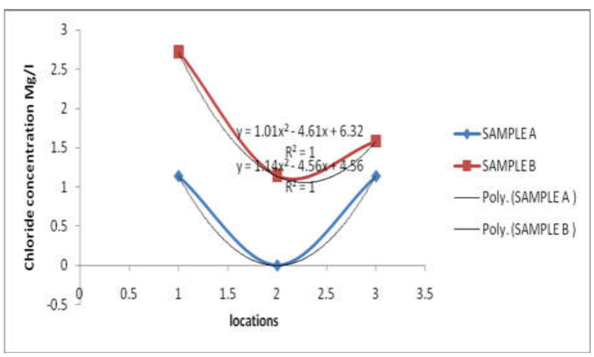


Fig. 4. Graph of chloride concentration against sample location

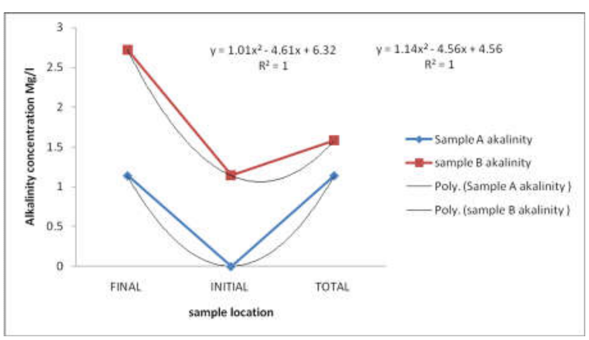


Fig. 5. Graph of Alkalinity Concentration against sample location for sample A and B

A decrease in alkalinity was observed with respect to final initial and total sample location values. A polynomial expression was obtained using the best fit line as shown in figure 5. Similarly, the square root (R^2) value was also evaluated as presented in the figure.

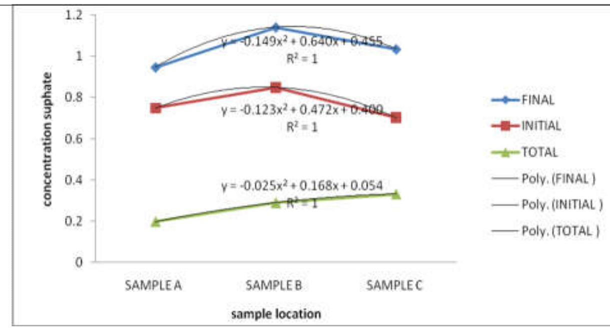


Fig. 6. Graph of sulphate concentration against sample location for dry season

From figure 6, the polynomial expression for sample A, B, and C was illustrated with respect to final and total, and the root of the equation was established as well as presented.

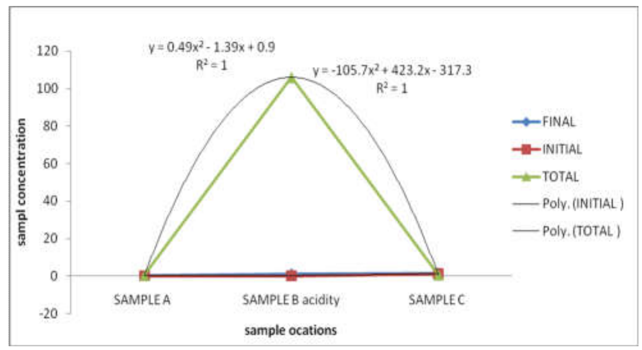


Fig. 7. Graph of acidity concentration against sample location for wet season

The polynomial expression of the curve was established as presented in figure 7, thus $y=0.49x^2-1.39x+0.9$ with $R^2=1$ and $y=-105.7+423.2x-317.3$ with R^2 for final initial and total sample of A, B, and C.

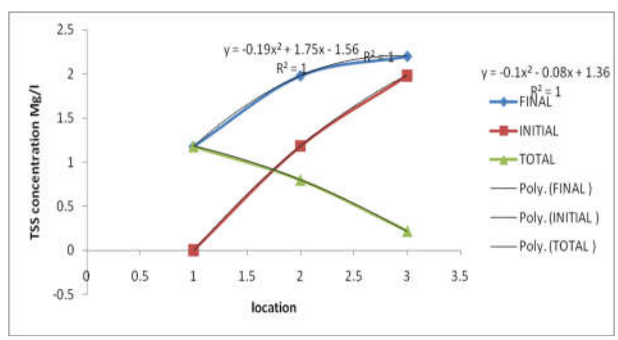
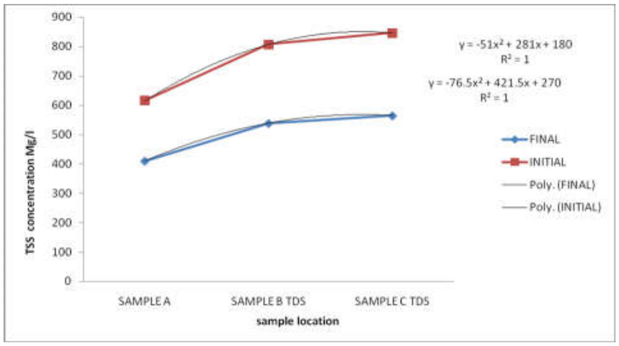


Fig. 8. Graph of total suspended solute (TSS) concentration against sample location

From Figure 8 it illustrates TSS concentration against sample location (distance) with increase and decrease in the TSS concentration with respect to sample location (distance) from the reference. Figure 9 illustrate the TSS concentration against sample location. The results obtained as shown in figure presented in TSS concentration with increase in sample location 9distance0 from reverence to the sample of A, B, and C. The data analysis that was carried out in the course of this experiment was to evaluate the consequential effect of road construction dust on particular plantain vegetation located along East west Road in Port Harcourt where there is an ongoing road construction project at the time of this work.



. 9: Graph of total dissolved solute against sample location

The data analyzed was plantain fluid (juice from plantain tree), this was used in place of the deposited dust which was to be found on the leaves of the various tested plantain trees within the test area. At the end of the fluid extraction from the various plantain trees libeled and referred to as SAMPLE A, B, C, D, and E respectively the said samples were taken to the laboratory where they were individually tested for the following;(i) P' value (ii) Ion content (Fe2) (iii) Total hardness(TH) (iv) Chloride (v) Sulphate (vi) Acidity (vii) Alkalinity (viii) Total suspended solute (TSS) (ix) Total dissolved solute (TDS). Analysis on Road Dust: The Road dust that was to be used on this experiment was supposed to be gathered from the leaves of plantain trees in any plantain vegetation located within a road construction site. Although in view of the fact that most of the plantain leaves were scanty (with little or no dust) it was resolved to use as an alternative the fluid extracted from the said plantain trees in the same vegetation. This decision was influenced by the fact that the supposed dust analysis was to cover for two distinct season of the year (dry and wet season respectively) and it would be most difficult to gather any dust during the wet season.

Hence in place of road dust deposited on plantain leaves the plantain fluid (juice) was extracted from each of the five(5) selected plantain trees to make up the five(5) samples (A, B, C, D, AND E) collected during the dry season. Same procedure was adopted also during the wet/raining season. It was observed that the amount of dust generated from cars and other equipments used in the course of road construction is more during the dry season because there were little or no dust during the wet/Raining season when the rain has fallen on the plantains and washed out large quantity of the deposited dust The result of this is that from the analysis the effect of dust oh the plantain trees during the dry season are more than its effect during the wet/raining season. The result of the analysis carried out on the effect of the road construction dust on the plantain vegetation is indeed very captivating. The results are of two (2) types (categories) as discussed early on the project. The following results and parameters were carried out and calculated. Thus the evaluated parameter include pH Value, Total Hardness, Chloride Test, Sulphate, Alkalinity, Acidity, Total dissolved solute and Total suspended solute. This analysis was carried out to know the extent of damage the road construction c unleash on plantain vegetation located within an ongoing road n site as to proffer solutions and or remedy. The various tests and respective outcome is represented in one table or the other with the final analysis presented in a bigger table labeled Table 1 for dry season and table 2 for dry season respectively. Note that apart from the analysis for samples D & E that was carried out, laboratory analysis for samples A, B, & C for dry season was done dry concurrently the hence the use of different tables to represent samples D & E. although each of the analysis for wet season is represented with a single table since laboratory analysis for the five samples was concurrent.

Conclusion

The whole essence of this work is to evaluate and ascertain the effect/impact of road construction dust on plantain vegetations. The inspection of the site where the samples collected shows that the dust is on the high side during dry season, unlike the wet (rainy) season when everywhere is usually covered by mud and marsh. This study has proven that the impact of road construction dust on plantain vegetation is very harmful to the plants (plantain) and the humans that consume the plantains as food. Dust does a lot of damage to plantains and other living organism living around any site where road construction is ongoing. This was deduced from testing the samples (plantain fluid) for the following test parameters and ions; P value, Ion content *($Fe^{2+)}$* Total hardness (TH), Chloride, Sulphate, Acidity, Alkalinity, Total suspended solute (TSS), Total dissolved solute (TDS).From the various laboratory test carried out it is very clear that even though the effect is less during the rainy (wet) season the negative impact of these dust is very severe both in dry and wet seasons. The above laboratory test carried out on the various parameters have show how dangerous dust can be to the plantains, these are represented on the various Tables and graphs (Figures) as it appears above. Based on this research the following conclusions on negative impact from dust on plantain have been reached and they are as follows:' That the dust impairs normal growth of the affected planted trees.' that the affected plantain trees usually have flowers (leaves) coloring differently from the normal green color. That the dust delays the plantain trees in the production of fruits and also brings about reduction in the iron content and protein in the affected plantains. The plantain trees once affected by road construction dust finds difficulty in regeneration and reading as it is expected of a normal plantain vegetation. The result of this research has given rise to the following recommendations indicating the various methods and roles that can be played by both the construction companies and those in authority to reduce the negative impact of road construction dust in our society. It is recommended that those in authority, (the government) both at the state and federal level should ensure that there is in existence an enforceable legislation (Act) that insist on paying full compensation to the respective owners of plantain vegetation in and around anywhere, there is an ongoing road construction and to see to the relocation of such vegetation, before the commencement construction of such road on the proposed site.

It is further recommended that the construction companies should come-up with what to do before, during and after any road construction to ensure that the environment is not heavily affected in the course of the construction. One of such methods/roles can be the provision of a Health Safety Environment (HSE) policy that would ensure the application of certain dust control methods, such as the use of chemical dust control i.e. calcium chloride and other methods including spraying of water before commencement of work, and to ensure that the workers are also properly provided with gargets to cover their nose as to prevent massive intake of dust,

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