Fjrs.futa.edu.ng
FUTA Journal of Research in Sciences
ISSN: 2315 – 8239 (Print); E-ISSN: 2489 - 0413

FUTA Journal of Research in Sciences, Vol. 13 (1) 2017:158-167

HARMATTAN DUST MASS OVER ILORIN A GUINEA SAVANNA AFRICAN CITY

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ABSTRACT
Harmattan season in Nigeria is the period during which dust cover the atmosphere as a result of aerosol particles being transported from the Sahara region of Africa. Samples of these dust particles were collected over Ilorin (8° 32' N, 4° 34' E) guinea Sahara *region of West Africa using clean Petri-dishes which were exposed on the ground level and an elevated platform of five meters above the ground level in twelve different locations within Ilorin metropolis including the University of Ilorin. Some of the dishes were exposed to collect dust particles for a period of eight weeks between January and March while some other sets were left over a period of three months (January-March). The samples were stored in desiccators prior to analysis in order to avoid contamination which could influence the results. It was observed that more and heavier dust samples were collected on the ground levels which are of average size of (9.70g/m^2)compared to those collected at an elevation which are of average size of (7.10g/m^2). At a particular location, Olunlade ($8^0$44'764''N, $4^0$58'398''E) area of Ilorin, the volume of dust collected was higher than that of all other locations. In conclusion, the weight of harmattan in Ilorin is found to be lower in mass as compared with locations further north of Nigeria.*
Keywords: Harmattan, Dust Particle, weight, location Olunlade and Ilorin.

INTRODUCTION
The period of harmattan season in Nigeria is always associated with dust laden atmosphere called harmattan dust haze. Minto, (1966) describes harmattan as a strong easterly or north-easterly wind experienced in West Africa blowing direct from the sahara. These dust particles are small discrete mass of solid earth matter which are very fine and can remain suspended in the air for a long period of time. The presence of this dust is indicated by a dusty atmosphere which reduces visibility to less than 1000m as reported by Kalu (1979). Since the last few decades, the enormous spread of Saharan dust outbreaks can be witnessed usingsatellite imagery; hence the identification of the Faya Largeau, Chad, as the key source area ofnorth-west African Aeolian dust (McTainsh and Walker, 1982). This was confirmed using satellite images (Prospero *et al.*, 2002, Stuut *et al*, 2005).

These harmattan dust particles are transported downward from the source region in the form of a plume by the prevailing winds. Aina (1972) reported that on the average, it takes about twenty-four hours to reach the Northern part of Nigeria. This dry wind transports and deposits the Saharan dust over the entire region and extends as far as to the Gulf of Guinea. The dust plumes predominantly originate from the Bodele depression in the Chad Basin (Bertrand *et al*., 1979) and accounts for the dust particles deposited over the region.

The harmattan is influenced largely by the variability in the incursion of air pressure into the Saharan region. This fact has been pointed out by

various meteorological observers (Samway, 1975; Adedokun *et al*, 1989). High pressure to the north of Bodele Depressions intensifies the northeasterly trade winds leading to an increase entrainment of dust in the Bodele Depression (Adedokun *et al.*, 1988; Schwanghart and Schutt, 2007).

Falaiye (2008) reported that the aerosol optical thickness (AOT) which is a measure of the amount and size of dust particles present in the atmosphere during the harmattan months can be extremely high and ranges from 1.0 to 4.0. This contributes significantly to the attenuation of incoming solar radiation, thereby leading to reduced visibility (Pinker *et al.*, 1994). The harmattan spells are often accompanied by droplets in the evening and early morning temperatures associated with an oscillation of the axis of the subtropical high (Adedokun, 1978; Adedayo, 1980; Adedokun *et al.*, 1989). The dust spell may last up to three to five days, but on occasions of advection of dust from a line rather than a point source, the persistence may be longer than ten days (Adedayo, 1980; Adedokun *et al*, 1989). Hence, there exists the need to further quantify the amount/mass of dust particles deposited at the site. Nwadiogbu *et al.*, (2013) found Residential (RS) 28.165g/m^2 and 1.76g/m^{2}at average of 14.96g/m^2 and Commercial Area (CM) 39.37g/m^{2}and 2.461g/m^2 at average of 20.92g/m^2 for Zaria, with a total average dust value as 17.94g/m^{2}while Dimari *et al.*, (2008) found that Maiduguri for the year 2006/2007 have average dust value as 26g/m^2.

STUDY DESCRIPTION

This study intends to know the variation in the quantity and mass of deposition on the ground and at an elevation, and the average mass of harmattan dust particles deposited over Ilorin (8°32' *N*, 4°34' *E*) a sub-Sahara Africa, located at the upper tip of the guinea-savanna zone with a mean monthly average temperature of about 30.2^oC and average annual rainfall of about 873 *mm* as reported by Olaniran, (1991a,b).

Harmattan dust production in the Chad Basin was estimated to be up to 6.3×10^8 and 7.1 $\times$ 10^8 t/yr in 1981 and 1982 respectively (McTanish and Walker, 1982). In Sahelian and Saharan Africa, harmattan dust transport is accomplished by the north-easterly trade winds (Schwarghart, 2007). The effect of this dust is seriously felt on the environment (Falaiye, 2008; Adefolalu, 1984; Adedokun *et al.*, 1989). Health cases such as, cough, catarrh and respiratory related diseases, are mostly reported in the hospitals during the harmattan period (Carlson and Prospero, 1972; Shutz, 1980).

Table 1.0: Annual average regional soil dust emission contributions estimate

Region	Annual average Contribution to Global Dust Emission (%)
Sahara	50.7
Central Asia	16.0
Australia	14.5
North America	5.2
East Asia	4.9
Arabia	4.2

Source: Miller *et al*., 2004.

SITE LOCATION

Ilorin (8°32' N, 4°34' E), a guinea savanna African central state of Nigeria in West Africa, is in the transition zone between the deciduous forest of the south and the savannah of the north. Precisely, Ilorin is located at the upper tip of the guinea-savannah zone with a mean monthly average temperature of about 30.2º C and average annual rainfall of about 873 mm (Olaniran, 1991a,b).

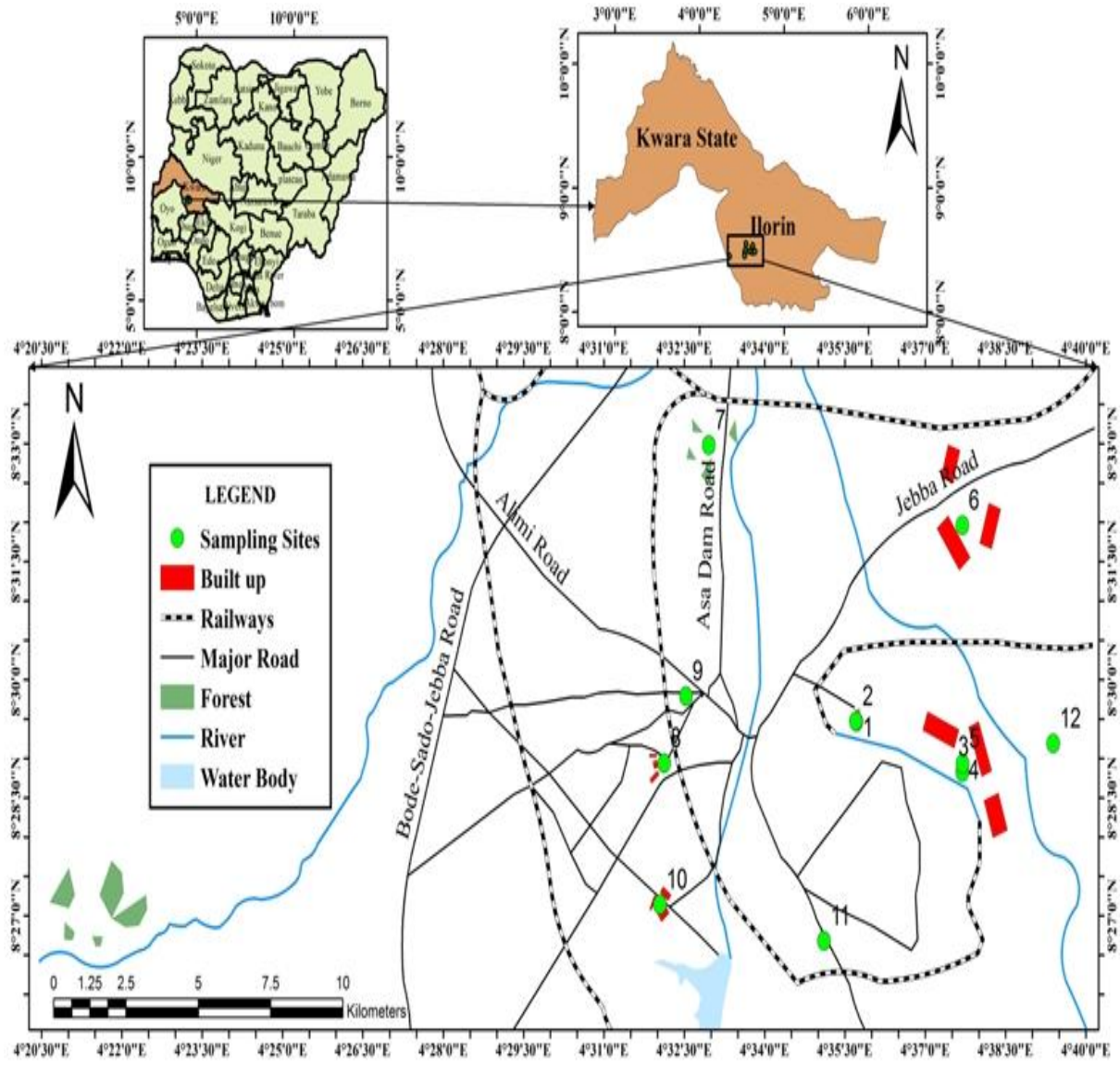

Fig. 1.0: Map of Ilorin showing the sampling site.

Table 2.0: Geographical Characteristics of the Ilorin

Location Number	Location	Latitude (^{0}N)	Longitude (^{0}E)	Altitude (m)	Average Annual Rainfall(mm)	Climatic classification	Vegetation
1	Block 4 Unilorin	8.4911	4.5952	303.89	1217	Tropical hinterland	Guinea Savanna
2	Works Department Unilorin	8.4912	4.5951	303.28	✓	✓	✓
3	Oke-Odo	8.4805	4.6282	284.53	✓	✓	✓
4	Tanke Tipper Garage	8.4804	4.6282	281.94	✓	✓	✓
5	GRA	8.4822	4.6283	285.92	✓	✓	✓
6	Zango	8.5327	4.6282	291.89	✓	✓	✓
7	Taiwo	8.5497	4.5493	303.89	✓	✓	✓
8	Saw mill	8.4823	4.5354	302.98	✓	✓	✓
9	Gari-Alimi	8.4965	4.5422	303.78	✓	✓	✓
10	Oja-Oba	8.4524	4.5341	252.98	✓	✓	✓
11	Olunlade	8.4447	4.5852	333.00	✓	✓	✓
12	Post Office	8.4865	4.6565	300.56	✓	✓	✓

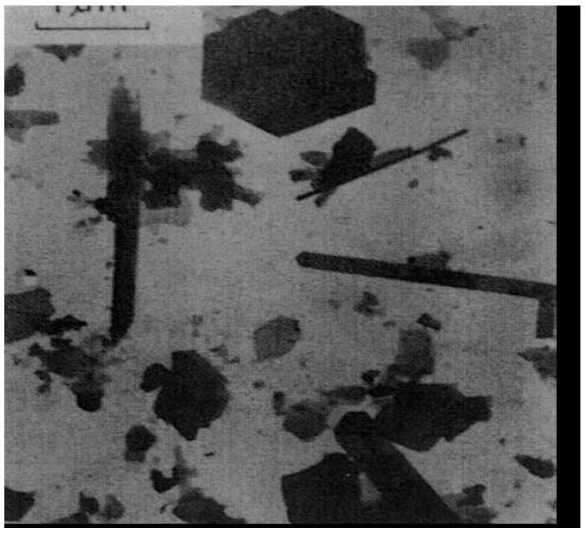

Fig 2.0: Electron photograph of dust particles (Alexander and Kokhanovsky 2008).

METHODOLOGY

Clean Petri-dishes of known masses (weighed using weighing machine) were exposed on the ground level (half a meter above ground) and an elevated platform (five meters) above the ground level in twelve different locations around Ilorin metropolis including the University of Ilorin campus. The locations were chosen randomly to cover Ilorin. Some of the dishes were exposed to collect dust particles for a period of eight weeks and some over a period of two months (January-March). The month January – March are usually periods of heavy harmattan. The samples were stored in desiccators prior to analysis in order to avoid contamination which could influence the results. During the collection process, caution such as keeping the sample containers away from public roads and high ways were taken in order to minimize the effect of saltation due to local dust plumes raised by vehicular or human movement which are local in source and not due to the north-easterly wind incursion. This experiment procedure follows after Falaiye *et al*., 2013. Where, Petri-dishes were also exposed to collect dust particles in order to study the mineralogical and chemical properties in Ilorin. The samples collected (i.e. dishes with sample) were weighed on a weighing Electronic Balance machine of Golden mettle USA, Model 20002 with Max 2000g, d:0.01g, e:0.1g located at the Department of Chemistry University of Ilorin. The machine was used to determine the mass of the samples only. Meanwhile, the mass of empty dishes were subtracted from the dishes with sample. This was used to determine the actual mass of the sample since the dishes without sample had been measured. The locations were selected randomly based on the vehicular traffic, population and free exposure of the environments.

RESULTS AND DISCUSSION

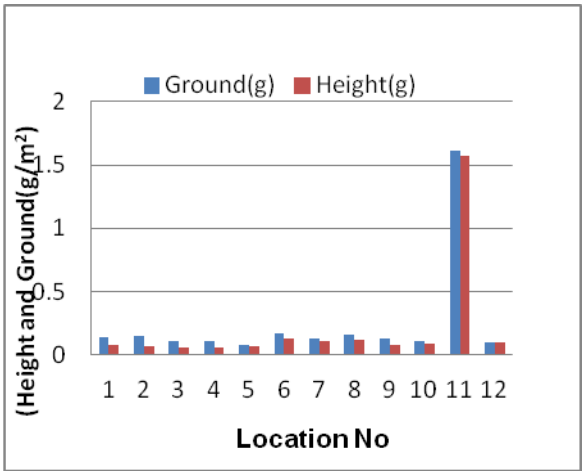

Fig 3.0: Mass of the first week

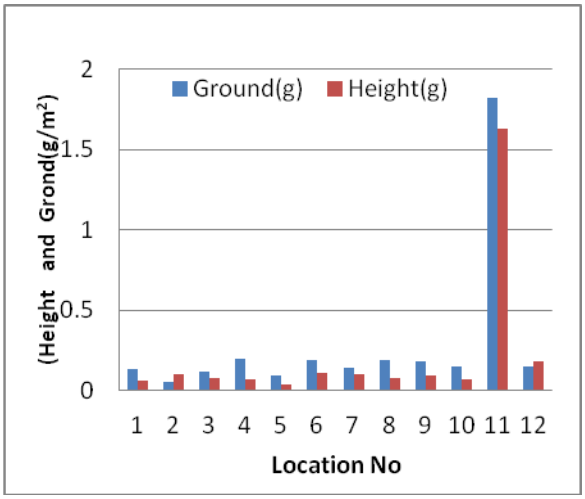

Fig 4.0: Mass of the second week

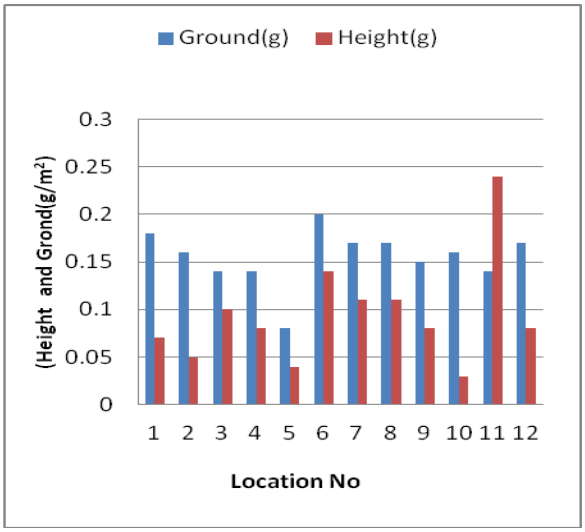

Fig 5.0: Mass of the third week

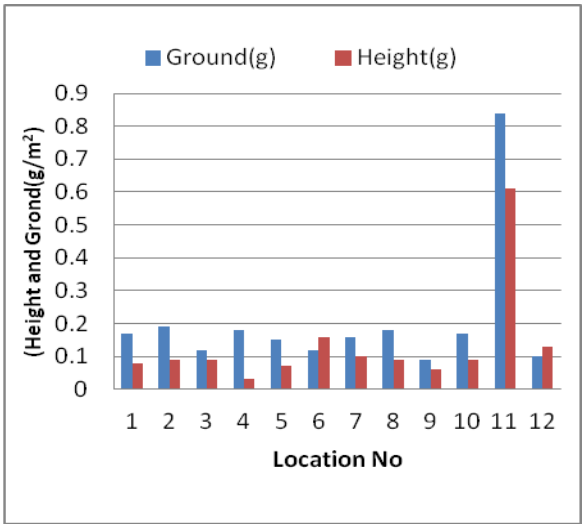

Fig 8.0: Mass of the sixth week

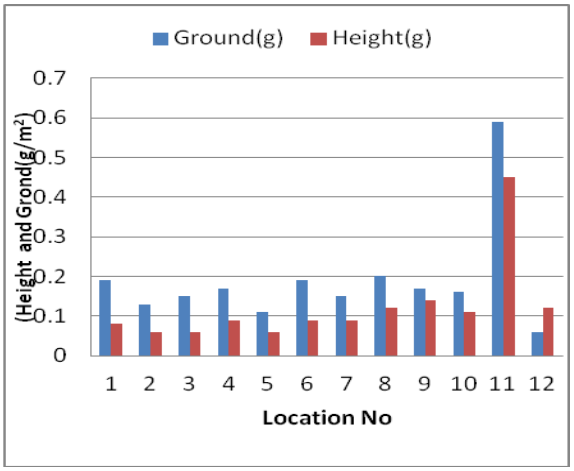

Fig 6.0: Mass of the forth week

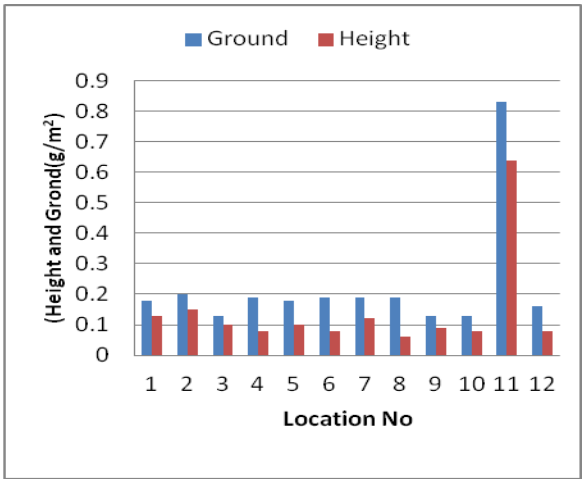

Fig 9.0: Mass of the seventh week

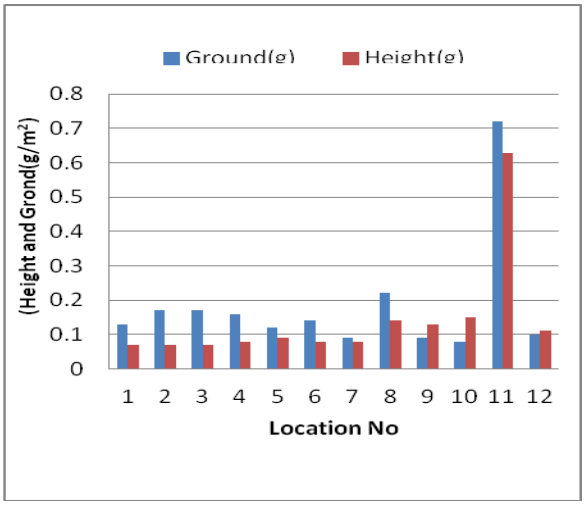

Fig 7.0: Mass of the fifth week

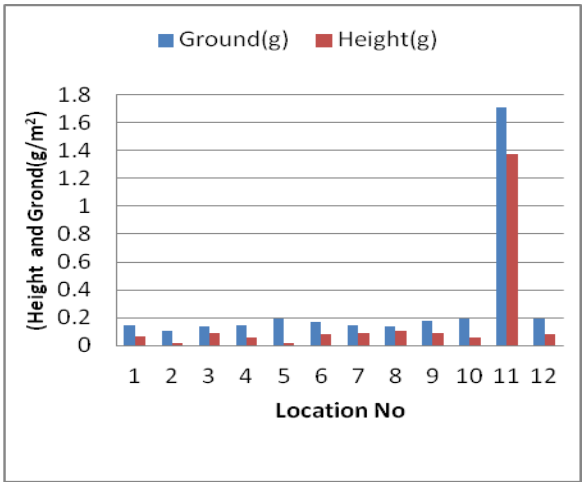

Fig 10.0: Mass of the eight week

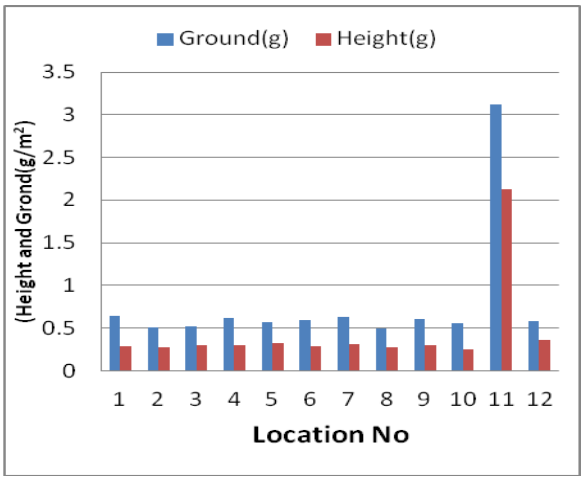

Fig 11.0: Average mass of the first month

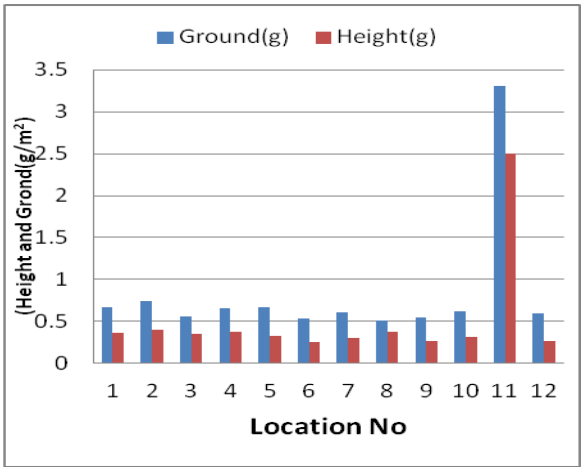

Fig 12.0:Average mass of the second month

DISCUSSION

From the results above it can be observed that at a particular location, that is location 11Olunlade (8^0 44'764"N, 4^0 58'398"E) area of Ilorin, the mass of dust deposited is distinctly higher as compared to all other locations, this may be attributed to human activities (road construction, vehicular movement etc.) going on around the location during the period of data collection.

Weekly variation of the results shows that the average mass of samples collected at ground level (1.67g/m^2) is greater than that of those collected on an elevated platform (1.60g/m^2), which may be as a result road side dust. This can be observed by the weekly pattern of dust collection during the period of investigation although at certain locations, such as 11(Olunlade) and 12(Post-Office Area) which have a marked elevated mass of dust deposited at the elevation (five meters) than that of ground level(half a meter). This could be as a result of intensity of human interaction such as vehicular movement, human movement trampling the ground, road side kitchens, open air waste incineration and wood burning (Anuforom *et al*., 2008). Depositions at higher elevations are higher because they would have become more dispersed by settling on vehicles, human beings and other objects which are more at lower elevation hence a lower concentration. Similarly, monthly variation across locations follows the same pattern with weekly variation, table 2.0 above gives the geographical location of each location Ilorin, therefore; from the results it can be shown that the dishes placed on the ground level has more particulate dust matter than the dishes placed at elevated platforms, which may be as a result of road side dust, vehicular movement and some other unknown activities that may be taking place around the locations. This can be attributed to all the particulate dust matter been deposited on the ground level during the dust transportation. Nwadiogbu *et al.,* (2013) in the year 2009/2010 harmattan season at Ahmadu Bellow University Zaria found that dust deposition rate (average 28.165g/m^2 and 1.76g/m^2) at residential (RS) area are lower to commercial (CM) area (39.37g/m^2 and 2.461g/m^2) and that this could be as a result of intensity of human interaction such as vehicular movement, human movement trampling the ground, road side kitchens, open air waste incineration and wood burning (Anuforom *et al*., 2008). But at Ilorin the average mass of the dust was 8.40g/m^2.The result of Ilorin present a lower value as compared to what was observed in Zaria (17.94g/m^2) and Maiduguri (26g/m^2) which may be due to the dust settling and dropping out of the atmosphere along the way as it makes it transversal from the source in the North eastern direction towards the Atlantic ocean.

However, the weight of the sample collected over Ilorin presents lower values as compared to locations further north of Nigeria. Therefore, as a result of this, Ilorin located in north central Nigeria, will likely have lower value of harmattan dust haze as a result of wind transportation. More so, the dust weight is also being affected by vehicular movement around Ilorin metropolis and industrial smoke concentrated in some part of the city. Harmattan dust also causes some domestics disturbance as been reported by (Falaiye, 2008; Adefolalu, 1984; Adedokun *et al.,* 1989).The harmattan spells are often accompanied by droplets in the evening and early morning temperatures associated with an oscillation of the axis of the subtropical high (Adedokun, 1978; Adedayo, 1980; Adedokun *et al.,* 1989). This research was limited to weekly and monthly variation of the harmattan dust which was collected during the period of harmattan.

CONCLUSION

Harmattan dust lifting, transportation and deposition, occur naturally (Falaiye *et al.,* 2013), which could be as result of wind transport. Studies have identified two key sources, the region around the Mauritania, Algeria and Morocco and the Bodele depressions dust in the Chad Basin, which is mainly responsible for the harmattan-dust deposited across Nigeria (Balogun, 1974). But the relevance of the result to other field of study is that Ilorin could be observed to be far away from the sources of dust which could reduce the mass of the dust depositing at Ilorin due to transportation of the dust from the source.

In conclusion, it shows that harmattan particulate dust matters have more weight if the sample collector is placed on the ground level which is half a meter than the sample collector placed at five meters high above the ground level. During the period of dust deposition (November- March), dust deposition around November to January have more deposition than from the period of February to March. This may be as a result of more aerosols which may be present during this period and also as a result of human interaction such as vehicular movement, human movement trampling the ground, road side kitchens, open air waste incineration and wood burning (Anuforom *et al*., 2008), in Ilorin during the period of sample collection. However, as compared to Nwadiogbu *et al.,* (2013) and Dimari *et al.,* (2008),it shows that the mass of harmattan dust in the Northern part have higher mass than that of the North Central towns of the country. This could be as a result wind transportation that blows the dust from the source and deposition along the trajectory path. The selection of the locations was random based on the vehicular traffic, population and free exposure of the environments. Meanwhile, location 12 (Post-Office) areas have more of traffic during the period of the study and Location 11 (Olunlade) area; there was road construction during the period of the sample collection, which may influence the results.

Therefore, it shows that the more the harmattan dust mass in the air, the less the visibility of both human and animal. This also affects some agricultural products, as a result of some heavy elements such as lead (Pb) that may be present in the sample which may have effect on human health.

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