International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Fungal Pathogens of Postharvest Rot of Groundnut (*Arachys hypogaea* L.) in Hong Local Government Area of Adamawa State Nigeria

Asama, P.[1], Channya, F.K[2]

Department of Plant Science, Modibbo Adama University of Technology, Yola, Nigeria

Abstract: ***Fungi such as Aspergillus niger (brasiliensis), Aspergillus flavus, Alterneriadianthocola, Curvularia lunata, Curvulari apellesecens, Fusarium oxysporum, Fusarium equiseti, Microphomina phaseolina, Rhizopus stolonifer, Penicillium digitatumare associated with heavy losses of seeds, fruits, grains, vegetables and other plant products in transit and storage rendering them unfit for human consumption. The research sought to identify fungal pathogens of groundnut rot in storage in Hong Local Government area of Adamawa State, Nigeria a major groundnut producing area. A survey was carried out using random sampling on incidence of groundnut rot in the seven districts of Hong local government area in the month of July 2016. Isolation and identification, frequency of occurrence, virulence, as well as effect of pathogens on germination of groundnut seeds and seedling growth were carried out. Incidence of rot occurred in all seven districts with the highest in Hong, Hildi and Gaya, pathogens associated with the rot were identified as follows; Aspergillus niger (brasilensis), Aspergilus flavus, Penicillium chrysogenum, Rhizopus stolonifer, Paecilomyces lilacinus, Pseudallescheria boydii, Cylindrocarpon lichenicola and Scedosaporium prolificans. The frequent occurring fungi were Aspergillus niger (brasilensis) and Aspergillus flavus while the most virulent was Aspergillus flavus. There was significant reduction in seed germination and seedling growth at 99.99% probability level for both the Valencia(kampala) and Peruvian(kwathrumthrum) from 33.33% for un-inoculated to 11.00% for inoculated.Proper storage practices to reduce groundnut rot as well as enhance seed viability are therefore suggested.***

Keywords: Groundnut, postharvest rot fungi, Hong L.G.A., Adamawa State, Nigeria

1. Introduction

Agriculture remains significant in the Nigerian economy, and involves small scale farmers scattered over wide expanse of land, with small holding ranging from 0.5 to 3.0 hectare per farm land, characterized by rudimentary farm systems, low capitalization and low yield per hectare (Kolawale and Ojo, 2007). The roles of agriculture remain significant in the Nigerian economy despite the strategic importance of the oil sector (FAO, 2005).

Groundnut (*Arachis hypogea* L.) is an annual, self-pollinated, growing plant found in many tropical, subtropical and temperate countries of the world (Halima, 2000). It is now grown in about 108 countries of the world (Srivastava *et al.*, 2015). Asia with 63 – 66 % land mass produces 71.72% of world groundnut followed by Africa with 18.6% production and North-Central America with 7.5% (Hakeem*et al.*, 2015).

The major food crops of Adamawa State according to Adebayo and Tukur (1999) are mainly cereals, legumes and root crops, while the cash crops are mainly cotton, groundnut and sugar cane. The variable climatic and edaphic factors of the state as well as cultural and socio-economic factors are adduced for the distribution of food and cash crops in the State.In the North-East Zone, groundnut is a major cash crop produced especially in Hong (Adebayo, 1997). Rowland (1999) reported that seed yield in Northern Nigeria is about 3000Kg/ha. Adamawa Agricultural Development Programme, ADADP (1996) enumerated groundnut types commonly grown in Adamawa State to include; "Ordaaji"; (2 nuts/shell), "Kwamakuni"; (3 nuts/shell), "Kwathrumthrum"; (2 nuts/shell larger), "Kwanyambi" or Ex Dakar and Kampala (brown/white striped nuts).

Stored food commodities are severely damaged by different groups of fungi including *Aspergillus* spp, *Fusarium* spp, and *Penicillium* spp.*Aspergillus flavus* is common in tropical and subtropical countries and causecontaminationas a result of moulding of badly stored commodities such as groundnut, cereal and cotton seeds (Weiss,1983).

Fungi such as*Aspergillus niger (brasiliensis), Aspergillus flavus, Alterneriadi anthocola, Curvularia lunata, Curvulari apellesecens, Fusarium oxysporum, Fusarium equiseti, Microphomina phaseolina, Rhizopus stolonifer, Penecillium digitatum* and *Penecillium chrysogenum* cause discolouration, rotting, shrinking, seed necrosis, loss in germination capacity and toxification to oil seeds (Chavaen and Kakde, 2008). These fungi are associated with heavy loss of seeds, fruits, grains, vegetables and other plant products during picking, transit and storage rendering them unfit for human consumption even by producing mycotoxins and affecting their total nutritive value (Verma *et al.*, 2003b). The tropical climate with high temperature and high relative humidity along with unscientific storage condition adversely affect the storage of cereal grains and oil seed, and this can lead to the total loss of seed quality (Bhattacharya and Raha, 2002).

Groundnut seed is susceptible to a wide range of pathogens and pests which cause alot of damage to the crop, thereby reducing yield (Weiss, 2000).

Groundnut (*Arachis hypogea* L.) is an important oil seed crop in Nigeria and is widely grown in the tropics and sub-

tropics (Nigam *et al.*, 1994). It is one of the most important crops that have the ability to thrive on newly reclaimed sandy soils as a legume of high nutritive value as well as being a source of edible oil (Spears *et al.*, 2002). Moulds are associated with heavy loss of seeds, fruits, grains, vegetables and other plant products during picking, transit and storage rendering them unfit for human consumption even by producing mycotoxins and affecting their total nutritive value (Verma *et al.*, 2003a), there is therefore need to identify the pathogens prevalent in the area and assess their threat to this crop that is of utmost importance to the community (Kilba) and come up with an alternative control method other than the conventional un eco-friendly fungicides to control the fungi associated with the postharvest rot of groundnut. This research seeks to assess the incidence of postharvest rot of groundnuts as well as the fungal pathogens responsible in all the eight districts of Hong Local Government Area.

2. Materials and Methods

2.1 Study Area

A survey for the incidence and severity of groundnut rot in storage was carried out in Hong Local Government Area of Adamawa State (Fig. 1). The Local Government is divided into seven districts, which served as the locations for the survey. The districts are namely Hong, Pella, Gaya, Kulinyi, Dugwaba, Hildi and Uba (Fig 2).

The isolation and identification of fungi associated with groundnut spoilage, determination of the pathogenicity of the isolates were conducted in the Medical Laboratory of Microbiology Department, Modibbo Adama University of Technology (MAUTECH) Yola, from 18th July 2016 to 24th October 2016.

Hong Local Government Area is situated on latitude 10.13^0N and longitude $12.\ 40^0$E, it has a tropical climate marked by the dry and rainy seasons, the rainy season commences in April and ends in October, the average rainfall is 759 mm; the wettest months are August and September, the dry season starts from November and ends in April, the temperature is moderately hot ranging from 25^0 C – 35^0 C (Adebayo, 1999).

Adamawa State is located at the North-Eastern part of Nigeria and lies between latitudes 7° and 11°N of the equator and between longitudes 10^0 and 14° E of the Greenwich meridian. It shares boundaries with Taraba State in the South and West, Gombe in its North West, Borno to the North and Cameroon Republic along its Eastern borders. It lies in the Northern Guinea Savanna ecological zone (Adebayo, 1999).

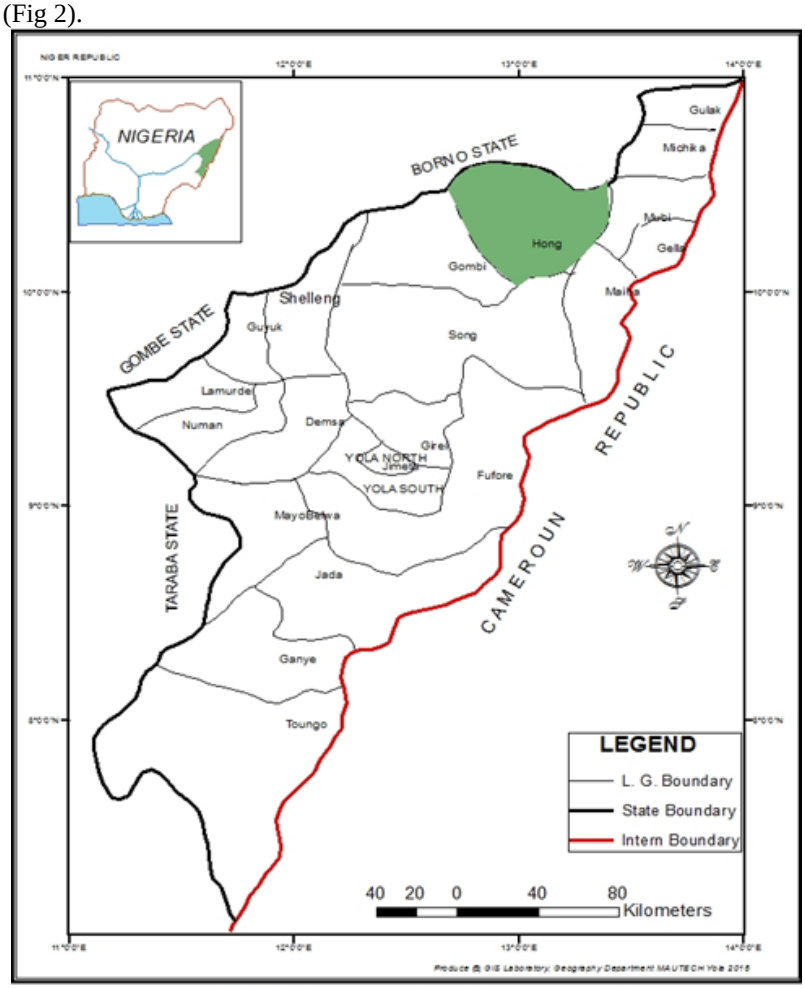

Figure 1: Map of Adamawa State Showing the Study Area

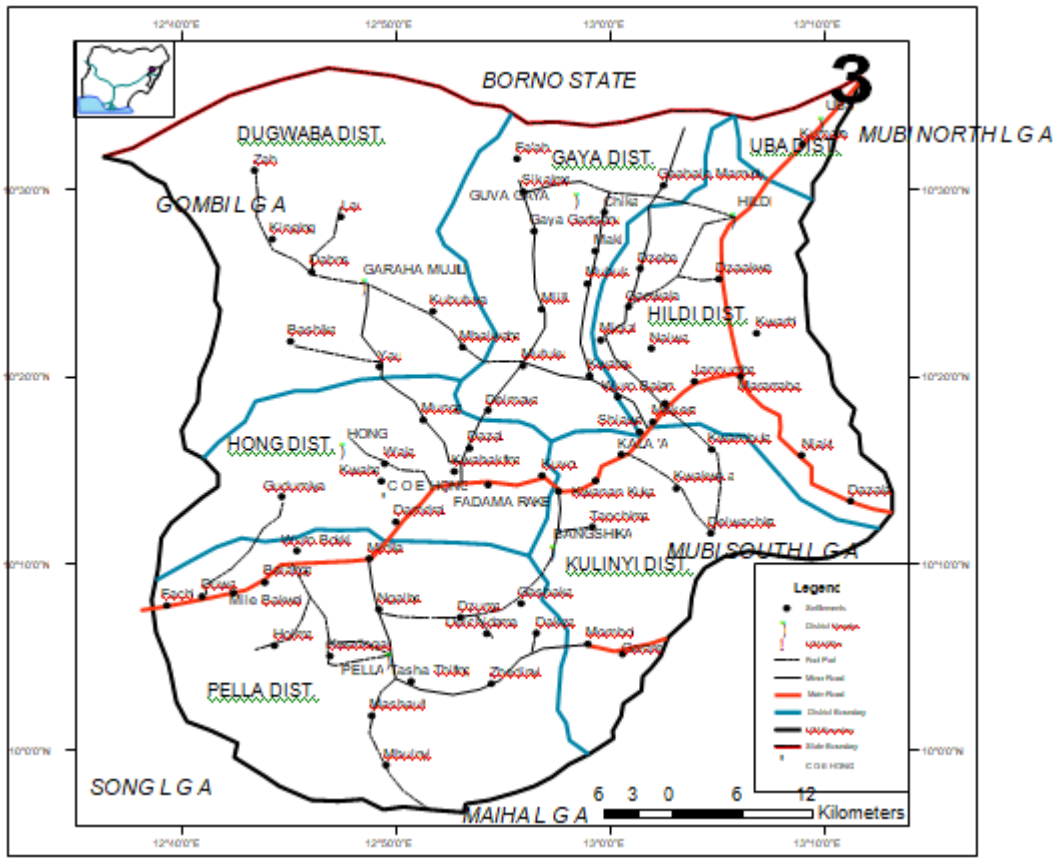

Figure 2: Hong Local Government Area Showing the Study Sites
(Source: GIS Laboratory Department of Geography, MAUTECH, Yola 2015)

2.2 Source of Samples

Samples of unshelled groundnut seeds of two genotypes namely Kampala and "kwathrumthrum" (Table 1) werecollected from one (1) major market in each of the seven (7) districts namely Hildi, Kulinyi, Dugwaba, Uba, Gaya, Pella and Hong. Fifty (50) of the samples of each genotype were purchased fromseller (two randomly selected sellers/traders within the selected market) in each district making a total of 700 being collected from the various districts, the samples were conveyed to the laboratory in a dry clean polythene bag.Groundnut samples were labelled according to location and then photographed (Plate I A, I B and II A, II B).

Table 1: Groundnut Variety used for the Study

No	Subspecies	Variety	Botanical types	Seed coat colour	Pod sizes
1	*fastigiata*	Kampala	Valencia	Red-white (var)	3 – 4 cm
2	*hirsuta*	Kwathrumthrum	Peruvian	Brown	3 – 4 cm

Plate I A. Sample of healthy "Kwathrumthrum" groundnut seeds

Plate I B: Sample of "Kwathrumthrum" diseased groundnut seeds

Plate II A. Sample of healthy Kampala groundnut seeds

Plate II B. Sample of diseased Kampala groundnut seeds

2.3 Incidence of Rot on Groundnut in Storage

Incidence of rot of groundnut in storage was carried out. The samples purchased from the markets were assessed by determining the number of groundnut seeds showing rot out of the total number of groundnut seeds purchased from the market. The incidence of fungal spoilage/ rot was expressed in percentage using the formula:

$$\text{Incidence of fungal disease} = \frac{\text{Number of rotted groundnut seeds collected}}{\text{Total number of the groundnut seeds collected}} x\ 100$$

2.4 Sterilization of Inoculation Room and Instruments

Sterilization of laboratory environment was carried out in order to avoid contamination of the bench and tables used for inoculation were swapped clean using 95% ethanol and UV light switched on for 30 minutes before carrying out inoculation. Petri- dishes were sterilized at 160^0 C for 1 hour in the oven, forceps, needles used for inoculation were sterilized by flaming and dipping into methylated spirit to cool.

2.5 Preparation of Potato Dextrose Agar (PDA)

Thirty nine grams (39 g) of potato dextrose agar (PDA) was dissolved in one 1 litre of distilled water, the Potato Dextrose Agar was then poured into two 500ml conical flask, then plugged with cotton wool and wrapped with aluminium foil before autoclaving it 121^0 C for 15 minutes at 10 lbs. pressure, and 6 ml (0.1%) of streptomycin was added to the litre of sterilized media and swirled gently to mix properly, just before pouring into Petri dishes to prevent bacterial growth and allowed to cool and solidify according to the method of Suleiman and Michael (2013).

2.6 Isolation of Pathogens

Under aseptic conditions the diseased sample of groundnut seeds showing rot was picked with a pair of sterile forceps. The seeds were then immersed into 1% sodium hypochlorite solution contained in a sterile 90 mm diameter Petri- dish for surface sterilization for 30 seconds, the sterilized seeds were then rinsed in three changes of sterile distilled water and then blotted dry between sterile filter papers. With a flamed and cooled pair of forceps, each sterilized seed was then split and plated aseptically on 90 mm diameter Petri-dish containing sterile solidified Potato Dextrose Agar (PDA) and incubated at an average room temperature of 33 ± 2^0 C for seven (7) days (i.e. immediately when new colonies begin to grow) before sub- culturing on fresh sterilize PDA using the method of Klick and Pitt (1988) and Robert *et al*. (1996). Pure colonies were photographed, Pure colonies were obtained from hyphal tip transfer to fresh PDA, pure isolates of fungal species obtained were stored on solidified sterile PDA in Mc-Cartney bottles, and these were appropriately labelled according to organism. The slant was initially corked loosely to allow the content fungus to grow and then was tightly corked and stored in a freezer to serve as stock culture.

2.7 Identification of the Isolated Pathogens

Microscopic examination was carried out to observe the structure and characteristics of the fungal isolates. A sterile needle was used to pick a portion of the hyphae / spore and placed on a sterile glass slide stained with Lacto-phenol blue and examined under the photographic microscope using the method of Fawole and Oso (1995). Micrograph of the isolates showing (conidia etc.) and the morphological and cultural characteristics observed were compared with structures in the identification guides of the Centre for Research on Pathogenic Fungi, and of Hunter and Barnet (1998).

2.8 Pathogenicity Test

Pathogenicity test was carried out using techniques of Ikpefan *etal.*(2013). Healthy dried groundnuts seeds were surface sterilized with 1% sodium hypochlorite (NHCL) solution for 30 seconds to remove surface contaminants and rinsed in three changes of sterile distilled water and then dried between a 12 cm diameter Whatman filter paper. The

cultured isolates were dissolved into sterile distilled water and poured into 9 cm diameter Petri dish laid with cotton wool and filter paper (Whatman No 1). Five healthy seeds of *A. hypogea* were spread on each plate and incubated. The control set up seeds were treated with sterile distilled water andincubated, the level of rot was measured using the method of Ikpefan *etal.*(2013).

The set up was arranged in three (3) replicates and incubated for seven (7) days. On establishment of rot, innoculum from the infected seed was re-isolated and compared with the first isolate. Result was analysed using Statistics for Agricultural Sciences (SAS). Isolates' virulence was assessed based on Silva and Bettiol (2005) pathogenic potential of grouping isolates: 0 - 20 low virulent group, 21 – 40 moderately virulent group, 41 – 60 highly virulent group, 61 – 80 very highly virulent group, above 80 totally virulent group.

2.9 Effect of Pathogen on Germination of Seeds

The effect of pathogen on germination of seeds was carried out using the techniques of Ikpefan *et al*. (2013) as described in 3.8 above. Three healthy seeds were placed on a plate and inoculated with each of the pathogens, the control seeds were inoculated with sterile distilled water. Germination was determined through the formula:

$$\frac{\text{Number of seeds germinated}}{\text{Total number of seeds plated}} \text{ x100}$$

2.10 Effect of Pathogen on Growth of Seedlings

Effect of the pathogen on the growth of the seedlings was carried out following the inoculation procedure as described in 3.8 above. Three healthy seeds of *A. hypogea* inoculated with eachpathogen were spread on each plate and incubated in the dark. The control seeds were treated with sterile distilled water. The lengths (mm) of the radicles and plumule emerging from the seeds were measured for seven days using a measuring ruler. The set up was arranged in three replicates and kept for seven (7) days. Result was analysed using Statistical Analysis System.

3. Results

3.1 Incidence of Groundnut Rot in Hong Local Government Area

Results of the study showed that incidence of rot varied among all the seven (7) districts at 99.99% level of probability, in the case of Kampala, the highest incidence of rot occurred in Hong (8.67 %) with the least in Dugwaba district with 5.33% (Table 1).The percentage incidence on the "Kwathrumthrum" showed the highest incidence occurring in Hong (6.67%), with the least in Uba district with 2.67% (Table 2).

Table 2: Incidence (%) of Groundnut Rot in Hong Local Government Area of Adamawa State, Nigeria.

District	Kampala	Local
Kulinyi	7.33	6.00
Hong	8.67	6.67
Pella	6.67	5.33
Dugwaba	5.33	4.67
Gaya	7.33	4.00
Hildi	8.00	6.67
Uba	6.00	2.67
LSD(0.05)	1.68	1.31

LSD: Least Significant Difference

3.2 Fungal Isolates of Groundnut in Hong Local Government Area

Fungi found associated with groundnut rot in the seven (7) districts of Hong Local Government Area were; *Aspergillus niger (A. brasiliensis), Aspergillus flavus, Penicillium chrysogenum, Rhizopus stolonifer, Pseudaiiescheria boydii, Paecilomyces lilacinus, Cylindrocarpon lichenicola* and *Scedosporium prolificans*.

3.4 Frequency of Fungal Isolates (%) on Groundnut in Hong Local Government Area

Occurrence of the isolates on rotten groundnut seeds in Hong Local Government Area ($P \leq 0.05$) showed a wide variation within the seven (7) districts (Table 3). The highest occurrence of *Aspergillus niger* was in Kulinyi (15.17%), Dugwaba (12.83%) and Hildi (11.83%), followed by Pella (11.17%), Gaya (8.83%) and Hong (8.50%) and then by Uba (6.83%). For *Aspergillus flavus* its highest occurrence was in Gaya (11.67%) followed by Pella (10.50%), Dugwaba (10.50%), Uba (9.17%), Kulinyi (6.83%), Hildi (4.33%) Hong (2.83%). *Penicillium chrysogenum* occurrence was high at Hildi (5.67%), Pella (5.50%), Uba (5.00%), Hong (4.33%), Gaya (4.17%), Kulinyi (2.67%) and Dugwaba (1.17%). The highest occurrence for *Rhizopus stolonifer* was at Hildi (5.00%), Gaya (2.83%), Uba (2.00%), Dugwaba (1.17%) and Hong (1.33%) followed by Kulinyi (0.00%) and Pella (0.00%). *Pseudaiiescheria boydii* ranked high in Dugwaba (2.83%) and Hong (2.83%) followed by Gaya (1.50%), Hildi (1.33%) and Uba (1.00%) followed Kulinyi (0.00%) and Pella (0.00%). For *Paecilomyces lilacinas* high occurrence was in Uba (7.00%) followed by Dugwaba (2.83%) then Pella (1.67%), Gaya (1.50%) and Hong (1.50%) and then Hildi 0.00% and Kulinyi 0.00%. There was a higher occurrence of *Cylindrocarpon lichenicola* was in Pella 3.83%, Hong 1.33% and Hildi 1.33% followed by Uba 0.00%, Gaya 0.00%, Dugwaba, 0.00% and Kulinyi 0.00%. *Scedosporium prolificans* recorded a higher occurrence in Hong 2.83 and Dugwaba 2.83 followed by Hildi 1.33 and Uba 1.33 then Kulinyi 0.00%, Pella 0.00% and Gaya 0.00%.

3.5 Virulence of Rot of Pathogens

The eight isolates were confirmed to be pathogenic, as they produced rot lesions when inoculated to both the healthy genotypes of the groundnut seed.Virulence of the isolates also varied:*Aspergillus flavus* was rated as totally virulent, *Aspergillus niger (brasiliensis)* as very highly virulent, *Penicillium chrysogenum* and *Rhizopus stolonifer* as highly

virulent, *Pseudaiiescheria boydii* as moderate virulent group, *Paecilomyces lilacinusCylindrocarpon lichenicola and Scedosporium prolificans* were the low virulent group (Table 4).

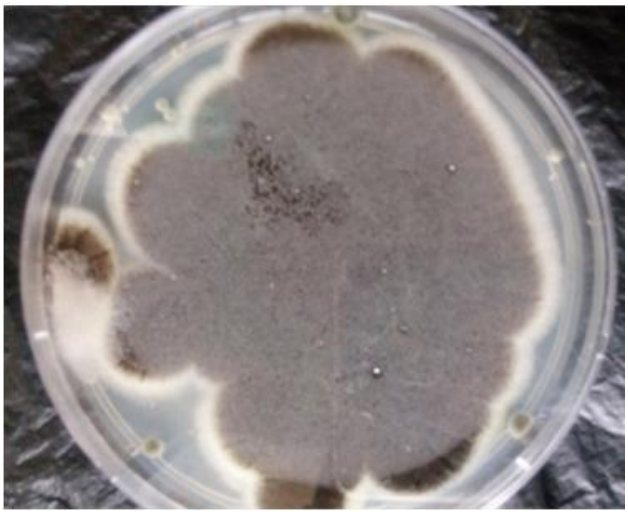

Plate II: Seven- day old culture of *Aspergillus niger syn Aspergillus brasiliensis*

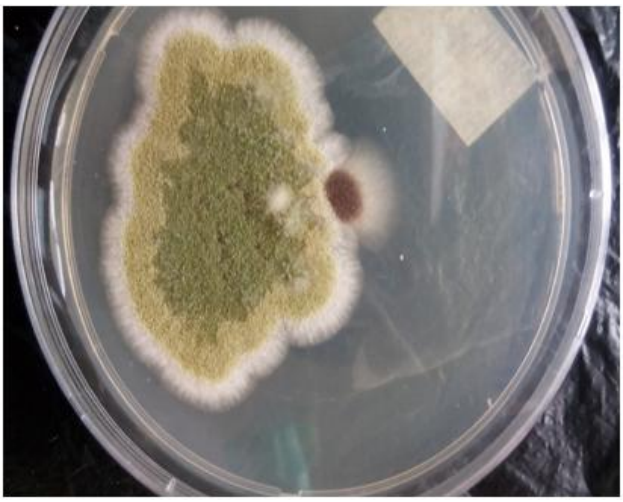

Plate VIII: Seven- day old culture of *Aspergillus flavus*

Plate IX: Seven- day old culture of *Penicillium chrysogenum*

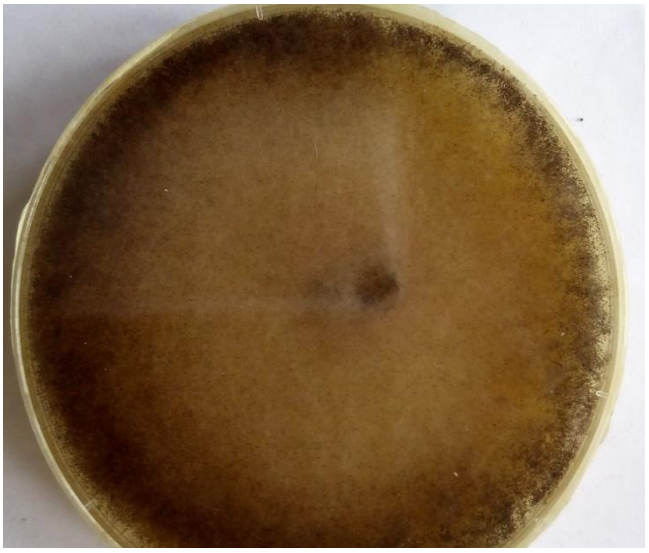

Plate X: Seven- day old culture of *Rhizopus stolonifer*

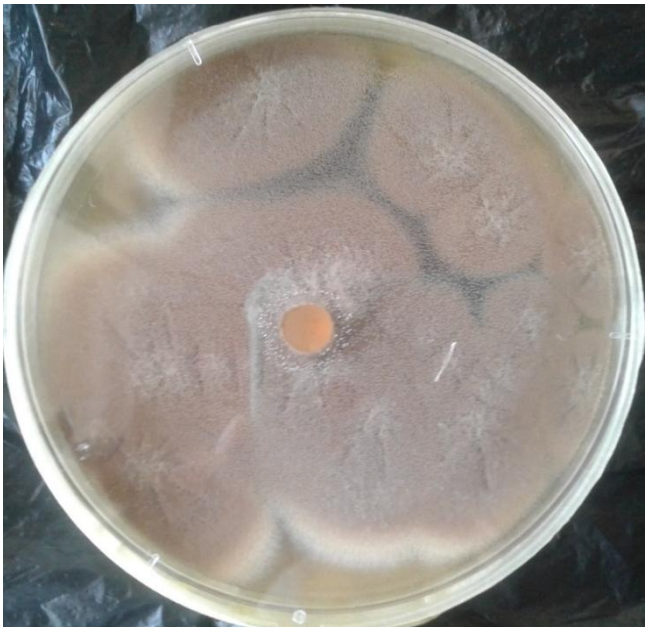

Plate XI: Seven- day old culture of *Pseudaiiesceria boydii*

Plate XII: Seven- day old culture of *Cylindrocarpon lichenicola*

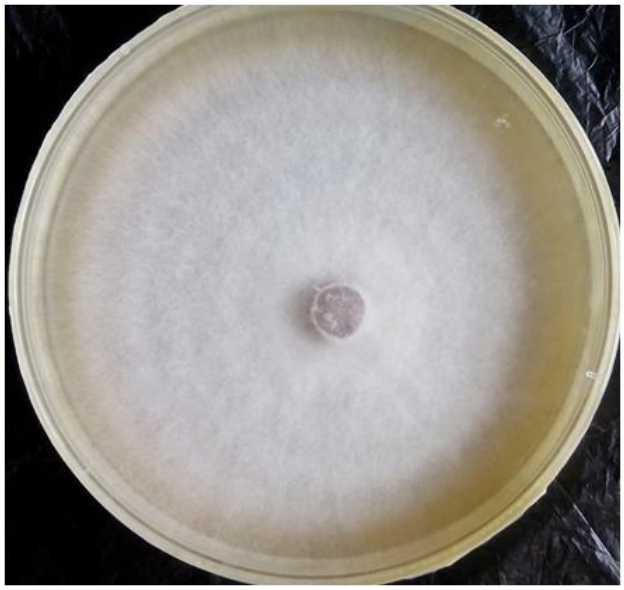

Plate XII: Seven- day old culture of *Paecilomyces lilacinus*

Plate XIV: Seven- day old culture of *Scedosporium prolificans*

Table 3: Frequency of Occurrence (%) of Fungi Isolated from Groundnut Seeds in Hong Local Government Area of Adamawa State, Nigeria.

	Pathogens							
	Aspergillus brasiliensis	*Aspergillus flavus*	*Penicillium chrysogenum*	*Rhizopus stolonifer*	*Pseudaiiescheria boydii*	*Paecilomyces lilacinus*	*Cylindrocarpon lichenicola*	*Scedosporium prolificans*
Location								
Kulinyi	15.17	6.83	2.67	0.00	0.00	0.00	0.00	0.00
Hong	8.50	2.83	4.33	1.33	2.83	1.50	1.33	2.83
Pella	11.17	10.50	5.50	0.00	0.00	1.67	3.83	0.00
Dugwaba	12.83	10.50	1.17	1.17	2.83	2.83	0.00	2.83
Gaya	8.83	11.67	4.17	2.83	1.50	1.50	0.00	0.00
Hildi	11.83	4.33	5.67	5.00	1.33	0.00	1.33	1.33
Uba	6.83	9.17	5.00	2.00	1.00	7.00	0.00	1.00
LSD(0.05)	3.42	2.31	0.93	0.64	0.26	0.19	0.30	0.35

Table 4: Virulence of Fungal Pathogens on Groundnut Seeds (%)

Pathogen	Pathogenic Potential	
	Kwathrumthrum	Kampala
Aspergillus flavus	Totally Virulent	Totally Virulent
Aspergillus brasilensis	Very highly Virulent	Very Highly Virulent
Penicillium chrysogenum	Highly Virulent	Very Highly Virulent
Rhizopus stolonifer	Highly Virulent	Very Highly Virulent
Pseudaiiescheria boydii	Moderately Virulent	Moderately Virulent
Paecilomyces lilacinus	Low Virulent	Low Virulent
Cylindrocarpon lichenicola	Low Virulent	Low Virulent
Scedosporium prolificans	Low Virulent	Low Virulent

Key:
0 – 20% - Low Virulent Group
21 – 40% - Moderately Virulent Group
41 – 60% - High Virulent Group
61 – 80% - Very High Virulent Group
80% and Above – Totally Virulent Group

3.6 Effect of Pathogens on Groundnut Seed Germination

There was a significant reduction in the rate of germination of seeds inoculated with all the pathogens except for *Pseudallescheria boydii and Cylindrocarpon lichenicola* as compared to the control, the highest reduction in germination was by *Rhizopus stolonifer* and *Scedosporium prolificans* (11.00% in the Kampala). The highest reduction in the "kwathrumthrum" cultivar was by the *Aspergillus flavus* 11.00%). However, there was no significant variation for reduction in germination between the Kampala and "Kwathrumthrum" (Table 5).

3.7 Effect of Pathogens on Growth of Seedlings

There was no significant reduction in the growth of seedlings (plumule and radicle) for the Kampala, however for the"Kwathrumthrum" growth of radicle was significantly reduced for all pathogen-inoculated seeds except *Pseudallescheria boydii* and *Cylindrocarpon lichenicola*, for the plumule all seedings showed a significant reduction in growth except *Pseudallescheria boydii* and *Paecillomyces lilacinus*(Table 6).

Table 5: Effect of Pathogen on Groundnut Seed Germination (%) in Hong Local Government Area of Adamawa State, Nigeria.

Organism	Kampala	Kwathrumthrum
Aspergillus niger	22.33	22.33
Aspergillus flavus	22.33	11.00
Penicillium chrysogenum	22.33	22.33
Rhizopus stolonifer	11.00	22.33
Pseudaiiescheria boydii	33.33	22.33
Paecilomyces lilacinus	22.33	22.33
Cylindrocarpon lichenicola	0.00	33.33
Scedosporium prolificans	11.00	22.33
Control	33.33	33.33
LSD (0.05)	0.81	0.93

LSD; Least Significant Difference

Table 6: Effect of Pathogens on Growth of Seedlings of "Kwathrumthrum" Groundnut (mm) in Hong Local Government Area of Adamawa State,Nigeria.

Pathogen	Radicle	Plumule
Aspergillus niger	20.00	16.67
Aspergillus flavus	7.33	3.33
Penicillium chrysogenum	21.67	10.33
Rhizopus stolonifer	19.67	10.67
Pseudaiiescheria boydii	26.00	24.33
Paecilomyces lilacinus	12.67	22.67
Cylindrocarpon lichenicola	24.33	14.00
Scedosporium prolificans	13.33	9.67
Control	39.33	33.67
LSD(0.05)	22.70	16.00

LSD; Least Significant Difference

4. Discussion

Incidence of the groundnut rot was universally spread in all the seven districts of Hong local government area of Adamawa state, there are reports according to Natarajan (1996) who reported that the method of storage of the seeds, and the initial seed quality affect the deterioration of the seed and would be subjected to invasion by fungi. Nakail *et al.* (2008) recorded the susceptibility of groundnut to colonization of *Aspergillus flavus* especially during storage.

Eight fungal pathogens were found on the groundnuts in Hong local government area of Adamawa state, the presence of these pathogens agrees with the report of Sullivan (1984) who reported that *Aspergillus flavus, Rhizopus stolonifer and Penicillium* spp are storage pathogens of groundnut seeds which are highly susceptible to a number of disease causing pathogens because the seeds are very rich in nutrients for the fungi to thrive. Vikas and Mishra (2010) isolated nine species of fungi which include *Aspergillus flavusPenicillium* spp, *Fusarium* spp, *Aspergillus niger from* the seeds of different varieties of groundnut during storage of one year.

According to Chavan and Kakde (2008) the most occurring moulds of post-harvest products in storage were commonly the *Penicillium*, *Aspergillus, Rhizopus* and *Fusarium*., and this agrees with the findings of the research as the most occurring pathogens in all the seven districts are *Aspergillus flavus and Aspergillus niger (brasilenesis).* Chavan (2011) found that the species of *Aspergillus*, *Penicilium, Fusarium, Rhizopus* and *Alternaria* were commonly occurring post-harvest moulds in storage conditions.

Aspergillus flavus as recorded from the research was totally virulent and as found in other reports that most of the species of *Aspergillus* were dominant and play a vital role in the seed bio - deterioration, Ibiam and Egwu (2011) reported that among different species of fungal infection, *Aspergillus flavus* was the most predominant one.

Most pathogens caused a significant reduction in seed germination rate and growth of seedlings in both the kampala and "kwathrumthrum". This agrees with reports by Chavan and Kakde, (2008) fungi such as *Aspergillus niger (brasiliensis), Aspergillus flavus, Alterneria anthocola, Curvularia lunata, Curvulari apellesecens, Fusarium oxysporum, Fusarium equiseti, Macrophomina phaseolina, Rhizopus stolonifer, Penecillium digitatum* and *Penecillium chrysogenum* cause shrinking, seed necrosis, loss in germination capacity and toxification of oil seeds. Soil-borne fungal pathogens are a major constraint in crop production by infecting roots (Abdel-Kader *et al.*, 2002; Infantin *et al.*, 2006).

References

[1] Adamawa Agricultural Programme ADADP 1996. *Crop Recommendation for Extension Workers in Adamawa State*. pp. **1-40.**
[2] Adebayo A. A. (1997). The Agroclimatology of rice production in Adamawa State PhD Thesis Dept of Geography F.U.T. Minna, Nigeria. Pp 78.
[3] Adebayo A. A., Tukur AE (1999). Adamawa State in map (Editor). Department, Geography, F. U. T. Yola 1st Ed Paraclete publisher Yola, Nigeria, 33: 112
[4] Abdel-Kader, M.M., N.S. El-Mougy and A.M.A. Ashour. 2002. Suppression of root rot incidence in faba bean fields by using certain isolates of Trichoderma. Egyptian Journal of Phytopathology, 30(2):15-25.
[5] Bhattacharya, K. and Raha, S. (2002). Deteriorative changes of maize, groundnut and soybean seeds by fungi storage. *Mycopathologia*, 155: 135-141.
[6] Chavan, A.M. and Kakde, R.B. (2008). Studies on abnormal oilseeds mycoflorafrom Marathwada region. *Bionano Frontier*, 2: 101-104.
[7] Chavan, A.M., (2011). Nutritional changes in oilseeds due to *Aspergillus* spp. *Journalfor Experimental Science*. 2: 29-31.
[8] FAO. (2005). http:llwww.faostatdatabase.org retrieved 12/12/2015
[9] Fawole, M. O. and Oso, B.A. (1995). Laboratory Manual of Microbiology. 1st Edition. *Spectrum Books Ltd*, Ibadan, Nigeria, 34 - 35.
[10] Halima, A. S. (2000). Isolation and preliminary identification of fungi in stored groundnut. Higher National Diploma Project, Department of Science Laboratory Technology, Kano state Polytechnic, Nigeria.
[11] Hakeem A A., Farid W., Candidus A E., Ayuba K., Babu N M., Damilola E. and Abubakar I. (2015). A Farmer's Guide to Profitable Groundnut Production in

Nigeria. International Crops Research Institute for Semi-Arid Tropic

[12] Hunter B. B. and Barnet, H. I. (1998). *Illustrated genera of imperfect fungi,* (4th ed.). Minnesota. *American Phyto pathological Society*

[13] Ibiam, O.F.A. and Egwu, B.N. (2011). Post-harvest seed-borne diseases associated with the seeds of three varieties of groundnuts, (*Arachis hypogaea* L) Nwakara, Kaki and Campalla. Agriculture Biology *Journal of North American.*, 2: 598-602.

[14] Infantin, A., M. Kharrat, L. Riccioni, C.J. Coyne, K. McPhee, J. Niklaus and N.J. Grunwald. 2006. Screening techniques and sources of resistance to root diseases in cool season food legumes. Euphytica, 147: 201-221.

[15] Ikpefan, E. O.; Fajana, A. and Olowojoba, J. (2013). Cytotoxic and Growth Inhibitory Effects of the Methanol Extract of *Tridax procumbens* Linn (Asteraceae). *Journal of Pharmacognosy and Phytochemistry*, **2**(**1**): 26.

[16] Klick, M. A. and Pitt. J. I. (1988). A Laboratory Guide to Common *Aspergillus* species and their Teleomorphs. Published by *Commonwealth Scientific and Industrial Research Organisatio*n, Division of Food Processing. North Ryde, NSW Australia, 116.

[17] Kolawale, O. and Ojo, S. O. (2007). Economic efficiency of small scale food crop production in Nigeria. *J. For Social. Science.,***14** (**2**): 123-130.

[18] Natarajan, S., 1996. Influence of season and provenance on quality of groundnut seed. M.Sc. (Ag.) Thesis, Tamil Nadu Agriculture University, Coimbatore, (India).

[19] Nakail, V.K. Rocha, L.D.O. Goncalez, E. Fonseca, H. E. Ortega M.M. and Corre, B. (2008). Distribution of fungi and *aflatoxins* in a stored peanut variety. *Food Chemistry.*, 106: 285-290.

[20] Nigam, S. N.; NageswaraRao, R. C.; Wynne, J. C.; Williams, J. H.; Fitzner, M. and Nagabhushanam, G. V. S. (1994). Effect and interaction of temperature and photoperiod on growth and partitioning in three groundnuts (*Arachis hypogaea* L.) genotypes. *Am. Appl. Bio*.**125**:541-552.

[21] Robert, A. S., Hoekstra, Frisvad, J. C. and Filtenborg, O. (1996). Introduction to Food- borne Fungi. Printed by Ponsen and Looyen, Wageningen, The Netherlands.

[22] Rowland 1999. Profitability of groundnut production in Michika local government area of Adamawa State. Nigeria.

[23] Silva JC, Bettiol W (2005). Potential of non-pathogenic *Fusarium oxysporum* Isolates for control of *Fusarium* wilt of tomato.Fitopatologia Brasileira, **30**: 409-412.

[24] Spears, J. F.; Jordan, D. L.; and Bailey, J. E. (2002). Groundnut seed production - a guide for producers of Virginia-type groundnut seed. N. C. Coop. Ext. Serv. *Bull*. AG- 662 Pp 1-7.

[25] Srivastava, A. K., Gaiser, T., and Ewert, F. (2015). Climate change impact and potential adaptation strategies under alternate climate scenarios for yam production in the sub-humid savannah zone of West Africa. Mitigat. Adaptat. Strateg. Glob. Change 21, 955–968. doi: 10.1007/s11027-015-9639-y

[26] Suleiman, M. N. and Michael, A. J. (2013). Bioactive Properties of *Azadirachta indica* and *Cymbopogan citrates* on Some Pathogens of Guinea Corn Seeds in Storage. *Nigerian Journal of Mycology*, **5**: 74-81.

[27] Sullivan, G.A. (1984) Seed and Seedling Diseases *In*: Compendium of Peanut Diseases. Porter, D.M, Smith, D.H. and Rodriguez, K. (Eds.) pp37- 38., St Paul Minesota, U. S. American Phytopathological Society.Toxic Black Mold Information Centre (TBMIC) (2006) *Common Species of Mold. Div. of Indoor Health Products*, Inc.334 North Marshall Way, Suite C Layton, UT 84041.http://www.toxic-black-mold- info.com/moldtypes.htm.

[28] Verma, S.S., Tomer R.P.S. and Verma, U. (2003a). Loss of viability and vigour in Indian mustard seeds stored under ambient conditions. *Seed Research*., 31: 98-101. Verma, S.S., Verma U. and Tomer, R.P.S. (2003b). Studies on seed quality parameters in deteriorating seeds in Brassica (*Brassica campestris*). *Seed Science. Technology*., 31: 389-396.

[29] Vikas, P.V. and Mishra, U.S. (2010). Effect of temperature on dynamics of storage fungi of oil seeds. *International Journal of Plant Research*., 23: 9-14.

[30] Weiss, E. A. (2000). *Oilseed Crops.* Blackwell Science Ltd. Paris, Tokyo, Berlin, Victoria. Pp. 317-364.

[31] Weiss, T. J. (1983). Physical and Chemical properties of fats and oils. In food oils and their uses. AVI publ. Co. Inc. Westport.Com. USA. Second edition, pp:25-31, 44-84.