Influence of Fertilizer Application on Postharvest Storage of Two White yam *(Dioscorea rotundata)* Cultivars in Ghana

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Abstract

Yam growers across major growing areas are being encouraged to increase tuber yield through the application of fertilizer at the recommended rates and periods. Ghana, the leading exporter of yam in Africa, is currently facing the problem of poor tuber storability. Some actors along the food value chain attribute most storage rots to the application of fertilizer by farmers. This study was conducted to investigate in to the claim that fertilizer application has an effect on the shelf life of white yam tubers. Four fertilizer application models were tested on two white yam cultivars, Serwa and TDr95/19177. No fertilizer application served as the control experiment. Healthy- looking white yam tubers of the two cultivars were randomly selected from a fertilizer application trial at Ejura-Sekyedumasi District in Ashanti Region of Ghana and storage rot experiment conducted at CSIR-CRI(on-station) between January and July, 2015.The experimental design was a Split plot design with three replications. The main plot represented the two cultivars whilst the sub-plot was the fertilizer models. Initial parameters taken were tuber weight, yield and moisture content. Temperature and relative humidity were periodically recorded. Rot assessment were done at 3rd, 4th, 5th and 6th months of storage. Rot analysis parameters taken were tuber weight, number of rotten tubers, rot initiation point, rot type and associated pathogens. Percent incidence and severity were determined and used for the analysis and interpretations. Severity data was subjected to statistical analysis using the Genstat statistical package 9.2, after the results was transformed using the square root transformation. Major fungi identified from rotten tissues over the period were Lasiodiplodia the obromae, Fusarium oxysporum, Penicilliumsp., Rhizopussp., Aspergillus flavus. Fifty-four percent of rotten tubers were the dry rot type. There were similarities in the incidence of rot among all treatments. There was no significant difference in terms of rot severity among the fertilizer application models as well as the control. However, varietal differences and tuber sizes were key factors identified as having effect on storage rots. Further studies on commercial white yam varieties such as Pona and Dente need to be conducted to evaluate the influence of fertilizer application on their shelf lives.

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Key words: fertilizer application, storage rots, white yams and shelf life.

Influence de l'application d'engrais sur le stockage post-récolte de deux variétés d'igname blanche (*Dioscorea rotundata*) au Ghana

Résumé

Les producteurs d'igname dans les principales zones de culture sont encouragés à augmenter le rendement des tubercules par l'application déngrais aux taux et périodes recommandés. Le Ghana, qui est le premier exportateur d'igname en Afrique, est actuellement menacé par une faible capacité de stockage des tubercules. Certains acteurs de la chaîne de valeur alimentaire attribuent la plupart des pourritures de stockage à l'application d'engrais par les agriculteurs. Cette étude a été menée pour étudier l'allégation selon laquelle l'application d'engrais a un effet sur la durée de conservation des tubercules d'igname blanc. Quatre modèles d'application d'engrais ont été testés sur deux cultivars d'igname blanche, Serwa et TDr95 / 19177. Aucune application d'engrais n'a servi d'expérience de contrôle. Des tubercules d'igname blanche d'apparence saine des deux cultivars ont été choisis au hasard dans un essai d'application d'engrais dans le quartier d'Ejura-Sekyedumasi dans la région d'Ashanti au Ghana et une expérience de pourriture du stockage a été effectuée à CSIR-CRI (en-station) entre janvier et juillet 2015. La conception expérimentale était une conception de parcelle avec trois répétitions. La parcelle principale représentait les deux cultivars tandis que la sous-parcelle était les modèles d'engrais. Les paramètres initiaux ont été le poids du tubercule, le rendement et la teneur en humidité. La température et l'humidité relative ont été enregistrées périodiquement. L'évaluation de la pourriture a été effectuée aux 3e, 4e, 5e et 6e mois d'entreposage. Les paramètres d'analyse de la pourriture mesurés étaient le poids des tubercules, le nombre de tubercules pourris, le point d'initiation de la pourriture, le type de pourriture et les pathogènes associés. L'incidence et la gravité en pourcentage ont été déterminées et utilisées pour l'analyse et les interprétations. Les données de sévérité ont été soumises à une analyse statistique en utilisant le progiciel statistique Genstat 9.2, après transformation des résultats en utilisant la transformation de la racine carrée. Les principaux champignons identifiés à partir des tissus pourris au cours de la période étaient: Lasiodiplodia l'obromae, Fusariumoxysporum, Penicilliumsp., Rhizopussp., Aspergillusflavusetc. Environ 54% des tubercules pourris étaient des type pourriture sèche. Il y avait des similitudes dans l'incidence de la pourriture parmi tous les traitements. Il n'y avait pas de différence significative en termes de sévérité de pourriture parmi les modèles d'application d'engrais ainsi que le contrôle à P <0,05. Cependant, les différences variétales et la taille des tubercules étaient des facteurs clés identifiés comme ayant un effet sur les pourritures de stockage. D'autres études sur des variétés commerciales d'ignames blanches telles que Pona et Dente doivent être menées pour évaluer l'influence de l'application d'engrais sur leurs durée de conservation.

Mots clés: application d'engrais, pourritures de stockage, ignames blanches et durée de

Introduction

Whiteyam *(Dioscorea rotundata)* is produced in Ghana for both local consumption and the export market. The country is currently among the leading exporters of yam in the world (exports about 12,000 tonnes annually) (FAO, 2005). Yam is produced mostly in the Guinea-Savanna and Forest-Savanna transition zones. However, reasonable production occurs in almost all regions. White yam is much preferred to the other yam varieties and it constitutes about 80% of total

yam produced in in the country (Tetteh and Saakwa, 1994). Water yam (*D. alata)* is only consumed when white yam becomes scarce or expensive. The average daily consumption of yam in Ghana is currently 300 kcal per capita (FAO, 2013).

Yam growers across major growing areas are being encouraged to increase yield through the application of fertilizer at the recommended rate and time. However, export of yam tubers from the country to the global world is currently threatened by poor tuber storability, which has led to reduced income generated from its export as some consignments are rejected and returned.

Some actors along the food value chain speculate that fertilizer application by farmers' affects the shelf life of white yam tubers. In 2014, Ministry of Food and Agriculture (MoFA) reported that a large quantities of yam exported to the US from Ghana were rejected as 30-60% of sea and air freight imports were found to be unwholesome upon arrival in that country (GhanaWeb Report, 2014). These yam importing agencies attributed these losses to chemical fertilizers applied by farmers. There is the need to conduct investigations into the effect of fertilizer on yam deterioration in order to address the problem.

This study therefore aimed at determining the effect of fertilizer application on rots of two white yam cultivars at storage in Ghana.

Materials and Methods

Experimental Site:

The postharvest storage experiment was carried out in the Yam barn of CSIR - Crops Research Institute, Kumasi. The barn is a concrete and wooden structure covered with metal mesh (for ventilation) which contains several shelves for storing yam tubers.

Sampling of Experimental Materials

Healthy-looking white yam tubers of *Serwa* and TDr 95/19177were randomly selected from fertilizer application trials in Ejura-Sekyedumasi District, Ashanti Region, Ghana. About 300 tubers were collected and brought to the station.

Experimental Set-up and Design:

The experimental design employed was Split plot with three replications. The main plot represented the two varieties (Serwa and Tdr 95/19177) whilst the sub-plot was the fertilizer models (M1,M2,M3,M4 and M5) as shown in Table 1.The tubers were randomly arranged in the yam barn and labelled.

Data Collection and Analysis

Initial parameters that were taken prior to storage at the yam barn were initial tuber weight and moisture content. Temperature and relative humidity of the storage barn were measured weekly with the use of a thermo-hygrometer. Readings were taken at 9.00am in the morning and 3.00 pm in the afternoon.

After the third month of storage, the tubers were examined and data collected.

Table 1: The models below represent the various treatments for this experiment.

Model 1 (M1)	Model 2 (M2)	Model 3 (M3)	Model 4 (M4)	Model 5 (M5)
Fertilizer 45:45:60 N:P205:K_20 kg/ha	Fertilizer 45:45:60 N:P205:K_20 kg/ha	Fertilizer 30:30:36 N:P205:K_20 kg/ha	Fertilizer 38:23:50 N:P205:K_20 kg/ha	No fertilizer applied

Parameters collected for rot evaluation were weight of tuber, number of rotten tubers, rot initiation point, rot type and associated rot pathogens. These data were also taken in the fourth, fifth and sixth months of storage period. Rot incidence was calculated as follows:

$$\frac{\text{number of rotten tubers}}{\text{total number of tubers}} \times 100\%$$

Severity of rot was determined using rating scale of 1 to 5 (1=asymptomatic and 5= extremely symptomatic). Data for percent severity was analysed using Genstat package whilst simple statistical graphs were used to represent percent rot incidence and inferences made. Data for rot severity was transformed by using square root transformation before analysis was done. Back transformation of data was performed after the analysis.

Results

The barn had temperature ranging between and 25^{O}C and 30^{O}C with an average relative humidity of 77.86% over a period of three months (Figs 1 &2).

Three categories of rot were observed on the stored tubers. These were soft, dry and wet rots. About 61% of the total number of rots recorded were the dry type, whilst soft and wet rots identified 34% and 5% respectively (Fig 3).

Major rot pathogens recorded over the period were *Lasiodiplodia theobromae, Fusarium oxysporum, Penicillium sp., Rhizopus sp., Aspergillus flavus and A. niger*. These organisms have been identified by other researchers to be associated with storage rots of white yams across the globe.

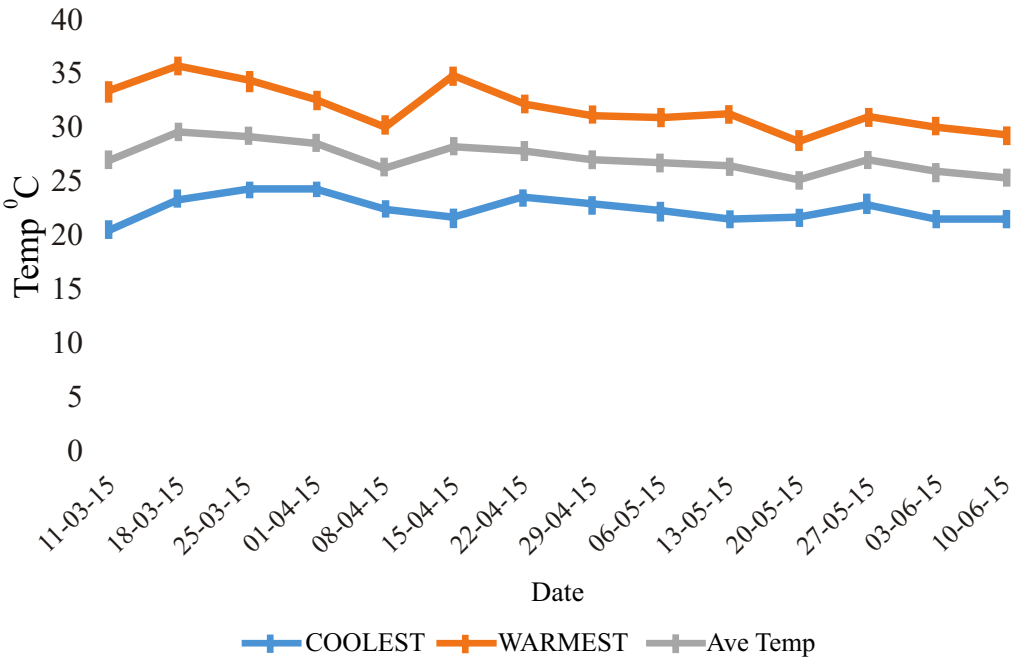

Fig 1: Temperature regimes for yam storage facility

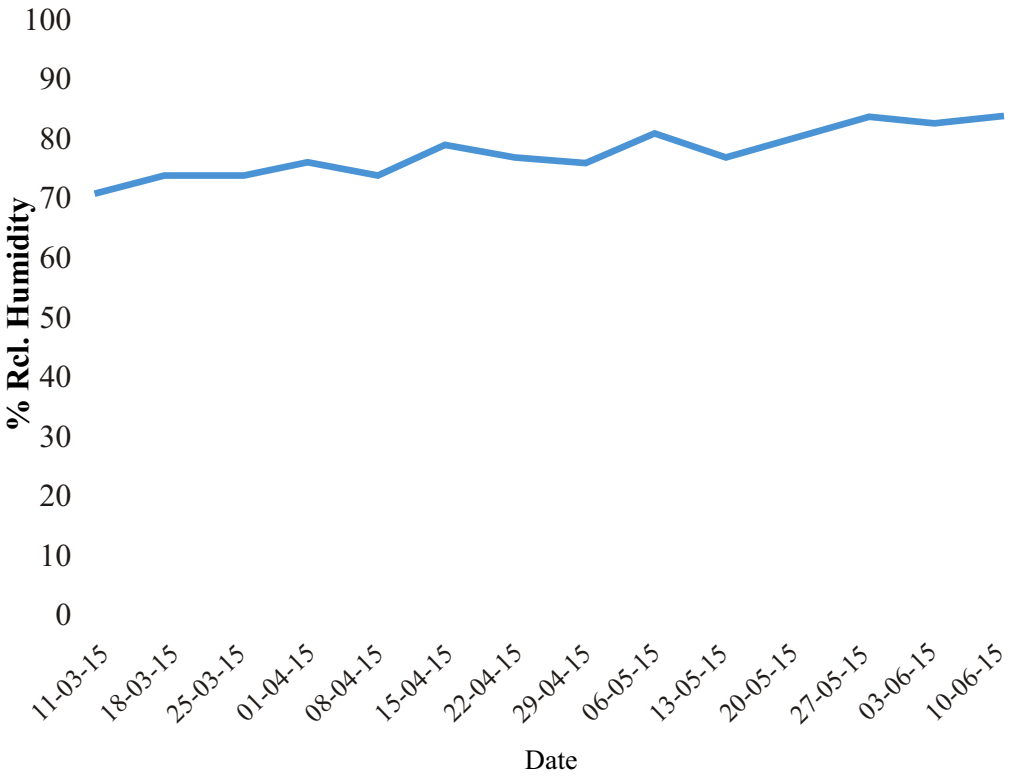

Fig 2: Relative humidity for yam storage acility where trials were carried out from March to June, 2015

Figures 4 and 5 shows the graphical representation of rot incidence of the two varieties during storage.After the six months of storage, the average rot incidence for Serwa and TDr 95/19177 were about 28% and 34% respectively. The highest incidence of rot for both varieties was recorded by M4 (35% and 40% respectively). From the graphs, differences in rot incidences among the treatments were not significantly different from each other.

Similarly, there were no significant differences among the five treatments in terms of rot severity for both varieties (Table 2).

Discussions

Results from this study indicates that application of recommended fertilizers on yam fields of the two cultivars have no effect on postharvest storability of tubers. This confirms a study done by Asieku *et. al.* (2015) that percentage rot difference was not significant amongst individual (sole) fertilisers applied at the recommended rates. However, it has been reported that a combination of chemical fertilizer and organic manure has an effect on yam tubers' storability (Asieku *et al.,* 2015), which needs to be further investigated.

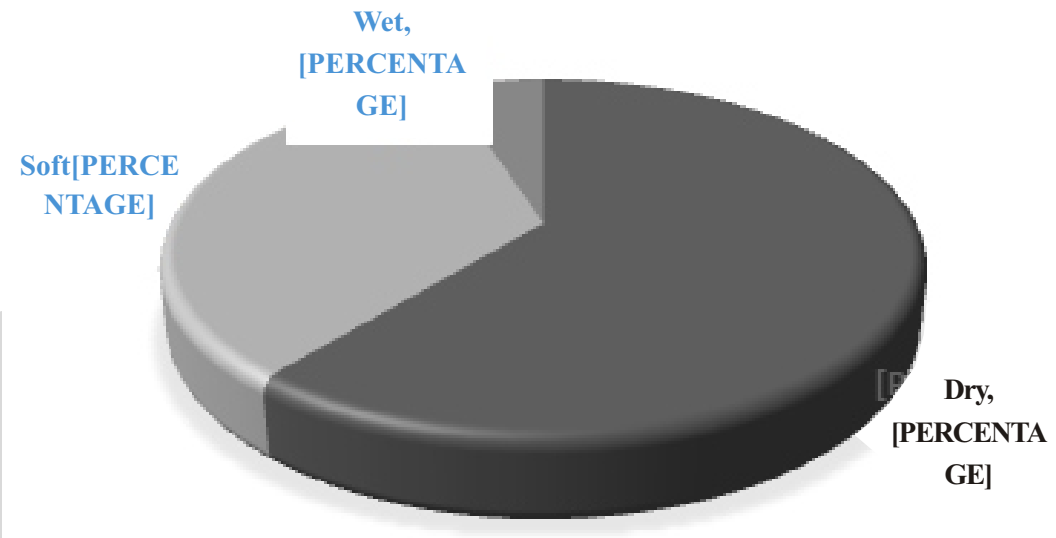

Fig 3: Rot categories observed during the storage periods of whiteyam tubers

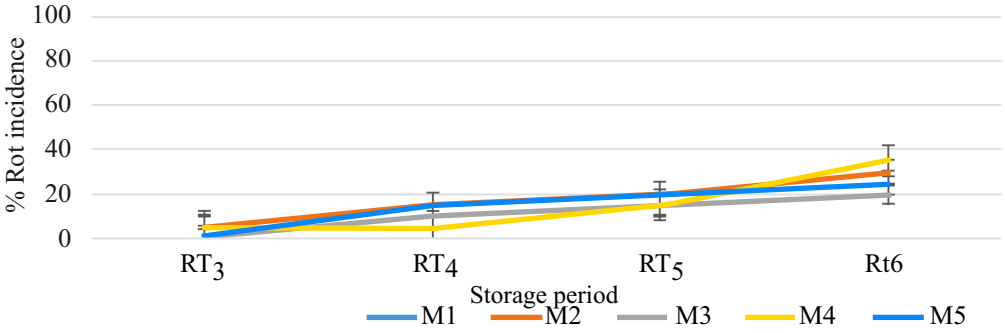

Figure 4: Effect of fertilizer application on rot incidence of *Serwa yam* tubers stored for 6 months

Other factors such cultivar type and tuber size are very important in the shelf life of most white yams. Asadu (1995) indicated that type of cultivar could play a role in high rotting rate of stored white yam tubers. The rate of rot for both cultivars were not relatively higher compared to other cultivars. This is due to the cultivar type as well as the size of the tubers. Gray (1996) observed pona to be more perishable and susceptible to rotting under storage compared to other varieties of D. *rotundata* species. Postharvest losses of yam are, in part due to field management but mostly dependent on species and cultivars (Eze and Orkwor, 2010).

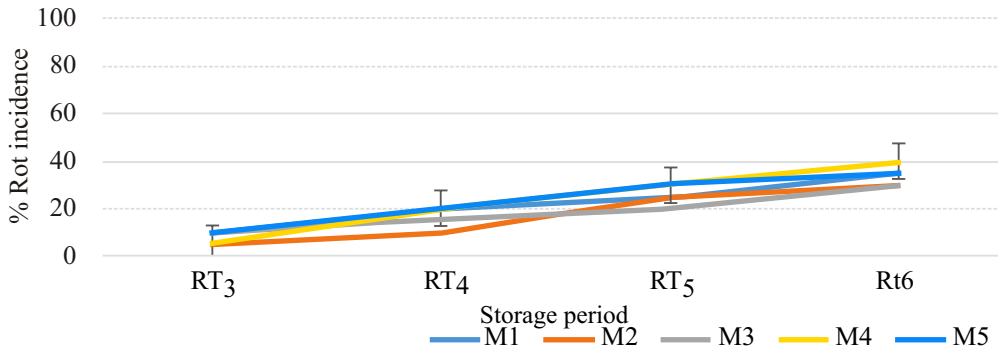

Figure 5: Effect of fertilizer application on rot incidence of *TDr 95/19177* yam tubers stored for 6 months.

Table 2: Effect of fertilizer application on rot severity of yam tubers (Serwa and TDr 95/19177) stored for six months.

Whiteyam variety	Severity score for Treatments				
	M1	M2	M3	M4	M5
Serwa	1.423	0.669	0.652	1.467	0.790
TDR 95/19177	0.843	0.872	0.748	0.757	0.773

SED(P <0.05)= 0.5086

In conclusion, yam export market and its use as a food security crop is under threat due to the perception that chemical fertiliser application is affecting its storability. Finding a lasting solution to the concerns have been raised by stakeholders. Awareness creation among farmers, exporters and other stakeholders on this issue, is important in finding a lasting solution to the problem. This preliminary results indicate that there is no effect of fertliser application on the postharvest shelf life of these two cultivars of white yam. Other trials on commercial white yam varieties such as Pona and Dente should be undertaken extensively under different storage conditions and at different ecological zones.

References

Asadu, C.L.A. 1995. Traditional/field storage practices intended to promote shelf life of yam in southeastern Nigeria. A paper presented on pests and pathogens of yam in storage at the International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria;

Asieku, Y., Otoo. E. & Asare, E, 2015. Yield and storage characteristics of whiteyam *(Dioscorea rotundata Poir)* as influenced by fertilizer application and time of harvesting in forest zone of Ghana. Jr. of Sci. Res. & Rep. 8(6):1-7

Eze, S.C. and Orkwor, G.C. 2010. Studies on effects of mineral fertilizer, organic manure and cultivar on the yield and storability of Yam *(Dioscorea rotundata Poir)*. Afri. Jr. of Food, Agri., Nut. & Dev. 10(6): 2755-2771

F.A.O.2005.FAO Annual Report. Food and

Agriculture Organisation Production Year Book. FAO Rome

F.A.O. 2013. Agribusiness Public Private Partnerships: A country report of Ghana. Food and Agriculture Organization of the United Nations, Rome

GhanaWeb Report. 2014. Ghana's yam Rejected. Http://www.ghanaweb.com /GhanaHomePage/ economy(date accessed: 3/3/2016).

Gray, A.1996. Report on yam marketing in Ghana. Project A0497; R6505. Chantham: Natural Resource Institute.

Tetteh, J.P., & Saakwa, C. 1994. Prospects and constraints of yam production in Ghana. In proceedings of 9th symposium of the International Society for Tropical Root Crops. Ofori and Halm. Accra, Ghana. 20-26 pp.ed: 10-032008)