



EFFECTS OF WEATHER VARIABILITY ON POTATO (*Solanum tuberosum* L.) STORAGE AT KURU, JOS, PLATEAU STATE , NIGERIA

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Abstract

This study examined the effects of two weather elements on potato (*Solanum tuberosum* L.) storage using three varieties such as (Nicola, Bertita and Diamant) and four different storage media (clay pot, basket, plastic crate and wooden crate). Daily mean Temperature (°c) and Relative humidity (%) were collected for the period of storage using thermo hygrograph. Each variety was divided into ware and seed tubers. Each method of storage was replicated three times and the experimental design was randomized complete block. ANOVA was used to analyze the data using gens tad statistical package. Results showed that, temperature and relative humidity influenced potato storage because as temperature increases, percentage sprout increases. It was also observed that, storing the three varieties used in this experiment for a period of four weeks and under temperature of 22.9°C and 61 % relative humidity, the Bertita variety sprouted faster, while Nicola had the lowest percentage sprouts. Also, storing potato at a temperature 23.3°C and 51 % for six weeks, Bertita had the highest percentage sprout, while the Nicola variety stored better because of the lower percentage sprout. High relative humidity increases the shelf life of potato while low humidity leads to dehydration of seed stored. The study concluded that, global warming influences potato storage because as temperature increases, percentage sprout increases. It was thereafter recommended that, data on all climate parameters should be collected, analyzed, and used for further study so as to view the effect of each parameter on potato storage.

Keywords: Global warming, relative humidity, sprout, storage, temperature, shelf life.

Introduction

Harvested potato tubers are living organisms and hence interact with the surrounding environment. To maintain potato quality during storage, the storage environment must be adjusted to minimize tuber deterioration. Temperature, humidity, and air movement can always affect keeping the quality of stored potatoes. Potatoes should always be kept in complete darkness to prevent greening. When potatoes are not properly stored, tuber losses due to fungal and bacterial infections can be high. To prevent this, storage conditions should be properly controlled depending on the type of potatoes stored (Khalil, n.d).

It is likely that the currently observed trend of global warming which has been 0.6°C + 0.2 since 1900 will

continue and the average global temperature will increase by between 1.4 and 5.8°C over the period 1900 to 2100 (Houghton *et al.*, 2001). The impact of this type of global warming that leads to climate change will probably lead to a decrease in crop productivity, but with important differences between regions and crop types (Rosenzweig and Liverman, 1992; McCarthy *et al.*, 2001).

The influence of temperature and relative humidity on crop production and storage can be complex, depending on the temperature regime and the crop (type and variety). High temperature can lead to low yields due to increased development rates and higher respiration. However, a short growth cycle can also be beneficial such as to escape drought or frost and the use of late maturity cultivars could offset the effect of high development rates. In environments

where low temperatures now limit production, global warming could lead to a beneficial lengthening of the growing season and temperatures close to optimal for assimilation. Moreover, global warming is related to the increase of atmospheric CO₂ concentration which is likely to increase crop yields particularly when water limits crop production (Lawal, Geoffrey, Adebayo, Wahab and Sani, 2022).

According to the Intergovernmental Panel on Climate Change (IPCC, 2007) cited in Lawal *et al.* (2022), the activities of man together with some natural phenomena have caused persistent emissions of greenhouse gases to the atmosphere. These have resulted in continuous increase in global warming which has consequently led to climate change. According to Ogunkolu and Atawodi (2022), high temperature causes thermal or heat discomfort. This discomfort also affect both plants and animals. In crops, the discomfort may affect all the stages of growth and storage. This has called for this research which aims at looking into the effects of weather variability on potato (*Solanum tuberosum L.*) storage at Kuru, Jos Plateau, Nigeria. Potato (*Solanum tuberosum L.*) is grown in many different environments, but it is best adapted to temperate climates (McCarthy *et al.*, 2001). At high temperatures (above 17°C; tuberization diminishes (Okonkwo, Nwokocha, and Ifenkwe, 1986).

Pardo *et al.* (2000) indicated that the quality of potatoes is a combination of various physiochemical and nutritional characteristics, which are greatly influenced by storage conditions. Fresh horticultural and agricultural crops are living organisms. They must be remained alive and healthy until processed or consumed. Energy needed for these life processes comes from the accumulated food reserves through a process called respiration. The final result of respiration activity leads to product deterioration and senescence, and hence achieving as low respiration rate as possible very important to prolong the shelf life of biological materials (Brosnan and Sun, 2001). Chourasia and Goswami (2001) pointed out that low-temperature storage can cause freezing injuries which cause tubers to become soft and unusable. However, high storage temperature produces greater quality loss and increases respiration activity and thus lowered shelf life. Nourian *et al.* (2003) stated that appropriate storage environment should maintain tubers in their edible and marketable conditions by preventing large moisture losses,

spoilage by pathogens, quality deterioration and sprout growth. Therefore, it is against this reason that this research employs the use of different storage media to see which storage media may provide the necessary environment to prevent weight loss, shrinkage, and shape marketable of potato tubers. Verboven *et al.* (2006) determined many factors that affect the respiration rate such as commodity, variety, maturity or ripeness stage, injuries, temperature, gas conditions and other stress related factors. During cooling process of agricultural crops, particularly potato, cooling conditions should be controlled carefully especially with respect to air temperature and humidity (Hoang et al., 2004). The optimum range of temperature and relative humidity of the air inside cold stores are 2-4 °C and 85-90% respectively for long term storage (Van't Oostar, 1999). However, previous studies showed large variation in temperature and relative humidity in cold stores ranging from 2-5 °C and 80 – 92% respectively. Long term storage tests at 0–10°C indicated that for potatoes the optimum relative humidity was 98–100%, for potatoes, the high relative humidity minimized moisture loss, generally reduced decay and maintained firmness and a thin skin (WARD, 2008);

The Objectives of this study are to;

- i. determine the influence of temperature and relative humidity on various potato storage media and
- ii. assess the effect of variety and storage media on percentage sprout.

Materials and Method

The study was carried out at Kuru, Jos Plateau, Nigeria. National Root Crops Research Institute Potato Programme, Kuru Meteorological Station where empirical rainfall data were collected for this study is 1,257 meters above sea level located on Latitude 9°44'10" and Longitude 8°48'21". The station has mean climatological mean maximum temperature of 27,4 °C and a range of 24-29°C and a mean minimum temperature of 16.4°C with a range of 12-20°C (Audu, 2021). Similarly, the mean relative humidity was 56% with a range of 28-83% with the highest in August (83%) and lowest in January (28%) Audu, 2021). Data on yield of three potato varieties,

Diamant a late maturing variety, Nicola a medium maturing variety and Bertita early maturing variety were collected from the germ plasm for eight years.

Four methods of potato storage such as clay pot, basket, plastic crate and wooden crate were assessed under Jos Plateau condition. The study was set up in a thatch diffused light store described by Okonkwo, Nwokocha, and Ifenkwe, (1986). Each variety was divided into ware and seed tubers. Each method of storage was replicated three times, and the experimental design was randomized complete block. The potato was stored from 15th September to 30th December 2021. Data on Relative humidity (%) and mean temperature (°C) were taken using a self-recording instrument thermos-hygrograph at intervals of 4,6,8,10,12, and 14 weeks. Also, data on weight, rot, disease, and percentage sprout were recorded at the same intervals for the period of the experiment. ANOVA was applied to analyze the data using Gens tad statistical package.

Results and Discussion

Table 1 shows the weather condition of the storage environment and the outside environment as recorded during the storage research period between September and December 2021. From the data above the mean temperature recorded in the storage environment seems to be higher than the outside environment. This might be due to air in motion that regulate temperatures at the Meteorological station which is not so in the storage environment. However, the relative humidity did not follow the temperature pattern where it varies from month to month and location that is in or outside the storage environment as shown in table 1.

The temperature at which a tuber is stored has a profound effect on some important physiological processes that occur in the tuber during storage. The rate of respiration, evaporation and sprout growth increases with temperature (Okonkwo, Nwokocha,

and Ifenkwe, 1986). High temperature may lead to overheating and tuber rots when ventilation is inadequate. Temperature is the single most important factor in keeping the quality of stored potatoes. Respiration, sprouting, water loss, relative humidity, chemical composition, and the development of storage diseases are all influenced by temperature. Respiration consumes oxygen and releases carbon dioxide, volatile gases, water and heat (Khalil, n.d).

Relative humidity of the storage environment affects the rate of evaporation and water loss by the tuber. At low relative humidity the rate of evaporation and water loss from the tuber is very high. High relative humidity at high temperature may favour rots of potato tubers. Low relative humidity experience during the harmattan months of November to March on the Jos Plateau makes it difficult to store potato tuber especially tiny tubers produced from true potato seed (TPS) because of the dehydrating effect of the air. At 4-5°C and relative humidity of 95-98 %, potato tubers can be stored for over twelve months (Burton, Van and Hartmans, 1992). At low relative humidity, water loss of tubers by evaporation and transpiration increases with the development of sprouts.

Effects of Rainfall, Rain Days, Maximum and Minimum temperatures on yield of Diamant and Nicola

From the regression analysis carried out for the yield of the two potato varieties, result shows no significant difference and the constant estimate for Diamant and Nicola gave high negative values which show that there are a lot of factors that were not captured.

Figures 1 and 2 in appendix show the linear trend of rainfall from 1978-2011 and linear trend of temperature respectively. Both trend graphs show there is an increase in both temperature and rainfall.

Table 1: Mean Temperature and Relative Humidity of Storage Environment and Outside 2021

Month	Storage Environ.		Outside Record	
	Mean Temp.	Relative Humidity%	Mean Temp.	Relative Humidity%
September	23	62	22	66
October	24	56	22	54
November	24	22	21	21
December	22	17	20	19

Source: Authors' computation, 2022

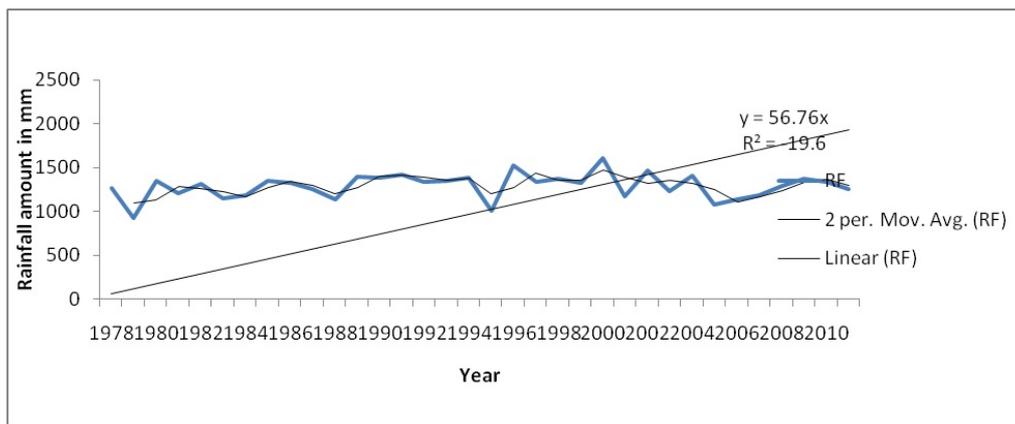


Figure 1: Rainfall trend in Kuru, Jos Plateau, Nigeria from 1978 to 2011

Source: Authors' computation, 2022

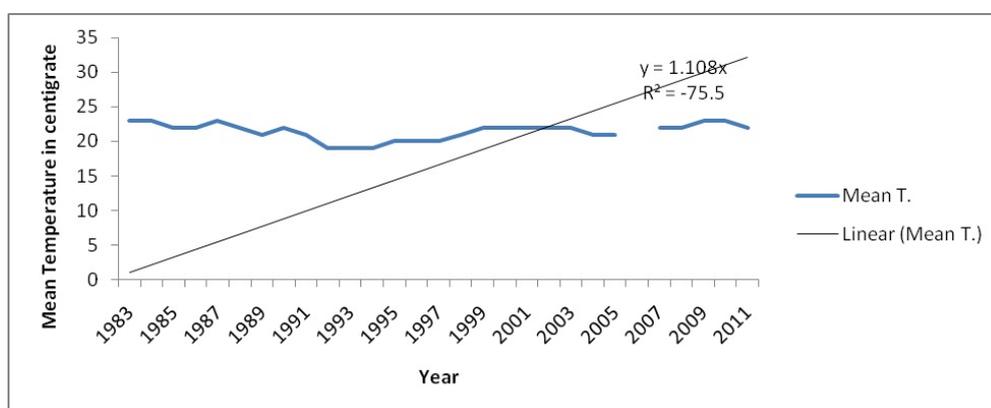


Figure 2: Linear trend of Mean temperature in Kuru, Jos Plateau, Nigeria from 1983-2011

Source: Authors' computation, 2022

Table 2: Effect of storage medium and variety on percentage sprout of potato at four weeks after storage at Kuru (6 Sept.-12th Oct 2021)

Storage Medium	Variety			Means
	Diamant	Bertita	Nicola	
Clay pot	7.72	14.30	1.17	7.73
Plastic crate	5.50	14.43	4.72	8.22
Wood crate	5.37	13.28	2.58	7.08
Means	6.69	15.59	2.62	
LSD (0.05)	4.614			

Mean Temperature 22.9°C, and Relative humidity 61%

Source: Authors' computation, 2022

Table 2 shows the effect of storage medium on the varieties in percentages. It is observed that, storage medium does not affect percentage sprout; but there are differences due to variety, though Nicola is long dormancy breaking variety compared to the other two. Among the three varieties, there is significant difference with Nicola having low percentage sprout followed by Diamant while Bertita showed highest percentage sprout under average mean temperature

and relative humidity of 22.9°C and 61 % respectively between 14th Sept-15th October in Kuru. The early percentage sprout recorded at four weeks after storage may be due to high mean temperature of 22.9°C and low relative humidity of 61 % recorded in the store as against 10 -15°C recommended for three-month storage of potato by Booth and Shaw cited in Okonkwo, Nwokocha, and Ifenkwe, (1986).

Table 3: Effect of storage medium and variety on percentage sprout at six weeks after storage (20th -25th October 2021)

Storage medium	Variety			Mean	LSD
	Diamant	Bertita	Nicola		
Clay pot	70.5	100.0	40.7	70.4	
Basket	71.0	99.5	63.0	77.8	
Plastic crate	67.5	97.8	30.5	65.3	9.67
Wood crate	70.2	100.0	26.0	65.4	
Mean	69.8	99.3	40.0		
LSD (0.05)	8.38				

Mean Temp. 23.3°C, Relative humidity 51 %

Source: Authors' computation, 2022

Table 3 shows the effect of storage medium and variety on percentage sprout at six weeks after storage at Kuru (20th – 25th October). There are significant differences among the three varieties, with Nicola having the lowest percentage sprout, followed by Diamant while Bertita has the highest percentage sprout. This followed the trend in Table 2. Among the storage mediums there is no significant difference under mean temperature and relative humidity of 23.3°C and 51 % respectively.

Conclusion and Recommendation

From the experiment, it was observed that global warming influences potato storage because as temperature increases and relative humidity

decreases percentage sprout increases. It was also observed that, storing the three varieties used in this experiment for a period of four weeks and under temperature of 22.9°C and 61 % relative humidity, Bertita sprout faster while Nicola had the lowest percentage sprouts and Diamant is intermediate in terms of sprouting under the above conditions. Also storing potato at a temperature 23.3°C and relative humidity of 51 % for six weeks, Bertita had the highest percentage sprout, while Nicola stored better because of the lower percentage sprout. Arising from this study, it is highly recommended that, data on all climate parameters should be collected, analysed and used so as to view the parameter with the highest positive or negative effect on potato storage in the study area.

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