Mutation breeding is an alternative to conventional method of breeding especially in plants. This method has been utilized extensively in developed nations, but the story is different in African countries especially in Nigeria. This book is an effort that bring to limelight the state of mutation breeding in Nigeria. It considered information on some important crops that have received attention in the area of mutation breeding.

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Mutation Breeding in Nigeria

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STATUS OF MUTATION BREEDING OF CROP PLANTS IN NIGERIA

CONTENTS

OVERVIEW OF INDUCED MUTAGENESIS IN NIGERIA

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Introduction

Mutagenesis is an induction of sudden heritable changes in the genetic makeup of an organism through the use of chemical, physical or biological agents (Roychowdhury and Tah 2013). According to Oladosu *et al*. (2016), three types of mutagenesis are adopted in mutation breeding. The first is induced type, in which mutations result due to application of physical mutagens (like gamma rays, X-rays, ion beam etc.) and or chemical mutagens (such as sodium azide, Ethyl methane sulphonate etc.). Site-directed is the second

type and it involves creating a mutation at a defined site in a DNA molecule (Oladosu *et al*., 2016). The third is insertion mutagenesis which involves insertion of DNA molecule. This can be achieved either through genetic transformation and insertion of T-DNA or activation of transposable elements (Kharkwal and Shu, 2009; Forster and Shu, 2012). Induced mutagenesis shall be our area of discussion as it is the most commonly used technique in Nigeria.

History of mutagenesis

The history of plant mutation could be dated back to 300 BC with reports of mutant crops in China (Kharkwal, 2012). Mutation induction by radiation advanced as a field of research after Stadler demonstrated the mutagenic action of X-rays in maize, barley and wheat (Oladosu *et al*., 2016). Tobacco plant was the first to have its mutant variety commercialized in 1934. Earlier to 1995, a total of 77 mutant cultivars was reported by Acquaah (2006). However, in 1995, the number of mutant varieties commercialized and released rouse to 484. Since then this number has grown sharply with new cultivars being reported

continuously in different continents (Oladosu *et al*., 2016). Some agronomic traits modified by mutation breeding include resistance to lodging, early maturity, hardiness to winter, quality of the plant products (such as protein and lysine content) and many ornamental mutants. According to IAEA (2015), China, Japan, India, Russia and Netherland are the first five ranked countries in terms of released mutant varieties. Although mutation induction as a field is old, it has gained very little attention in Africa and particularly in Nigeria. Nigeria (giant of Africa) is lagging behind in the area of induced mutagenesis. Internationally, Nigeria has record of only 3 released mutant varieties which were registered between 1980 and 1988 (Table 1).

Table 1: The List of top five rank countries and some African countries with released mutant varieties.

Country	Registration date	No. of released varieties
China	1957-2011	810
Japan	1961-2008	481
India	1950-2010	330
Russia	1965-2011	216
Netherlands	1954-1988	176
Cote D'Ivoire	1976-1987	25
Mali	1998-2000	15
Iraq	1992-1995	23
Egypt	1980-2011	9
Nigeria	1980-1988	3

Source (IAEA, 2015)

Kharkwal and Shu (2009) brought to limelight achievements in the area of food security in Africa through mutagenesis. Egypt, Sudan and Ghana made significant achievements while Nigeria was not mentioned due to her little or no achievements in the recent years. Egypt for example introduced two mutant varieties of rice; semi-dwarf, 'Giza 176' (1989) and 'Sakha 101' (1997). Similarly, in Sudan a banana mutant cultivar (Albeely) was released in the year 2003 which excelled the yield of the existing cultivars by 40% and has better crop stand and fruit quality (Table 2).

Table 2: Some African countries that have significant achievements in recent years

Country	Crop	Achievements	Source
Egypt	Rice	Increased yield from 3.8 t/ha to 8.9 t/ha	González *et al*., 2008
Sudan	Banana	Increments in yield by 40%	Ali, 2008
	Ground nut	Drought tolerant	Ali, 2008
	Tomato	Resistant to yellow leaf curl virus and good poundability	Ali, 2008
Ghana	Cassava	High dry matter content (40%)	Danso *et al*., 2008
	Cocoa	Resistant to cocoa swollen shoot virus	Danso *et al*., 2008

Mode of operation of induced mutagenesis and its products

All induced mutations (whether by physical or chemical method) occur at random across the whole genome and within any locus or gene (Forster and Shu, 2012). In addition to the probability of generating mutations for any gene of interest, induced mutagenesis, also enables in a predictive manner, the development of multiple mutations for any target gene (Oladosu *et al*., 2016). The source of genetic diversity for crop breeding as well as functional analysis of the targeted genes, are multiple mutant alleles. The bulk of gene mutations produced by radiation efficiently destroy gene function as the gene is either knocked out or the mutation product is nonfunctional. Therefore the bulk of mutated genes are recessive in nature.

Importance and Advantages of induced mutagenesis

Induced mutagenesis as plant breeding strategy, is a recognized, harmless, robust and low-cost technique (Mba, 2013). In some crops, many parents used in hybridization had their desired genes from induced

mutation (Maluszynski *et al*., 2000). Mutagenesis has over time become an important aspect and useful tool in plant breeding. It has helped in increasing variations in plants which is the raw material needed for plant breeding. These variations form the basis for the evolution of new and better forms, varieties or species.

Induced mutations has helped in supplementing natural genetic variability which may not occur as fast as needed by the plant breeders considering the rapid changing needs for food and fiber, there is need for a more rapid generation of new genetic forms which can only be supplied by induced mutations (Nilan *et al*., 1977). The effectiveness of mutagenesis in generating desired variation in crop plants has been widely proven and properly documented (Maluszynski *et al*., 2000). Genetic variation of desirable traits for crop improvement, is a core requirement in plant breeding. According to Maluszynski *et al*. (2000) mutation techniques are highly efficient especially in generating desirable variation in crop plants.

Induced mutations have been used to produce improved varieties of crop plants with desirable characters such

as higher yield, disease resistance, improved nutritional composition and abiotic stress resistance. Mutagenesis produces new phenotypic characters which increases the scope for selection and hybridization. Therefore artificial induction of mutation can be of help in hybridization work especially if the parents lack variability or are deficient in certain desirable characters (Aamir 2016).

Mutation breeding is also a faster way to produce crops with improved traits compared to the traditional hybridization method which may take up to seven years, but with induced mutation, one can arrive at crops with improved traits in the M_2 or M_3 mutants. Induced mutation is the ultimate source to alter the genetics of crop plants that may be difficult to achieve, through cross breeding and other breeding procedures (Khan and Wani, 2004). In addition, for some crops that are propagated by vegetative method, mutagenesis provides an alternative and useful tool in improving such crops in which hybridization cannot be used (Aamir, 2016). Rapid improvement of plant yield and quality could be ascribed to direct use of mutation

in the development of molecular maps in structural and functional genomics (Raina *et al*., 2016).

Conclusion

Literatures have shown many elementary works on plant mutagenesis in Nigeria. However, the number of registered mutant varieties by Nigeria as a nation is an indication that the country is lagging behind in the area of Plant mutagenesis. Achievements made in recent years by other African countries like Egypt, Sudan, Ghana implies that Nigeria has not given enough attention to this area of research.

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