

## Radioisotopes in Agricultural Industry

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**ABSTRACT**

*In environment there are approximately 300 nuclei, containing of different components and their isotopes. Isotopes are nuclei having the similar number of protons and different number of neutrons. Radioisotopes can be applied in vast range of agricultural systems. Scientists are solving the mysteries of multitude agricultural difficulties, which could not have been conceivable with formal ways. Radioisotopes were used in many range of application such as killing insects which damage the food grains by radiations, determining the function of fertilizers in different plants and increase the agricultural produce. Fruits, cereals, canned food and vegetables can be stored for longer periods by moderately exposing them to radiations. Uses of radioisotopes applicable techniques are helping the researchers to find the answer of difficulties in much lesser time. Radioisotopes can be produce from different sources such as nuclear reactors and other atomic installations, and this situation have increased the use of radioisotopes in the agricultural systems. The current paper shortly illustrates the importance of radioisotopes and their radiation in the agricultural areas.*

**Keywords:** Isotopes; protons, Radiations, Agricultural products.

**Introduction**

Nuclear science suggests methods that are being used to modify efficiency while conserving useful skills needed for human life [15]. The isotopes are known as radioisotopes have unstable nuclei. Radioisotopes have played an important role in improving productivity in agricultural products. Ionizing radiation is very appreciated for preservation of farming and food products. Many agricultural products used in our daily life have in some way benefited from radiation through their production. Radioactive exposure progresses quality and productivity of agricultural products along with pest, insect and disease controlling [3]. They are valuable in study of best utilization of fertilizers, pesticides and insecticides in agricultural produces without injurious effects. Radioisotopes are used as an investigation tool to advance new strains of farming products that are drought and disease resistant, are of greater quality, have smaller growing time and produce a greater yield. Radioactive features emit a variety of radiations and energy particles through decay which are used in health care, farming and physical sciences for basic investigation and in comprehensive variety of applications [16].

International Atomic Energy Agency (IAEA) promotes the broader use of radiation in research, farming, engineering, and medicine. Food and Agriculture Organization (FAO) and IAEA works to simplifying growth and adoption of nuclear approaches at worldwide levels for improving productivity of agricultural products. Radioisotopes and controlled radiation are now used in a range of studies like nutrition preservation, yield improvement, sterilize medical supplies, control industrial procedures, determine groundwater resources and to study environmental contamination [13]. FAO and IAEA jointly supports research projects during the world on the use of radioisotopes and radiation in the fields of health and nutrition preservation, soil productiveness, irrigation and crop production, insect and pest control and livestock production[4]. Development of agriculture industry is one of the most important contributions that atomic energy can make to meet the challenge of food security for present and future generation, to protect the environment and also to conserve natural resources [9]. While some development in this way has already been made, the full potential is yet to be explored sufficiently.

**Applications of Radioisotopes in Agricultural Industry****Animal Production**

In many countries animal production is restricted by reproductive performance, poor growth and milk production of livestock, which limits the availability of animal products such as milk, meat, leather, etc. insufficient nutrition can reduce animal production, it is because from absence of adaptation to the prevailing climatic situations and some diseases. Coordinated research programmers on the research of non-protein nitrogen metabolism using nitrogen-15 with studies on mineral imbalances, are helping to devise alternative feeding practices in countries where old-style feeds for livestock are in small supply.

### **Crop improvement**

Different kinds of radiation can be used to induce mutations to advance desired mutants line that are resistant to infection, are of greater quality, produce a greater production, and allow earlier ripening. In the first time, Stadler in 1930 attempted to induce mutations in plants by using X-rays. Later on, neutron and gamma radiation were employed as ionizing radiations. This method of utilizing radiation energy for inducing mutation in plants has been widely used to gain desired or improved factors in number of plant varieties. An appropriate selection of mutant varieties can lead to improved efficiency and quality. During past decades, radiation-induced mutations have more and more contributed to the development of crop plant varieties and it has become an established section of plant breeding approaches. Radiation induced mutation experiments are showing promising results for development of cultivated crop varieties in various countries. Bhabha Atomic Research Centre (BARC) has developed number of great yielding varieties of black gram, green gram, groundnut, rice and jute by using radiation energy for inducing mutation [17]. Some varieties of Crops developed by using induced mutations have been found appreciated by many countries so they have been released and approved for economical production.

### **Plant nutrition**

Fertilizers are very costly and their well-organized use is of great significance to reduce the production price of farming products. It is necessary that a maximum quantity of manure used through cultivation finds its method into the plant and that the minimum is lost. Radioisotopes are very valuable in guessing the quantity of nitrogen and phosphorus available in the soil. This guessing helps in determining the quantity of nitrogen and phosphorus fertilizers that should be applied to soil. .Radioactive isotopes such as phosphorus-32 and nitrogen-15 have been labeled fertilizers and have been used to study the uptake, retention and utilization of fertilizers. These isotopes provide a means to determine about quantity of fertilizer taken and lost to the environment by the plant [7]. Only small quantity of fertilizer applied to the soil is taken up by the crop. The rest either remains in the soil or is lost through several procedures. IAEA and FAO have jointly conducted several research plans for the efficient use of radioactive isotopes for fertilizer managing practices in main crops like rice, wheat and maize [8]. Radioactive isotopes can be used as “tags” to monitor uptake and use of important nutrients by plants from soil [9]. This method allows researchers to measure the exact water requirements and nutrient of crop in specific conditions. A key factor in successful crop production is the presence of an adequate water supply. Nuclear science have really facilitated such studies and are now being broadly used in soil plant nutrition and investigation to make the most efficient use of limited water sources. Ionizing radiation is also used to sterilize the soil and there is a well deal of current attention in the use of radiation for the eradication of bacteria in the soils which causes diseases and is dangerous to plant life.

### **Food processing and protection**

Request for instant food which is wholesome and which has a long shelf life is growing in developing countries and developed countries and the 25-30% of the world’s food produce are lost due to spoilage by pest and microbes. Results show developing countries are more in these losses. This injury of food can be avoided by using effective food protection approaches. Radiation can be used to abolish microbes in food and control insect and parasite infestation in gathered food to prevent various types of wastage and spoilage [10]. Irradiation of food is energy-preserving when compared with conventional approaches of preserving food to achieve a similar shelf-life [18]. Food irradiation can replace or decrease the use of food additives and fumigants which are dangerous for users as well as workers in food processing trades. Food irradiation does not warmth the food material so food keeps its freshness in standard state. The agents which cause spoilage (microbes, insects, etc.) are eliminated by irradiation from packaged food and packaging materials are impermeable to insects and bacteria so recontamination does not take place. Irradiation of food kills parasites and insects, prevent reproduction of insects and microbes, deactivate bacterial spores and delays ripening of fruits and improve important properties of food. FDA has approved irradiation as a technique to inhibit sprouting and to delay ripening in various fruits. Several steps were taken by the IAEA and FAO division in close cooperation with the World Health Organization (WHO) to promote worldwide acceptance of food under irradiation [19]. Results show irradiation of food is controversial in various countries [5]. Efforts and support from, governments, international organizations and the food industry will be needed for the introduction of irradiation in food industry on a correctly commercial scale [6]. Some governments and businesses do not recognize this inexpensive and effective food preservation approach. In the last 30 years of testing of some foods under irradiation, no destructive effects to human or animals have been found so now attitude of relevant governments is changing and some irradiated foods are being released for general consumption. Many governments have accorded clearance for gamma irradiation of food items.

**Insect pest management**

Insect pests are responsible for major reduction in production of farming crops all over the world [1]. They are serious threat to farming productivity. Insect pests not only reduce crop yields but also transmit disease to cultivated agricultural crops. Researches have helped to trace and decrease the side effects of pesticides and insecticides. There are worries that constant uses of pesticides have harmful influences on the environment and it also results into progress of resistance against pesticides in several insect species [2]. IAEA is using nuclear knowledge to develop environmentally friendly alternatives for pest control. IAEA and FAO division jointly sponsors projects and conducts study on control of insects using ionizing radiations. They have placed significant emphasis on the Sterile Insect Technique (SIT). This method relies on application of ionizing radiation as a means to efficiently sterilize male insects without affecting their ability to function in the field and effectively mate with wild female insects [14]. It is very specific form of birth control which decreases and eliminates the insect population after two or three generations. It has been successfully screw worm infestation in the US and Mexico and also successfully utilized in elimination of Mediterranean fruit fly from US, Mexico and Chile [12, 20, 11].

**Discussion**

Main restriction to increased agricultural yields is that caused by parasitic and many diseases. Radioisotope technologies are not only providing a well-defined picture of the effect that parasites and diseases have on hosts but are also illustrating how management and genotypes (breeds and species) can be modified to decrease the effect of the disease or parasite on final production. Ionizing radiation has been effectively used to produce an attenuated vaccine against lungworm sheep in and cattle and this knowledge is being transferred to some countries such as Brazil, India, and Ethiopia where control of this parasitic disease is very important.

In agricultural industry, radioisotopes are generally used as tracers. Radiation can be used to exterminate insects and Sterile Insect Technique (SIT) is applied to inhibit the reproducing power of the insects so as to reduce their population. With the support of the International Atomic Energy Agency (IAEA) and the United Nations Food and Agriculture Organization (FAO), the SIT programmers are underway in many countries. Stable isotopes are used in the similar way as radioactive isotopes in agricultural industry studies. The most common stable isotope used in agricultural industry is <sup>15</sup>N but a large number of other stable isotopes are produced which are increasingly being used (Table 1). Table 2 shows several isotope of nitrogen.

Table1. Some useful stable isotopes in commercial production

Atomic Number	Isotopes
6	<sup>13</sup> C
7	<sup>15</sup> N
8	<sup>18</sup> O
12	<sup>24</sup> Mg
14	<sup>28</sup> Si
16	<sup>33</sup> S
	<sup>36</sup> S
26	<sup>54</sup> Fe
30	<sup>68</sup> Zn
82	<sup>204</sup> Pb

Adapted from IAEA Bulletin No.14.2001

**Table 2. Several isotopes of nitrogen**

Mass number	Natural abundance(%)	Half-life(Time)
12		-0.0125 sec
13	10.05 min	
14	99.634(light) -	
15	0.366(Heavy) -	
16		7.36 sec
17	4.14 sec	

### Conclusion

Radioactive and radiation have been developed to many parts of agricultural industry. They have facilitated response problems that seemed unresolvable. Radioisotopes are used to increase the quality and efficiency of agricultural crops. It is sensed that in addition to the enormous efforts of researchers engaged in developing nuclear knowledge, the sincere efforts of media in popularizing and spreading the advantageous uses of radioisotopes for national development are going to play a key role in recognizing the full potential of atom. Perhaps the most characteristic realization of the researchers today is that the world is too complex to be completely described, that models must change continually to absorb new findings, and that the recurring miracle of life is more majestic than any formulation, any processor, or any rocket that human's brain can devise.

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