

Use of Radioisotopes to Produce High Yielding Crops in Order to Increase Agricultural Production [†]

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Abstract: Nuclear technology can play an important role in innovating weapons capabilities and energy. The use of the influence of radioisotopes, agricultural sector has made tremendous progress. Fertilizers are used in agriculture to increase soil fertility, thereby increasing crop yields. Radioisotopes are used to produce high-yield crop seeds to increase agricultural production globally, the use of chemical fertilizers is very expensive, improper use will lead to a waste of money and resources and may cause damage the environment. Radioisotopes can be applied in a variety of ways to resolve many problems in the agricultural production and improve industry efficiency. These applications are particularly important for resource-poor developing countries or regions like water is scarce as a result of drought, and for protecting natural resources while addressing food security challenges. This article will explore how to use radiation to improve plant nutrition in fertilizers and produce seed variants, both of which have created higher efficiency in the production.

Keywords: radioisotopes; soil fertility; crop productivity; drought-resistant; disease-resistant

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1. Introduction

Radioisotopes are isotopes of chemical elements. The production of radioisotopes in the reactor is based on the capture of neutrons in the target material, which is generated by fission of the target material through activation or thermal neutron bombardment. Radioisotopes are used as research tools to develop new agricultural strains [1]. Drought-resistant, disease-resistant, high-quality, short-growing crops Time and produce higher yields. Radioactive elements emit all kinds of radiation, Energy particles in the decay process, used in healthcare, agriculture and sports Basic research and widely used science [2]. Radioactive exposure can improve the quality and productivity of agricultural products with insects, pests and diseases management. Radioisotopes can also be used to study soil properties to monitor the emission and utilization of necessary nutrients from soil by plants [3]. Radioisotopes used as labels, scientists can measure the exact nutrient and water requirements of crops under specific conditions. Radiation used in agriculture for illustration, radioisotopes and controlled radiation are used to improve food crops [4], preserve food, determine groundwater resources, disinfect medical supplies, analyze hormones, X-ray pipelines, control industrial processes, and study environmental pollution [5]. Radiation is used to make high-performance polymeric materials. Radiation can cause some molecules to cross-link, forming giant molecules with higher heat resistance, chem-

ical resistance and mechanical properties [5]. The effective use of fertilizers is very important because not only [6]. The price is expensive, but for many countries, this means a lot of foreign currency spending of improper use of fertilizers can cause huge losses and may damage the environment [7]. Therefore it is essential that the maximum amount of fertilization fertilizer can enter the plant, Due to improper placement, incorrect timing and other reasons, the minimum was lost [8]. Fertilizers labeled with radioactive isotopes (for example 32 phosphorus) or stable isotopes. For example, Nitrogen 15 , provides a way to determine how much fertilizer is absorbed The damage caused and the damage to the environment. Nitrogen 15 can also be provided directly Evaluation of fixed nitrogen content in the field atmosphere condition [9].

Phosphorus- 32 is used in plant science to track the fertilizer absorption of plants from roots to leaves. When fertilizers labeled with phosphorus 32 are applied to plants in a hydroponic manner or through water in the soil, the amount of phosphorus used can be mapped from the emitted beta radiation [10]. Irradiation can preserve the nutrients in food and kill the microorganisms that destroy them. Preservation technology exposes food to electron beams or gamma rays, a type of high-energy light that is stronger than X-rays used by doctors to take pictures of the inside [11]. Irradiation does not change the appearance or taste of food. Chemical fertilizers are expensive, and improper use can cause water pollution [12]. Therefore, the effective use of fertilizer has attracted the attention of developing and developed countries [13]. It is important to get as much fertilizer as possible into the plants and minimize the damage to the environment. Fertilizers "labeled" with specific isotopes (such as nitrogen 15 or Phosphorus- 32) provide a way to find out how much the plant has absorbed and lost, so that fertilizer use can be better managed [14]. Using N- 15 can also assess how much nitrogen the root bacteria in the soil and beans have fixed from the air [15].

Recent studies on radioisotopes have also shown that for many crops, supplying plant nutrients through leaves is faster and more effective than applying them in the soil. For example, it has been found that up to 10% of nutrients that are hardly absorbed by the roots can be absorbed up to 90% when applied to leaves [16]. It has been found experimentally that nutrient absorption by leaves not only occurs during the day, but also at night [17]. Through the isotope technology, not only can determine the amount of nutrients absorbed by the plant, but also give people the opportunity to understand the movement of the plant and the location of its accumulation [18]. In plants, most of the radioactive phosphorus has been used in this type of research, and the results show that the nutrient is absorbed faster than expected. Radioisotopes and radiation are used for mutation induction [19]. Mutation is a sudden genetic mutation of the genetic factor organ on the chromosome of an organism. Using radiation to induce genetic variation is a potentially valuable tool in agriculture. We have been able to prove with certainty that radiation can produce changes in genetically modified tissues, and these changes are useful for plant improvement [20].

At present, the application of radioisotopes in agriculture is more extensive than in any other scientific fields, and their applications enable us to solve many agricultural problems more accurately in a shorter time [21]. Therefore, radioisotopes have become an important help for scientists who solve agricultural problems [22]. In addition, radiotracers and energy sources consume become indispensable to all complex agronomic research issues. Radioisotopes and radiation provide us the opportunity to clear away mysterious events that were once in the nutrition and growth of plants and the evolution of new crop varieties [23]. They help us eliminate accidental factors that have adverse effects on plants in different ways. In agriculture [24], radioisotopes are used for the nutritional research of major and minor elements, milk production, and the research of photosynthesis mechanism. Plant protection, plant pathology, the role of pesticides, the absorption of fertilizers, the migration of ions in the soil, and the preservation of plants and food. In order to determine the correct nutrients for plants, we need to know the exact soil-plant relationship and the factors involved [25]. The production of radioisotopes through nuclear reactors

and other atomic devices has increased the use of radioisotopes in agriculture. In order to obtain higher yields from the soil by applying fertilizers, one must determine the fertility status of the soil, which seems to be non-productive. Radioactive phosphorus is used in most studies to determine the status of soil P (Figure 1). Through this research, some problems can be solved, such as the comparison of various fertilizers, particle size, placement, application time, dosage, plant absorption and the effect of the applied fertilizer in the soil.

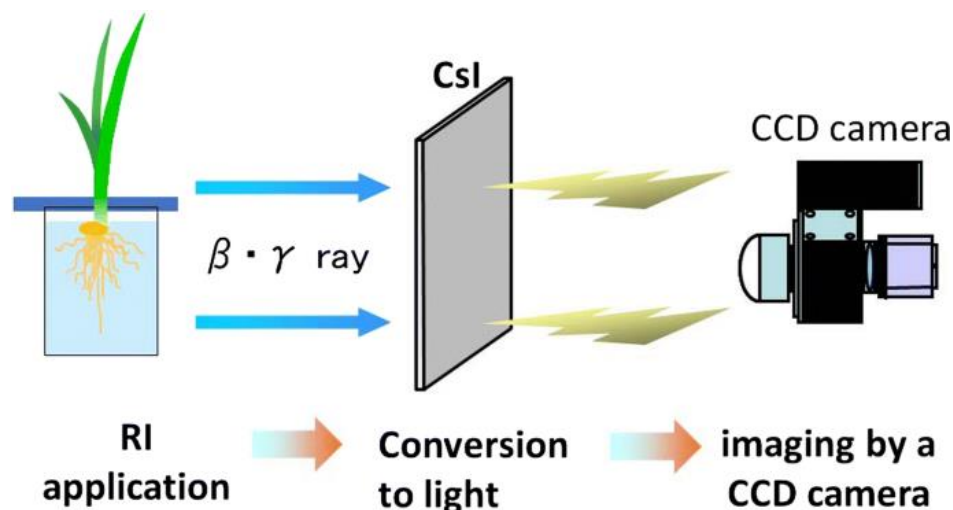


Figure 1. Schematic illustration of real-time imaging system. After application of the radioisotopes to the plant, the radiation of the radioisotopes coming out from the plant was converted to light by a scintillator deposited on FOS (Fiber Optic Plate). Then, the light was introduced to a highly sensitive CCD camera to produce the radiation profile image. Since the light intensity is very weak and the sensitivity of the camera is high, initially, everything was kept in dark to protect the camera. Then, a plant box was prepared where only the above-ground part of the plant was illuminated by light and the plant box was sealed tightly to prevent the leakage of light. Now a chamber is prepared and the light was off when the CCD camera is on. Two imaging systems were prepared; one is for macroscopic and microscopic samples. To image an entire plant, from root to shoot, the macroscopic imaging system is used and for microscopic imaging, a modified fluorescent microscope is used to obtain three images simultaneously, light, fluorescent and radioisotope images. This schematic is reproduced from the study by Nakanishi 2018 [58].

2. Application of Radioactive Tracers in Agricultural Chemistry

The radioactive materials released by the accident have many direct harmful effects on plants, animals and their environment [26]. In the first two months after the accident, this problem of direct deposition on plants is of the greatest concern because radioactive iodine decomposes rapidly. After the initial stage of sedimentation, a growing concern is the contamination of plants by absorbing radioactive materials such as cesium and strontium from the soil to the roots of the soil [27]. In the first few years after the accident, due to factors such as weathering and decay, the content of radioactive substances in agricultural animals and plants declined rapidly, but the level of radioactivity continued to decline afterwards, but at a slower rate [28]. In order to restore the soil used for cultivation, scientists and farmers are trying to find a way to eliminate radiation in the soil. They used various expensive methods to find a solution to the radioactive problem in areas with high planting rates [29]. The solution is the sunflower plant, which is a super-accumulating plant with an effective mechanism to absorb nutrients, water, minerals and certain radioisotopes (such as strontium and cesium) from the soil. Sunflower is also very attractive because it grows well and can quickly produce large amounts of biomass [30]. Compared with many other crops, it can adapt to many different climates and can grow without much management.

3. Sunflower in Field Extracts Radioisotopes from the Soil

These radioisotopes mimic some of the nutrients normally absorbed by plants. Therefore, plants do not actually distinguish between these radioactive isotopes and some naturally absorbed nutrients in the soil, such as potassium and calcium [31]. The goal is for sunflowers to concentrate the radioactivity in the soil (which is quite low in concentration) to a higher concentration in the plant material. The plant material needs to be treated by transferring specific pollutants or radioisotopes from silica from the soil to the carbon-based substance in the aluminosilicate matrix (difficult to handle) in the soil [32]. This is actually the connection between the sunflower and the discovered nuclear power plant. So far, growing sunflowers is the best solution to remove radioactive isotopes from the soil, but scientists need to find new agricultural techniques to achieve better results. Since radioisotopes act like plant nutrients, strontium is very similar to calcium and is easily absorbed by plants, while cesium acts like potassium, which is fixed on soil particles and is difficult to remove from the soil [33]. At the site of the Fukushima nuclear disaster, sunflowers could only remove 0.5% of radioactive cesium from the soil [34]. The role of sunflower as the most effective and non-invasive means to eliminate nuclear radiation is not yet fully understood, but the inherent prospects and possibilities of plant biology are constantly being revealed. Sunflowers are an international symbol of nuclear disarmament. This is another subtle sign that few gardening activities can change the world. Abnormal isotopes can be used to help understand chemical and biological processes in plants [35]. There are two reasons for this: 1) The radioisotope is chemically the same as other isotopes of the same element and will be replaced in a chemical reaction; 2) The element can be easily detected by a Geiger counter or other similar radioactive form of equipment. Example: Inject a phosphate solution containing radioactive phosphorus 32 into the roots of plants. Since phosphorus 32 behaves the same as phosphorus 31, which is the more common and non-radioactive form of the element, plants use phosphorus 32 in the same way [36]. Then, a Geiger counter was used to detect the movement of radioactive phosphorus 32 throughout the plant. This information helps scientists understand the detailed mechanisms of how plants use phosphorus for growth and reproduction [37].

Radioisotope, also known as radioisotope, radionuclide or radionuclide, refers to any one of several substances with different masses of the same chemical element, its nuclear is unstable, and spontaneously with α , β and Gamma rays emit energy and dissipate excess energy [38]. Radioisotopes, also known as radioisotopes, radionuclides or radionuclides, are substances of several different qualities of the same chemical element. The nucleus is unstable and passes through α , β and gamma rays [39]. Each chemical element has one or more radioactive isotopes. For example, hydrogen is the lightest element and has three isotopes with mass numbers 1, 2, and 3. However, only hydrogen 3 (tri) is a radioactive isotope [40]. The other two are stable. More than 1,800 radioactive isotopes of various elements are known. Some of them are found in nature [41]. The rest are artificially produced as direct products of nuclear reactions, or indirectly produced as radioactive offspring of these products. Each "maternal" radioisotope will eventually be decomposed into one or at most several stable isotope "daughters" unique to the parent [42]. There are several sources of radioisotopes. Some radioisotopes exist in the form of ground radiation. For example, the radioactive isotopes of radium, the uranium that naturally occur in rocks and soil. Uranium and or are also present in water [43]. The air is produced by the radioactive decay of radium. Organic materials usually contain small amounts of radiocarbon and potassium [44]. Cosmic radiation from the sun and other stars is the source of background radiation on the earth. Humans also produce other radioisotopes through nuclear reactions, which can lead to unstable combinations of neutrons and protons [45]. One way to artificially induce nuclear Trans is to bombard stable isotopes with alpha particles. A brief treatment of radioactive isotopes follows. For full treatment, see isotope: Radioactive isotopes [46]. Each chemical element has one or more radioactive isotopes. For example, hydrogen, the lightest element, has three isotopes with mass numbers 1, 2, and 3 [47]. However, only hydrogen 3 (tri) is a radioisotope, and the other two are

stable. More than 1,000 radioactive isotopes of various elements are known. About 50 of them are found in nature. The rest are artificially produced as direct products of nuclear reactions, or indirectly produced as radioactive offspring of these products [48].

4. Radioisotopic Determining the Function of Fertilizers in Different Plants

The application of tracer technology in agriculture and related sciences This article reviews the principles of tracer technology and its application in agriculture and related sciences [49], involving radioactive counting, synthesis of radiolabeled compounds and their applications in analysis, metabolism and biology [50]. Use in synthesis problems Barley field, which has benefited from the use of fertilizer it is well known how nuclear technology can play a major role in innovating weapons capabilities and energy [51]. As we all know, thanks to the use of the power of radioisotopes, the agricultural sector has made tremendous progress [52]. In 1964, the United Nations Food and Agriculture Organization (FAO) and the International Atomic Energy Agency (IAEA) established the Joint Department of Atomic Energy for Food and Agriculture. The purpose of this joint department is to coordinate research projects related to the use of isotopes and radiation in the fields of plant breeding, soil fertility, irrigation and crop growth, and chemicals in food. This article will explore how to use radiation to improve plant nutrition in fertilizers and produce seed variants, both of which have created higher efficiency in the industry [53]. Plant nutrition uses fertilizers in agriculture to increase soil fertility, thereby increasing crop yields. The study showed a picture of a large wheat field, which may have produced such high crop yields due to the use of fertilizers [54]. For many countries, the use of fertilizers is very expensive, and incorrect use will result in a waste of money/resources and may damage the environment [55]. Radioisotopes are very useful in estimating the amount of phosphorus and nitrogen available in the soil, which helps determine the amount of phosphate and nitrogen fertilizer that should be applied to the soil [56]. In this process, fertilizers P-32 and N-15 labeled with radioisotopes are used to determine how much fertilizer the plants absorb and lose fertilizer to the environment [57]. The goal is to obtain higher grain yields from chemical fertilizers by optimizing absorption. Radioisotopes can also be used to study the characteristics of the soil to monitor the uptake and use of essential nutrients by plants from the soil [58]. By using radioisotopes as labels, scientists can measure the exact nutrient and water requirements of crops under specific conditions [59]. This is especially useful in drought and water-poor areas.

Mutation; another major impact of radiation in agriculture is the use of radiation to induce genetic changes to improve crop variation and mutation breeding [60]. As part of the plant breeding method, a method using radiation-induced genetic changes has been established [61]. By applying a certain dose of gamma rays or neutron irradiation, it is possible to produce mutations; thereby creating crop varieties that are more resistant to disease, tolerate harsh conditions, and show increased yield and shorter growth time [62]. Approximately 1,800 crop plants have been developed through the use of radiation-induced mutations, which is economically important [63]. A successful example is in Hungary, where they tried to develop new rice variety resistant to rice blast, which is a harmful rice disease [64]. They first tried to test a type of French rice, but due to the different climates between Hungary and France, French rice was ripened too late in Hungary to get the best crop yield [65]. Thousands of these French seeds were irradiated with varying amounts of gamma rays in an attempt to mature early [66]. One variety died three weeks earlier than the non-irradiated female, so the seed was selected for propagation in Hungary. It was released in 1976 and put into commercial use under the trade name Nucleo-ryza. In conclusion Radioisotopes can be applied in a variety of ways to solve many problems in the agricultural industry and improve industry efficiency [67]. These applications are especially important for resource-poor developing countries or regions (such as California, where water resources are limited due to drought) and for protecting natural resources while responding to food security challenges [68]. Radioactive tracers are sub-

stances containing radioactive atoms that can be detected and measured more easily. (Radioactivity is the property of certain elements that spontaneously emit energy in the form of particles or waves through the decomposition of their nuclei.) [69] For example, it is possible to create a water molecule in which one of the two hydrogen atoms is hydrogen. Radioactive tri (hydrogen 3) atom [70]. The behavior of this molecule is almost the same as that of ordinary water molecules [71]. The main difference between tri-containing tracer molecules and normal molecules is that the tracer molecules continuously emit radiation that can be detected by a Geiger counter or some other type of radiation detector [72].

Agricultural Applications Radioactive Tracers. Radioisotopes can be used to help understand chemical and biological processes in plants [73]. A Geiger counter is then used to detect the movement of the radioactive phosphorus-32 throughout the plant, Chromic phosphate P 32 is used to treat cancer or related problems [74]. It is put by catheter into the pleura (sac that contains the lungs) or into the peritoneum (sac that contains the liver, stomach, and intestines) [75] to treat the leaking of fluid inside these areas that is caused by cancer, By utilizing radioactive phosphorus research laborers have prevailed to recognize soil phosphorus and the manure phosphorus, taken by the plants [76]. Radioisotopes like Fe, Mn, K, Ca, N, Rb, C, Cs, Si and Sr and so on and other large scale and miniature components have additionally been utilized by laborers to discover their development in various sorts of soils and furthermore their situation in various earth parts of the dirt [77]. The radioisotope technique is entirely dependable and supportive in deciding richness level of soil [78]. Hence, the use of radioactive components in horticulture has gotten enormous significance in deciphering specific parts of soil richness and other many-sided issues [79,80]. Radioisotopes have likewise helped the examination of the impact of such factors as development, water system techniques and time on the root arrangement of plants [81]. Ongoing investigations with radioisotopes have likewise shown that with many harvests, supply of plant supplements through the leaves is more speedy and compelling than the application in soil [82]. For instance, it has been found that a supplement, which is not really retained up to 10% by root, can be consumed up to 90% when applied on leaves [83]. Tentatively, it has been observed that the ingestion of supplements by leaves happens during the day time as well as at evening time [84]. Through isotope procedure it is conceivable not exclusively to decide the measure of supplement that are taken by plants, however it likewise offers the chance to be aware of their development and their places of amassing [85]. In the plants, for the most part radio-phosphorus has been utilized for this sort of examination works and the outcomes have shown that retention speed of this supplement was more than the normal [86]. Radioisotopes and radiation is utilized in transformation acceptance. Transformation is an abrupt heritable [87] change of the genetic elements organs on the chromosomes of the life forms [88]. The work of radiation to actuate genetic variations is a helpful apparatus of likely worth in horticulture [89]. We have had the option to show convincingly that [90], with radiations changes can be achieved in the association of the inherited make up that are helpful in plant improvement [91,92]. Radioisotopes and ionizing radiations are of incalculable incentive for acquiring a knowledge into biological propensities for bugs [93]. With the guide of radioisotopes we can discover populace thickness the development rate during various phases of the existence cycle, methods of dispersal, development and movement, flight range sleeping spots, egg living destinations connection to hunters, parasites, taking care of mating propensities and infection transmission and so on [94]. Ongoing examinations on radioisotopes have additionally shown that for some, crops, providing plant supplements through leaves is quicker and more compelling than applying them in the dirt [95]. For instance, it has been tracked down that up to 10% of supplements that are not really consumed by the roots can be assimilated up to 90% when applied to leaves [96]. It has been found tentatively that supplement ingestion by leaves happens during the day, yet in addition around evening time [97]. Through the isotope innovation, not exclusively can decide the measure of supplements consumed by plants, yet additionally offer individuals the chance to comprehend the development of plants and the area of their gathering [98,99]. In plants, a

large portion of the radioactive phosphorus has been utilized in this sort of examination [100], and the outcomes show that the supplement is ingested quicker than anticipated. Radioisotopes and radiation are utilized for change enlistment [101]. Change is an abrupt hereditary transformation of the hereditary variable organ on the chromosome of a creature [102,103]. Utilizing radiation to prompt hereditary variety is a possibly [104], significant apparatus in the table records some normally happening radioactive isotopes [105].

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