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Space breeding in modern agriculture

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ABSTRACT

Space breeding, also known as aviation breeding or space technology breeding, is a new type of breeding technology developed in recent decades, which combines space technology, modern agricultural technology and biotechnology. Compared with traditional breeding technology, it can greatly improve the quality of agricultural products in a short period of time, create many high-quality provenances, well solve the problem of food shortage, and bring endless benefits to the world. Therefore, space breeding technology will play an important role in the rapid development of modern agriculture. In this paper, the principles and characteristics of space breeding, development status and future prospects at home and abroad are introduced.

Keywords: Space breeding; mutagenic; Modern agriculture

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Introduction

Space breeding is the use of special space environment factors, such as the particle radiation, microgravity, weak magnetism, comprehensive factors such as high vacuum induced agricultural biological genetic improvement, through the mutagenic effect of space environment to the agricultural biological genetic changes that may be beneficial to its, to return to the ground for breeding, producing agricultural breeding materials and breeding of new varieties of agricultural biotechnology breeding of new and high technology.

principles and characteristics of space breeding

In essence, space breeding is to use a lot of complex space environment to induce the seed genes, make the seeds mutate, make their offspring traits mutate, and then carry out selection and cultivation on the ground. According to the study, among the complex comprehensive factors in outer space, various high-energy particle radiation is considered to be the main factor for the physiological mutagenesis effect of crop seeds, which changes the germination rate, morphology, photosynthetic pigment, chloroplast structure and antioxidant enzyme activity of seeds, thus changing the physiological and morphological properties of crops. Macroscopically, it is the crop yield, disease resistance, insect resistance, nutrient content and product color, size, shape of the different. Induction is characterized by randomness and unpredictability, so space breeding cannot make every seed undergo mutagenesis. According to statistics, mutagenesis only accounts for a few percent or even a few percent of the total number of seeds, and only about three percent of the mutations beneficial to humans. In terms of safety, it is not a transgene, since the induction only changed the genetic sequence of the seed and did not introduce new foreign genes. In the natural environment, seeds mutate similarly, but over longer periods of time and with less variation. Thus, space induction can be understood as the acceleration of variation on the ground, so space breeding is safe. Seeds that return to earth from space are also tested layer by layer and no radioactivity is found, so space-bred crops are perfectly safe.

The experimental results show that the space environment conditions affect the germination and growth of plant seeds, and the sensitivity of different plants or varieties of the same plant to space flight is different. The seeds of wheat, barley, corn, cotton, sunflower, soybean, cucumber and tomato that have been flown through space germinate on the ground, increasing their vigor and germination rate. The germination rate of rice, millet, pea, green pepper, tobacco and other plant seeds had no significant difference with the ground control. However, seeds of sorghum, watermelon, eggplant, radish and towel gourd were inhibited and their germination rate was reduced after space flight. The germination potential, germination index, seedling height and seedling vitality index of wheat, barley, small rye and other crops after space flight were significantly higher than those of the ground control group and the radiation treatment group, and the difference was also fully demonstrated in peroxidase activity. The germination and seedling of space flight sorghum seeds were strongly inhibited and the growth period was delayed. Soybean seeds greatly affect growth behavior and maturity through space flight.

Research status at home and abroad

Domestic research status

In recent years, China's space breeding has attracted more and more attention. As one of only three countries (the United States, Russia and China) that have mastered the technology of returning satellites, China has won praise around the world for a series of pioneering research results in space breeding

In 1987, China first used high-altitude balloons to carry the sweet pepper variety "dragon pepper 2", and obtained a new variety weighing more than 250g per fruit and increasing the yield by 120%, which opened the prelude of space mutation breeding. By the end of 2017, China had carried out 13 experiments of carrying more than 70 kinds of crops in space by means of recoverable satellites, and completed various experiments by means of high-altitude balloons and shenzhou spacecraft. Especially since the implementation of "863" plan, space breeding, key technology research has made significant progress in our country, successively in rice, wheat, cotton, green pepper and sesame seeds and other crop mutation breeding out on a series of new crop varieties, high yield, high quality, (new strains and new germplasm, which has been through the national or provincial examination and approval of new varieties and new combination more than 30, has bred a large number of comprehensive performance and has a good market competitiveness of new crop varieties. Space breeding makes full use of the unique environmental conditions in space to create conditions that are difficult to simulate on the ground, thus producing rare variations in mutagenesis materials and creating new germplasm resources.

Aerospace breeding technology for aerospace, biological, agricultural technology and other three requirements. All seeds before carrying strictly tested for purity, carrying the seeds back to 4 years or so of the ground test, for the first time shot, there will be a lot of separation traits such as height not neat, so for each tested strains, and the second generation of per plant with good variation, the shape is not good, low yield, no value of mutant eliminated entirely, the good mutant offspring grow into the third generation. After entering the fourth generation, keep stable and valuable varieties. Zhongzhi 11, a new sesame variety bred by the oil crop research institute of the Chinese academy of agricultural sciences, was planted in hubei, henan and anhui provinces, yielding 21% more per unit area than yuzhi 4. The new hami melon strain selected by xinjiang academy of agricultural sciences surpassed the main cultivar queen in quality, flavor, fruit size, appearance and resistance. In guangchang county, jiangxi province, the extra-large white lotus seed satellite 3 was cultivated through space breeding, with more than 2.4 grams of lotus seed per seed, 60% higher than the conventional variety. Now, it has become a brand of guangchang and an industry of poverty alleviation and wealth. Mango germ cells from hainan province, which were carried into space by the shenzhou-11 in October 2016, survived on the ground in the world's first mango breeding in space. The mango germ cells taken into space, from the "regenong no. 1" mango seeds of hainan haikun fruit industry group co., LTD., were sent to the subtropical crop research institute of the Chinese academy of tropical agricultural sciences for cultivation after returning to the ground after a space flight. At present, the carefully cultured germ cells have developed into living cells and will be selected and transplanted next.

At present, in shandong, hebei, jiangsu and other cities have space vegetable sales market, the sales of these cities space vegetables more similar than ordinary vegetables big size, the price will be more expensive than ordinary vegetables, because space vegetables taste good, rich nutrition, through comparison of relevant national institutions, aerospace vegetables is higher than ordinary vegetables nutrition is about 30%. The sugar content of space cherry tomato is up to 13%, which is the same as that of orange. Space eggplant has three times the vitamin C of ordinary peppers, and space corn can grow five colors and taste better than ordinary corn. A new variety of "space lotus", weighing up to 50000g, a "space cucumber" as thick as an arm, a 1.4-meter-long "space lotus root" and a "space lotus flower" with multiple petals, has been introduced in some provinces and cities and has achieved good social and economic benefits.

The experience of aerospace agriculture over the past 30 years shows that the aerospace industry's time has come. Space agriculture has huge business opportunities, and space communication technology is the "key driving force" for the development of modern agriculture. We must continue to be at the forefront of change and upgrading to reflect lower costs, improve efficiency, increase productivity, support the transformation of traditional industries, and develop new business models. In the future, in order to promote the sustainable development of space agriculture, we should follow the industrial model of "large groups, large industrial construction, park transportation and large-scale development".

Research status abroad

Space mutagenesis began in June 2002 at the space laboratory of the university of Wisconsin. Roses was taken to heaven for rose oil content increase of mutants, soybeans are included in order to obtain excellent soybean traits, Russia had Christmas trees and the green branches white into the sky, but now it is planted in large areas of Siberia and kazakhstan, from outer space to return to the Christmas tree will be higher. The United States once gave up the study of space mutation breeding, and now is strengthening research.

Since the early 1960s, scientists in the former Soviet union have been carrying out seed-to-seed space experiments on arabidopsis thaliana, beginning the beginning of space breeding. Later, the United States and Germany also successively carried out experiments of carrying plants in space to explore the growth law and aging process of plants under space environment, so as to improve human living space, solve the problem of astronauts' living safety and food supply. By the 1980s, the United States had sent tomato seeds into space for six years and, after testing them on the ground, obtained edible and non-toxic tomato variants. In 1994, Russia began to cooperate with NASA and carried out several full-cycle wheat experiments in space on the mir space station, making important progress. In 1995, NASA established the center for the biology of gravity at north Carolina state university to study how plants feel and react to gravity. In 1996, Bruce bagby of the United States developed dwarf wheat in space. With a plant 40 centimeters tall and a growth period of only 60 days, this wheat yields three times as much as normal wheat and is likely suitable for space growth. In addition, Russia and the United States have successfully planted wheat, cabbage and rape plants on the mir space station. In 1999, Russia's space wheat was also a success. In the 21st century, the United States, Japan and Western Europe have made space development an important development project. In space breeding in the United States and Russia, cabbages, tomatoes, lettuce, cucumbers, turnips, potatoes and hundreds of other plants, as well as vegetables like Onions and carrots, have begun to appear.

Basic procedures for space breeding

When carrying the selection of original seeds and the space experiment, generally choose the good varieties with large planting area and strong adaptability as the carrying seeds of the spacecraft space experiment, such as the crop varieties with high yield, high quality, disease resistance and resistance. The first step in space breeding is to carry the original species up to the sky via spacecraft to carry out space mutagenesis. The following steps are performed on the ground after the return.

First generation seeds are recycled modern seeds, also known as "first generation seeds". Generally speaking, in order to shorten the growth cycle, facility cultivation techniques are used for cultivation. The unloaded species were used as control for comparative breeding. There were variations in the traits of spaceflight lines, such as growth, branching, internode length, leaf size, nodal position of the first tassel, number of flowers per tassel, and pod length, showing a certain variation rate. At this stage, all spaceflight seeds were selected per plant.

Second generation selection reseeds the seeds harvested from the first generation of plants and cultivates the second generation. Each plant is still compared to an unequipped primitive species. Since the variation of the second generation plant is more obvious and the mutation rate is increased, it is based on the selective selection stage of the breeding target, so the superior seeds are selected from it. Early selection is based on the selection of breeding objectives, such as screening the weight of individual plants, increasing the selection of individual plants, production, screening early maturity, and shortening harvest time.

The third generation (solar greenhouse) plus generation breeding was conducted with no original seeds as the control, single seedling per hole, and plant traits were compared. There were still 1 to 2 mutated single plants in some lines, but the difference was not large, so early selection was preferred according to the orientation of single plant. The single plant that was in line with the breeding criteria was selected, such as stronger growth, less branching, pod bearing of main tendrils, more pod bearing of single spike, longer pod bearing, yellow-green of young pod bearing, more pod bearing per plant, more pod bearing per pod bearing, more pod bearing per plant, more pod bearing per pod bearing than the control, etc. There was no separation and the seeds were mixed. Through screening, the third generation seeds were selected for further transformation, and the stable inheritance of mutant traits was determined.

In the fourth generation of breeding, single plant per hole was used as control. Several spaceflight strains were selected and bred in combination with the control group, with 3 repetitions per plant per hole and random block arrangement. According to the characters, all lines have been completely stable. Select the single plant that meets the breeding criteria, such as a strain of vine, strong growth, less branching, main tendrine pod bearing, purple flowers, compared with the control early maturity, single flower ear pod bearing, strong pod bearing power, single plant pod bearing number, young pod yellowish green, aging resistance, seed seed purple, high yield, disease resistance, stress resistance.

Problems and prospects of space breeding in China

The problem

China's space breeding started in the late 1980s. After 30 years of development, it has made remarkable achievements in breeding research and promotion of excellent varieties, but there are also many problems. These problems are reflected in the problems of space breeding and industrial promotion.

Problems in space breeding

Space breeding exist problems in the research of basic theory, space breeding, although after decades of development, but still failed to clarify its comprehensive mutagenesis mechanism, the theoretical research of space breeding is slower in applied research, is still in the "seeds of send first, and then the screening stage, especially compared with other means, can't be more clear and controllable directional breeding.

Compared with the shortage of basic theoretical research, applied research is relatively overheated. Many local research institutions and individuals lack technical and scientific conditions and need to be equipped with satellite crop breeding trials, which are profit-oriented, ineffective and unsatisfactory. At the same time, the lack of theoretical research has also brought many adverse effects to promote the industrialization of cosmic species.

Space breeding research cost is too high, crop space breeding, must go through the spacecraft to heaven, its cost is too high, affect space breeding research and promotion.

Ground-based "space simulation" breeding techniques have been studied for many years, but only one single factor, microgravity, has been simulated and related experiments have been conducted. No comprehensive factor (ray and microgravity) experiments have been reported. Land-based "spatial simulation" breeding techniques are not yet mature.

Problems in the industrialization of space seeds

Overhyped "space" concept. Mass, including many in the industry, the concept of space breeding, application, such as not enough understood, even misunderstandings, the main reason lies in the breeding unit and promotion and other related institutions, on the one hand, the space of seed breeding process and institutional mystification, on the other hand when promotion agencies in promoting excessive speculation the concept of "space", from the new crop varieties shall have the qualities, deviation from the crops to promote normal orbit, often backfire, makes the public distrust. In fact, as new crop varieties, people usually pay more attention to traits such as high yield, high quality, high disease resistance and stress resistance, but pay less attention to the novelty of breeding methods.

The public has questioned the safety of space seeds. In the current debate about science communication and overhype, especially about the safety of genetically modified organisms, questions have been raised about genetic safety and the safety of products bred in space.

The cost is too high. Crop space breeding needs to go through the spacecraft, so the breeding cost is high, which affects the popularization and promotion of space seeds.

Illegal promotion and illegal operation. Merchants in the introduction, without through the local experiment and demonstration permission, the administrative department and the local seed seed without authorization, promotion space, resulting in not adapt to the local environment of space varieties or ornamental varieties as edible crops, farmers suffer production precipitously, reputation damaged seeds and its space industry.

Looking

For many years, conventional breeding in China has been in a difficult situation, the important reason is that the core germplasm resources are too single, the lack of quality provenances, thus affecting the progress of breeding in China. It has been proved by practice that space mutagenesis can not only significantly improve some traits of crops, but also obtain rare mutations with important economic traits that are difficult to be obtained by ground breeding and conventional ground mutagenesis breeding. Through the use of these mutated materials, a breakthrough can be made in the breeding level of China, so as to breed new varieties of plants with target traits, which is of great significance to the transformation of germplasm resources of crops in China, and to improve the competitiveness of China in the international market. The advanced space and space technology has opened up a new way for the rapid breeding of good varieties and special germplasm resources, which has shown a bright future for mankind to enter the age of space agriculture. In the promotion of space breeding products, demystification should be carried out, and the emphasis should be placed on good traits rather than over-frying them for breeding. With the more and more urgent demand for space mutation breeding in China's agriculture, plus its good benefits and the gradual improvement of technology, we have reason to believe that space breeding technology will play an extremely important role in the development of modern agriculture. Moreover, the research on space mutation breeding is not only of great significance in breeding and application, but also of great theoretical significance in exploring the mechanism of the influence of space conditions on living organisms. At the same time, it creates conditions for human to exploit space resources and has a very broad development prospect.

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