

# Research Progress of the Effect of Acid Rain on Main Food Crops

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## Abstract

*In recent years, because of the dangers of acid rain, the growth of main crops such as corn, rice, and wheat were inhibited, and cut back on production, so that the development of agriculture in various countries are hampered. In order to solve this situation, summarize the acid rain on main crops growth, biomass, germination rate, the influence of in order to improve the agricultural production, reducing the loss of agricultural products provide a reference basis.*

**Key Words:** acid rain; food crops; impact; prevention and control measures

## Introduction

At present, all countries in the world by different degree of harm of acid rain. As one of the global pollution problems, the negative effects of acid rain on public health, industrial and agricultural production, ecological environment and global climate change have become more and more serious. Acid rain refers to the atmospheric precipitin pH value is less than 5.6. In the form of atmospheric precipitation including rain, snow, hail, fog and so on. Uncontaminated precipitation is neutral, pH value in about 7.0<sup>[1]</sup>. The formation of acid rain influenced by human factors and natural factors, natural factors are mainly volcanic eruptions, ocean waves splashing sea salt droplet, forest fires and other material, will be formed into the rain cloud water vapor adsorption on the carbonate, through REDOX reaction, formation of smaller sulfuric acid rain and carbonic acid rain. Then after flushing process under the cloud, smaller sulfuric acid rain and carbonic acid rain continuously around the adsorption containing acid rain drops, and finally formed the big rain

drops, and landed on the ground to form acid rain <sup>[1-2]</sup>. Human factors was the main reason for the formation of acid rain, whether developed or developing countries, in the development of industrial production process of a large number of burning fossil fuels, emissions of SO<sub>2</sub>, NO<sub>x</sub>, and become the main source of acid rain and SO<sub>2</sub> into the air after the gas phase or liquid phase oxidation generated H<sub>2</sub>SO<sub>4</sub>, and most were oxidized to NO<sub>2</sub>, NO rain generated when HNO<sub>2</sub> or HNO<sub>3</sub>, and with the settlement of rain to the ground, the formation of acid rain. Secondly, produce acidic particles also accelerates the catalytic SO<sub>2</sub> formation acid <sup>[3]</sup>. Acid rain, to human survival and development is a huge threat. Acid rain is mainly through respiratory inhalation and acid settling into the water and river cause harm to human, a large number of studies have shown that <sup>[4]</sup>, too much of the acid rain after SO<sub>2</sub> drawn into the lungs, the damage which has the function of defense alveolar macrophages, lead to respiratory tract infection, cause disease of lung cancer. No acid rain, which entered the body subsidence to the soil, harmful metals in the soil erosion to clean water, through a series of biological accumulation and amplification and absorbed by the human, indirect harm to human body health <sup>[5]</sup>. Reportedly <sup>[6]</sup>, along with the increasing of acid rain, Wuhan, Guangzhou and other southern cities in China the frequency of acid rain is as high as 60% to 80%, more than of other countries, some famous acid rain District, thus has brought a lot of damage. Strengthen the study of the mechanism of its harm to people's health, more conducive to the development of the mankind itself better and more effectively protect the ecological environment.

### **1. The harm of acid rain on plants**

Acid rain is a human is facing one of the top ten global environment problems, under the advanced industrial fan, acid rain, a serious threat to the balance of ecological environment in the world and human social and economic development, but also endanger the survival and development of human beings. Studies have shown that acid rain on plant will direct and indirect damage. Direct harm performance after contact with acid rain and plant leaves, the destruction of plant leaf photosynthesis, accelerated leaf nutrient leaching, stunted growth and death. Indirect harm to the fertility of the soil acidification, decline or releasing potentially toxic substances, harm the plant roots plants <sup>[7-8]</sup> stunted growth or death. In addition, the harm of acid rain directly or indirectly leads to the generation of reactive oxygen species and cleared out of balance, causing the toxicity of active oxygen in plant cells, especially caused by membrane lipid peroxidation <sup>[9]</sup>. Thus, the effects of acid rain on plant to be reckoned with.

### **2. The influence of acid rain of major food crops**

Scientists <sup>[2]</sup> through the experiment, a certain amount of sulfur dioxide smoke after the different crops showed different degrees of injury, according to the degree of damage, can be divided into sensitive crops, medium sensitive crops and resistant crops, etc. Barley, cotton, soybeans, spinach, carrots, ect belongs to sensitive crops .Wheat, beans, peanuts, cucumber, rape, belongs to the medium resistance crops such as tomatoes. Belong to resistance crops such as rice, corn, potato. Which belongs to medium resistance wheat crops, rice and corn are resistant crops, They differ in their ability to resist acid rain.

### **2.1 The influence of acid rain on wheat**

There are a lot of world's main food species, including wheat, rice and corn is the world's three major food crops. Wheat is the world's largest production and the most widely distributed, the largest number of food crops, referred to as "international food", the United States, Canada, France, Australia and Argentina are the main production of wheat<sup>[10]</sup>. Wheat adaptability is strong, can grow on the various types of soil. Wheat are divided into winter, half in the winter, the spring type three varieties, respectively, to adapt to the daily average temperature is 16 to 18°C, 14 to 16°C, 12 to 14°C. Wheat to soil PH value also to have certain requirements, PH 6-8 all can grow, but at pH 6.8-7 neutral soil is the best. MAI Bo- Ru et al were studied through field experiment of simulated acid rain on wheat growth and yield stress results show that under the acid rain stress, wheat leaf chlorophyll a, b and carotenoid content were significantly lower, influence on chlorophyll a more prominent. Acid rain stress will also inhibit the synthesis of wheat leaf soluble sugar, reducing sugar. When the pH is less than or equal to 3.5, the inhibition effect is stronger, and the higher the acidity, the greater the impact. The total free amino acids and soluble protein content of wheat leaves increased with the increase of the acidity of acid rain also reduce<sup>[11]</sup>. The biomass, chlorophyll content and photosynthetic rate of wheat seedlings decreased with the decrease of pH value of simulated acid rain, and the activity of root decreased<sup>[12]</sup>.

### **2.2 The influence of acid rain on rice**

Rice prolific in hot and rainy, densely populated southern and eastern Asia, and Asian residents more like to eat rice, the world's rice export volume of about 20 million tons per year<sup>[10]</sup>. Rice is suitable to grow in the soil with good permeability, close to neutral, strong water holding capacity and high fertilizer holding capacity. Seedlings germinated in the lowest temperature for 10 to 12°C, the optimal for 28 to 32°C. Flowering optimum temperature at 30°C, below 20°C or higher than 40°C. YanSongling etc. Through the experiment of simulated acid rain stress rice seeds and seedlings, it is concluded that pH5.0 simulated acid rain had no obvious effect of rice seed germination rate, pH4.0 and pH3.0 treatment can make the seed germination rate dropped significantly. Seedlings of various growth indices including the leaf length, seedling height, plant fresh weight, number of adventitious roots later showed that seedling stage more sensitive to the effects of acid rain<sup>[13]</sup>. In addition, the acid rain on rice leaf and rice grain to absorb nutrients has greater influence. Tang Xiangan and others made a similar simulation experiment of acid rain. When the pH is less than 2.5, with the reduction of pH value of total nitrogen content in rice grains of rice will rise, hinder the stem leaf on phosphorus absorption. But pH2.5 acid rain will promote stem leaf on phosphorus absorption. Acid rain can promote to the rice leaf nutrient potassium absorption, but unfavorable to rice grain to absorb nutrient potassium. Rice stems and leaves of total sulfur content in rice grain will rise with the loss of the pH of acid rain. Test results show that<sup>[14]</sup>, in the pH 2.5 rice yield significantly lower under the influence of acid rain, and pH 3.5 acid rain to a certain extent, promote the production of rice.

### **2.3 The influence of acid rain on corn**

Corn is native to the Americas, growing period long, water demand is higher than the sorghum, soybeans, etc. The output of 80% concentrated in North America, Europe, Asia, and to form the world's three big corn belt. Corns live in warm climate, 26 to 27°C for earing flowering daily average temperature,

25 to 30 °C is most suitable for seed germination. Corn adaptability is strong, can grow on the sandy loam, loam and clay. pH from 5 to 8 soil is suitable for its growth., optimum to pH from 6.5 to 7.0, but the tolerance ability of maize is poor, and it is easy to be influenced by chloride ions. YanZhongling etc. Research has shown that simulated acid rain can destroy the seed internal structure and inhibit seed germination<sup>[15]</sup>. YuanZhizhong and so on has made the simulated acid rain on corn seed germination and seedling growth of experiment, and further illustrated the physiological indexes of maize seed germination potential, germination rate, germination index and vigor index of different simulated acid rain pH show different symptoms. When the pH value of 5.6 to 4.5 influence was not significant. When the pH value of 3.5 to 2.5 have significant inhibitory effect on maize seed germination. Meanwhile after pH 2.5 and 3.5 of simulated acid rain treatment, germination rate fell by 41.11% and 28.72% respectively, seeds appeared deformity, shrink, water loss and other symptoms<sup>[16]</sup>. Effects of simulated acid rain on the leaves of corn seedlings which increased with the intensity of the simulated acid rain, seedling leaf nitrate ion of central Asia, chlorophyll a and chlorophyll b and total chlorophyll content will be reduced with the increase of the intensity of simulated acid rain, making the process of the growth and development of corn seedling leaves is restrained. Hinder corn plants of nitrogen nutrition uptake and assimilation function, reduce the ability of corn plant and utilization of nitrogen, reduce nitrogen accumulation rate, decomposition of chlorophyll in leaves, decreased photosynthesis capacity, resulting in corn plants can not be normal development trial<sup>[17]</sup>.

### 3. The impact of acid rain on crop prevention measures

Acid rain pollution is one of the important factors that affect the global economy and social development, human beings must to control acid rain and global acidification, accelerate the process of sustainable development<sup>[18]</sup>.The monitoring data indicate<sup>[19]</sup> that the acid rain in most parts of the earth is increasing due to the increase of the acidity in the atmosphere. Now many countries are trying to control acid rain and reducing acid rain damage to human health and the national economy, mainly has the following steps:

#### 3.1 Improve the environmental protection laws and regulations, strengthen international cooperation

According to the state of the environment and practical economic and technical conditions, to further improve and perfect environmental laws and regulations, control strictly of fixed sources of pollution emissions, strengthen the management of mobile sources of pollution. Through the legal means of state and government, urge the pollution emission source implement national emission standards, local standards or industry standards. For example the United States rules prohibit the new large thermal power plant, to strict control of emissions from coal-fired power plants, which has reduced the SO<sub>2</sub> emissions by half<sup>[18]</sup>.In Chinese history of the most stringent new "Environmental Protection law" and the "Environmental protection department of the implementation of daily consecutive punishment approach "and other measures to carry out formally on January 1, 2015. August 29, by the law of the people's Republic of "China air pollution prevention and control law" amendment, January 1, 2016 implementation. At the same time, actively participate in international environmental cooperation, the implementation of the international convention. Form on November 30, 2015 to December 12, the United Nations framework convention on

climate change 21 times the conference of the parties held in Paris. The General Assembly adopted the "Paris agreement", defined the goal of global warming control at 2°C, and planned the global response to climate change in 2020 after the action should be taken.

### **3.2 To implement cleaner production, pollution purification processing system of innovation**

To carry out clean production, improve the pollution purification technology, reform the traditional end of the treatment process, do a good job of source control. Such as coal as an energy source, in front of the coal burning, burning and after burning in three link control of pollutants. At present, according to the pre combustion phase, the wider application of the technology is low sulfur fuel, coal pre processing including desulfurization, denitrification ash, briquette technology and coal gasification. In the process of coal combustion, the main is to improve the combustion equipment or by adding the additive reaction with pollutants, to achieve the effect of purification. China mainly take the clean coal technology have high combustion technology, coal conversion technology. For post-combustion by controlling the combustion exhaust gas of SO<sub>2</sub> emissions to reduce the production of acid rain, the successful experience of international certificate of flue gas desulfurization is the main measures to control acid rain and sulfur dioxide <sup>[20-21]</sup>. In improving the technology at the same time, countries are encouraged to implement clean production and control the life of the product production cycle, from the source to control the generation of pollution and pollution in the production process, alternative terminal management technology, reduce the cost of energy consumption.

### **3.3 Adjust measures to local conditions, cultivate the acid varieties**

According to the degree of pollution of the acid rain area planting suitable for farming, acid rain areas with strong preference resistant crops, followed by moderate sensitive crop, but even a weak acid area also try not to choose or choose less sensitive crop to reduce acid rain causing economic losses <sup>[22]</sup>. Improve soil buffer capacity, delay soil acidification process is also one of the ways to deal with acid rain. Through using manure, right amount into quicklime in acidification region for prevention or adding quicklime in acidification of soil have to restore the soil <sup>[23]</sup>. In addition, to foster new type of resistance to acid rain, crop varieties, increase the adaptability of crops to acid rain contaminated soil, increase production, reduce the occurrence of disasters <sup>[24]</sup>.

## **4. Conclusion**

Acid rain is the difficult of together to face in the world. The daily life of human affected by acid rain. Nowadays, many countries and regions have suffered from the harm of acid rain, wheat, rice, corn and other crops to the survival of humans are facing dangers of acid rain stress. According to the study of the majority of people, we try to control the source of pollution, reduce the production of acid rain, to master the law of acid rain on crop damage, and enhance the ability of crops to adapt to acid rain, to ensure the supply of global food. At the same time, we can take active measures to solve the problem of acid rain.

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