

Potential Harm Analysis of Fertilizer Application on the Population Structure and Reproductive Behavior of Chinese Birds

Yuqi Xue

Jinling High School Hexi Campus, Nanjing, China

Abstract: The application of chemical fertilizers has provided significant yield increasing benefits for agricultural production, but its potential harm to ecosystems, especially bird populations and reproductive behavior, is increasingly attracting attention. The application of fertilizers directly or indirectly affects the habitat, food chain, and population structure of birds, thereby altering their reproductive habits and success rates. This article analyzes the impact of chemical fertilizer application on bird habitats and food resources, and explores the decline in biodiversity, ecological imbalance, and ecological chain reactions caused by chemical fertilizers. At the end of the article, measures such as reducing fertilizer use, optimizing agricultural management, and implementing biological protection measures were proposed to alleviate the negative impact of fertilizer application on bird populations and reproductive behavior.

Keywords: Fertilizer Application; Bird Population; Reproductive Behavior; Ecological Impact

1. Introduction

With the advancement of global agricultural production models, fertilizers play a crucial role in increasing food production and ensuring the supply of agricultural products^[1]. However, excessive and improper use of fertilizers leads to serious ecological consequences. This is especially true for bird populations and their reproductive behavior. Fertilizer use alters the structure and ecological environment of bird habitats. It also affects the food resources of birds, disrupting the food chain and impacting their population structure and reproductive success.

2. Overview of Fertilizer Application

2.1 Types and Application Methods of Fertilizers

Fertilizers are an essential input in modern agricultural production and come in various types, including nitrogen, phosphorus, potassium, and compound fertilizers. Nitrogen fertilizer mainly contains nitrogen and is used to promote crop growth, particularly for leaf and stem expansion^[2]. Phosphate fertilizer is important for root development and supports flower bud differentiation and fruit formation. Potassium fertilizer enhances plants' ability to resist diseases and pests and promotes water metabolism and photosynthesis. Compound fertilizer is a mixture of nitrogen, phosphorus, and potassium, providing a comprehensive nutrient profile tailored to different crops' needs. Fertilizers can be applied in different ways: as base fertilizer, topdressing, and foliar fertilizer. Base fertilizer is applied before sowing to provide initial nutrients for crop growth. Topdressing is applied at various stages to meet the ongoing nutrient needs of crops. Foliar fertilizer provides trace elements or supplementary nutrients directly to plants through leaf absorption. The choice of fertilization method and timing affects fertilizer efficiency and its potential environmental impact.

2.2 The Current Situation of Fertilizer Application

China is the world's largest producer and user of fertilizers, applying tens of millions of tons of these inputs. In recent years, fertilizer use has steadily increased, especially in regions focused on grain production. Data shows that fertilizer application in China has consistently risen year by year, and China's usage accounts for over a quarter of the global total. However, fertilizer application often does not follow scientific

principles. In some areas, ineffective fertilization management leads to excessive use, resulting in resource waste and environmental pollution. As fertilizer use increases, soil fertility decreases, and soil quality deterioration becomes more prominent. Common issues include soil acidification and salinization. Additionally, due to poor fertilization control, significant fertilizer loss occurs, particularly through rainwater runoff entering water bodies, leading to eutrophication and affecting aquatic ecosystems.

2.3 The Impact of Fertilizers on the Ecological Environment

The impact of fertilizer application on the ecological environment is multifaceted and far-reaching. Excessive use of fertilizers directly threatens soil health. The excessive application of nitrogen fertilizer leads to soil acidification, affecting the diversity and activity of soil microorganisms, which in turn reduces soil productivity and fertility. Soil acidification not only limits plant growth but also increases the release of heavy metals, causing further harm to plants and soil organisms. Fertilizer loss enters rivers, lakes, and groundwater sources, exacerbating eutrophication and damaging aquatic habitats^[3]. Excess nitrogen and phosphorus in water bodies promote rapid algae growth, leading to algal blooms, water quality deterioration, and negative effects on fish, amphibians, and other aquatic species. Fertilizer application also affects the environment through atmospheric circulation. Nitrogen fertilizers volatilize into the atmosphere, forming nitrogen oxides and contributing to air pollution, thus impacting air quality.

3. Changes in the Structure of Bird Populations

3.1 Changes in Bird Habitats

The impact of fertilizer application on bird habitats is multifaceted, especially with long-term use, which leads to notable changes in habitat structure and function. Excessive fertilizer application changes the chemical properties of the soil, causing acidification, salinization, and the accumulation of harmful substances. These changes affect plant growth and species composition. Birds depend on diverse habitats composed of plants, and fertilizers promote the overgrowth of

fertilizer-tolerant plant species, which replace native plant communities. As a result, birds lose their original habitats and foraging spaces, particularly species with specific habitat requirements. Fertilizer-induced eutrophication alters birds' dependence on water bodies, leading to the degradation of aquatic ecosystems. This degradation results in the loss of habitats for waterbirds. In wetland areas, excessive nitrogen and phosphorus cause rapid phytoplankton growth, which affects waterbirds' foraging resources^[4]. Overall, the habitat of birds is weakened, leading to a decrease in their population, with some species potentially facing a crisis due to the disappearance of their habitat.

3.2 Interference in the Food Chain

The impact of fertilizer application on bird habitats is multifaceted, especially with long-term use, leading to notable changes in habitat structure and function. Excessive fertilizer use changes the chemical properties of soil, causing acidification, salinization, and the accumulation of harmful substances, which affect plant growth and species composition. Birds depend on diverse plant habitats, and fertilizer application promotes the overgrowth of fertilizer-tolerant plant species, replacing native plant communities. As a result, birds lose their original habitats and foraging spaces, particularly species that require specific habitats.

Fertilizer-induced eutrophication alters birds' reliance on water bodies, leading to the degradation of aquatic ecosystems. This degradation results in the gradual loss of habitats for waterbirds. In wetland areas, excessive nitrogen and phosphorus cause rapid phytoplankton growth, affecting waterbirds' foraging resources. Overall, bird habitats are weakened, leading to a decrease in population. Some species may face a crisis due to the disappearance of their habitat.

3.3 Changes in Bird Population Diversity

The application of fertilizers has had a profound impact on the diversity of bird populations, especially in cases of excessive or unreasonable fertilization, resulting in significant changes in the composition of bird populations. Long term use of chemical fertilizers has led to habitat degradation and food chain destruction, which have made the living space of many bird species that rely on specific ecological conditions

narrow. Some bird species, especially those inhabiting wetlands and diverse forests, are gradually decreasing due to habitat loss or food scarcity, and even face the risk of local extinction. The population of birds that are resistant to fertilizer pollution may show an increase in numbers in the short term, but this increase is not a sign of ecological health, but rather a result of species adaptation changes caused by ecological imbalances. This adaptive change is often accompanied by the decline of populations of other species, further exacerbating the decline in species diversity within the ecosystem.

4. The Impact of Fertilizers on the Reproductive Behavior of Birds

4.1 Changes in Food Resources during the Breeding Season

Birds have a particularly critical need for food resources during their breeding season, and fertilizers directly affect birds' foraging efficiency and food sources by altering plant growth patterns and insect populations. Excessive application of nitrogen fertilizer often leads to excessive growth of certain plants, which may lack necessary nutrients due to nutritional imbalance, thereby affecting the growth and reproduction of insects and other food chain organisms that rely on these plants. Fertilizer may lead to a decrease in certain insect populations, which are important food sources for many birds during their breeding season, by altering the distribution of nutrients in the soil and the nutritional quality of plants. Overuse of chemical fertilizers may also exacerbate eutrophication of water bodies, leading to a dramatic increase in the number of aquatic plants and plankton. This ecological change affects the food chain structure of waterbirds, thereby reducing their food resources. The changes in food resources will directly affect the reproductive success rate of birds, especially in situations of food shortage, where birds face the risk of reproductive failure due to the inability to obtain sufficient energy and nutrients to feed their young.

4.2 Environmental Changes during the Breeding Season

The nitrogen, phosphorus and other components in fertilizers directly or indirectly alter the environmental quality of bird habitats through

water loss or airborne transmission. During the process of eutrophication of water bodies, excessive nutrients enter the water, which not only promotes the overgrowth of algae, but also leads to a decrease in dissolved oxygen in the water, seriously affecting the habitat and breeding environment of waterbirds. For terrestrial birds, the application of fertilizers changes the structure and nutritional composition of the soil, which in turn affects the growth and species composition of plants. In this situation, the plant communities that some birds rely on are disrupted, posing a threat to their nesting materials and breeding habitats. Fertilizer application may also alter climate conditions and microclimate environment, especially in the context of greenhouse gas emissions and air pollution. Changes in temperature and humidity during bird breeding season can affect their reproductive rhythm and behavior.

4.3 Hatching Success Rate and Chick Survival Rate

The impact of fertilizer application on the success rate of bird hatching and the survival rate of chicks is mainly reflected in the degradation of habitats and changes in food resources. During the hatching process, birds have a high dependence on suitable environmental conditions, such as temperature, humidity, and habitat stability, which directly affect the hatching success rate of bird eggs. The environmental pollution and habitat destruction caused by fertilizer application can lead to instability of these key environmental factors, thereby affecting the results of hatching. The interference of fertilizers on the food chain of birds also poses a threat to the survival of chicks. During the breeding season of birds, the survival rate of chicks is highly dependent on available food resources. If the food chain is negatively affected by fertilizer application, birds will not be able to provide sufficient nutrition for their chicks, leading to an increase in mortality rates. More seriously, the chemical components in fertilizers enter the bodies of birds through the food chain, affecting their health and reproductive ability, thereby further reducing the survival chances of chicks.

5. The Comprehensive Impact of Fertilizers on Ecosystems

5.1 The Decline of Biodiversity and Ecological Imbalance

The increase in fertilizer application has fundamentally changed the chemical composition of soil and water, often leading to a weakening of ecosystem stability. The intensification of soil acidification and salinization seriously damages the structure and microbial community of the soil, thereby affecting the growth and species diversity of plants. The changes in the types and quantities of plants have in turn affected the insect populations that rely on these plants, causing turbulence in the foundation of the entire food chain. Birds, as top predators in the food chain, are directly affected by changes in plant and insect populations. The process of eutrophication of water bodies exacerbates the degradation of aquatic ecosystems. The excessive growth of algae not only reduces the oxygen content in water, but also further affects the habitat and food resources of waterbirds by altering the species composition of aquatic plants. The application of chemical fertilizers not only leads to a decline in the reproductive capacity of certain species, but also exacerbates the trend of other species dominating in competition, disrupting the original ecological balance. The degradation of ecosystems accelerates the process of species extinction, further reducing biodiversity and causing imbalances in ecological functions, making it difficult to support a long-term healthy and stable ecosystem.

5.2 Ecological Chain Reaction

The ecological chain reaction caused by fertilizer application has a wide and profound impact, involving multiple ecological levels and biological communities. The direct impact of fertilizers on soil and water bodies changes the growth environment of vegetation, and changes in plant species and quantities lead to changes in insect population structure. The changes in the number of insects, especially those species that rely on specific plants for food, further affect the food chain of birds. When food resources are scarce, the foraging efficiency of birds decreases, the success rate of reproduction decreases, and the population size is suppressed. Excessive use of chemical fertilizers not only affects the growth of aquatic plants and plankton, but also alters the concentration of oxygen in water through eutrophication, posing a threat to the

survival of aquatic species. The decline of these aquatic species directly affects the habitat and food sources of waterbirds. Some chemical components in fertilizers are transmitted through the food chain to birds and other animals, causing cumulative effects that affect their health and reproductive capacity, further weakening the stability of ecosystems. The chain reactions triggered by fertilizer application are not limited to local environments, but ultimately exacerbate the imbalance of ecosystems by affecting the interrelationships of multiple biological populations, forming a self-reinforcing vicious cycle. This cycle makes ecological restoration extremely difficult, and the long-term impact on the ecological environment is even more difficult to estimate.

6. Conclusion

The application of fertilizers has had a profound impact on ecosystems, especially bird populations and reproductive behavior, while increasing agricultural yields. Fertilizer directly threatens the survival and reproduction of birds by altering habitat structure, food chain, and environmental conditions. Excessive use of fertilizers leads to soil and water pollution, causing a decline in biodiversity and ecological imbalance, thereby affecting the habitat and food resources of birds. The application of fertilizers not only interferes with the food supply during the breeding season of birds, but also reduces the success rate of hatching and the survival rate of chicks through environmental changes. In order to mitigate these potential hazards, measures such as precise fertilization and promoting the use of organic fertilizers must be taken to reduce fertilizer dependence and strengthen ecological protection and restoration work. By protecting bird habitats, promoting ecological agriculture, and implementing biological conservation measures, the negative impact of fertilizers on bird population structure and ecosystems can be effectively reduced, promoting the restoration of ecological balance and biodiversity.

References

- [1] Rashid IM, Athar M, Tabish NA. Risk management and loss prevention strategies for fertilizer industries [J]. International journal of occupational safety and ergonomics : JOSE, 2024, 11-14.
- [2] M M Mahfuz Siraz et al. Assessment of

- radioactivity level and associated radiological hazard in fertilizer from Dhaka [J]. Environmental monitoring and assessment, 2024, 196(2) : 192-192.
- [3] Li Q, Zhang S, Zhao H, et al. Effects of reducing chemical fertilizer combined with organic material application on soil nematode community structure in rape fields [J]. Chinese Journal of Ecology, 2021, 40(12): 3970-3981.
- [4] Liu D, Lv J, Deng H. Study on the relationship between environmental changes and avian population dynamics in Chongqing area [J]. Journal of Southwest Agricultural University (Natural Science Edition), 2004, (01): 84-87.