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Opinion Article

Agricultural Practices: Innovative Developments and the possibilities for Monitoring Fertilizers

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DESCRIPTION

Fertilizers are essential for enhancing crop production and ensuring food security for the growing human population. However, conventional fertilizers have many drawbacks, such as low nutrient use efficiency, nutrient leaching and runoff, environmental pollution, and plant toxicity and stress. Therefore, there is a need for more sustainable and efficient fertilization methods that can match the nutrient demand of crops and minimize the negative impacts on the environment and human health. One of the capability solutions is Controlled Release Fertilizer (CRF), which is a granulated fertilizer that releases nutrients gradually into the soil with a controlled release period. CRF can be classified into different types based on the coating materials and mechanisms of release, such as polymer-coated, sulfur-coated, resin-coated, biodegradable, and Nano composite materials.

The release rate of CRF affects crop growth by influencing the availability of nutrients to the plants and the potential losses of nutrients to the environment. The release rate of CRF depends on various factors, such as the coating materials and mechanisms, the environmental conditions, and the crop characteristics. Therefore, it is important to select the appropriate CRF type and rate for different crops and environments to optimize the crop growth and quality. Different crops have different nutrient requirements and uptake patterns, which affect their response to CRF. For example, some studies have suggested species-specific CRF rates for containerized nursery crops, such as rose of sharon, spirea, hydrangea, boxwood, and coral bells. These rates were determined based on the growth and quality parameters of each crop, such as shoot dry weight, height, width, visual quality rating, chlorophyll content, and leaf area.

CRF advantages over conventional fertilizers

Improving nutrient use efficiency: CRF can match the nutrient release with the crop demand, minimizing the losses from various processes that reduce the fertilizer availability. This can increase the crop yield and quality, as well as lower the fertilizer input and cost.

Reducing environmental pollution: CRF can decrease the nutrient loading into the soil and water systems, alleviating the issues of eutrophication, groundwater contamination, greenhouse gas emission, and soil acidification. This can improve the environmental quality and biodiversity, as well as avoid human health risks.

Preventing plant toxicity and stress: CRF can ensure a balanced and continuous supply of nutrients to the plants, preventing the fluctuations of nutrient concentration and pH in the soil solution. This can avoid the fertilizer burn and salt stress that may harm the plant roots and shoots.

CRF has been widely applied in various agricultural practices, such as field crops, horticultural crops, turf grass, ornamental plants, forestry, and nursery plants.

Challenges and limitations that hinder the widespread adoption of CRF

- High initial cost in CRF is more expensive than conventional fertilizers due to the complex manufacturing process and coating materials. This may discourage some farmers from using CRF, especially in developing countries where the economic resources are limited.
- Variable release rate in CRF is influenced by various environmental factors, such as temperature, moisture, pH, microbial activity, and soil properties. These factors may affect the release rate of nutrients from CRF, making it difficult to predict and control. Moreover, some factors may cause premature or delayed release of nutrients from CRF, resulting in insufficient or excessive fertilization.
- Potential toxicity of nanomaterials in Nanotechnology has emerged as a novel approach to enhance the performance of CRF by incorporating nanomaterials into the coating or core of CRF. Nanomaterials can improve the nutrient loading

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capacity, mechanical strength, biodegradability, and responsiveness of CRF. However, there are also concerns about the potential toxicity of nanomaterials to plants, soil organisms, aquatic organisms, and humans. The fate and transport of nanomaterials in the environment are still unclear and need further research.

In conclusion, CRF is a promising fertilization method that can improve the agricultural productivity and sustainability by providing a controlled release of nutrients to crops. However, there are still some challenges and opportunities that need to be addressed to optimize the design and application of CRF. Future research should focus on developing more cost-effective, reliable, biodegradable, and safe CRF products that can meet the diverse needs of different crops and environments.