Response of Wheat to Different Sources of Nitrogen

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Abstract

The response of wheat to various nitrogen sources has been the subject of extensive research in agriculture. The uptake and utilization of various nitrogen (N) forms vary in wheat. Hence, providing appropriate N forms could prove effective in enhancing yield, quality, and nitrogen use efficiency (NUE) synergistically. Nitrogen is a crucial element for plant growth and significantly influences wheat yield and quality. This study delves into the diverse impacts of different nitrogen sources, such as urea, ammonium sulfate, and organic fertilizers, on wheat cultivation. It examines their effects on plant growth parameters, grain yield, nitrogen use efficiency, and soil health. Additionally, the research explores the physiological and biochemical responses of wheat plants to these nitrogen sources, shedding light on nutrient uptake, photosynthesis, and nitrogen metabolism. Understanding the nuanced responses of wheat to diverse nitrogen sources is pivotal for optimizing agricultural practices, enhancing productivity, and ensuring sustainable wheat production systems.

Introduction

Wheat stands as a crucial cereal crop, heavily reliant on nitrogen (N) fertilizer for optimal grain protein accumulation, vital for its baking and processing quality (Zorb et al., 2018). Notably, India ranks as the world's second-largest wheat producer, with significant advancements in production as evidenced by the Second Advance Estimates for the agricultural year 2022-23, projecting a notable increase to 112.18 million tonnes compared to previous years (Sendhil et al., 2019). The expansion of wheat cultivation is evident, with harvested areas reaching approximately 31.87 million hectares in 2023/2024, reflecting a marked rise from 30 million hectares in 2022/2023.

Nitrogen's indispensable role in plant growth is underscored by its involvement in critical biochemical constituents such as amino acids, nucleotides, and proteins, as well as its pivotal role in metabolic functions mediated by essential enzymes (Jan et al., 2007). Additionally, nitrogen plays a fundamental role in chlorophyll synthesis and the formulation of certain plant hormones, exerting significant influence over vegetative growth and ultimately impacting the reproductive cycle of plants. Timing and quantity of fertilizer application emerge as crucial factors in maximizing crop yield, with research indicating that optimal timing can significantly enhance nitrogen utilization efficiency in cereals (Ragheb et al., 1993). Studies by Benziger et al., (1982) further suggest that late nitrogen applications can augment the photosynthetic capacity of the canopy, highlighting the importance of strategic nitrogen management practices in crop production.

Overall, understanding the nuanced responses of wheat to various nitrogen sources is pivotal in devising strategies to optimize its growth, yield, and quality, thereby contributing to sustainable agricultural practices and food security.

Form of Soil Nitrogen

The total N content in soil ranges from 0.03 to 0.4%. Ninety-five percent or more of the N in surface soil usually occurs in organic forms.

a) **Organic Compounds (Nitrogen):** The organic forms of soil nitrogen occur as consolidated amino acids or proteins or free amino acids, amino sugars and other complexes generally unidentified compounds.

b) **Inorganic Nitrogen Compounds:** The inorganic forms of soil N includes ammonium (NH4+), Nitrate (NO_2), Nitrate (NO_3), Nitrous oxide (N_2O), Nitric oxide (NO) and elemental nitrogen.

Sources of N for plants

1. **Atmospheric nitrogen**
   - ✓ About 78% of the earth's atmosphere
   - ✓ Fixed by bacteria, blue-green algae, leguminous plants etc.

2. Nitrates, nitrites, ammonia in the soil (inorganic nitrogen)

- ✓ Nitrate is the chief form of N taken up by the plants from the soil

3. Amino acids (organic nitrogen) in the soil

- ✓ Many soil micro-organisms make use of this form of nitrogen.
- ✓ Sometimes it may also be taken by some plants.

4. Organic nitrogenous compounds in bodies of the insects

- ✓ Insectivorous plants

Sources of N from Fertilizer

Plants such as legumes "make their own" nitrogen. A symbiotic (positive for both parties) relationship between a legume and rhizobium bacteria develops and the bacteria "fix" nitrogen out of the atmosphere and convert the nitrogen gas into forms that can be used by the plant. Other sources of soil nitrogen include: mineralization of organic matter and nitrogen released as plant residues break down in the soil. Animal manure is a good source of nitrogen as well.

Ammonium nitrate: is 34% nitrogen by weight. The volatilization losses from surface applied ammonium nitrate are usually quite small, especially compared to urea-based fertilizers. Ammonium nitrate can be broadcast as a dry product to the soil surface.

Ammonium sulfate: is 21% nitrogen with little or no surface volatilization loss. One disadvantage is that it is the most acidifying form of N fertilizer (will decrease soil pH). It requires approximately 2 to 3 times as much lime to neutralize the same amount of acidity as formed by other common nitrogen sources.

Urea: is a popular as a nitrogen fertilizer compared to other forms because of its relatively high nitrogen content (46% of total weight is nitrogen). Surface volatilization can be a problem if the urea is not placed in contact with the soil and it is dry for several days after spreading. Rate of volatilization depends on moisture level, temperature and surface pH of the soil. Temperatures greater than 50 degrees Fahrenheit and pH's greater than 6.5 significantly increase the rate of urea conversion to ammonia gases.

Urea-Ammonium nitrate (UAN): is a solution of urea and ammonium nitrate containing between 28 and 32% N. Since half of the solution is urea there is a risk of surface volatilization with UAN. Liquid UAN is popular because of the versatility of a liquid source can often be mixed with herbicides or insecticides. (Refer to pesticide labels before mixing with UAN). Some fertilizers that are applied as a source of phosphorus also contain significant levels of nitrogen.

Diammonium phosphate (DAP): contains 18% N and 46% P2O5

Monoammonium phosphate (MAP): contains 11% N and 52% P2O5

Conclusion

Nitrogen plays a pivotal role in wheat cultivation, influencing growth, yield, and quality. This study has examined the diverse impacts of different nitrogen sources on wheat production, highlighting their effects on growth parameters, yield, nitrogen use efficiency, and soil health. Understanding wheat's responses to varied nitrogen sources is crucial for optimizing agricultural practices, particularly in strategic nitrogen management regarding timing and quantity of fertilizer application. Moreover, considering physiological and biochemical responses of wheat plants to nitrogen sources is essential for maximizing productivity. Acknowledging the range of soil nitrogen forms and fertilizer sources provides valuable insights for sustainable wheat cultivation. Moving forward, optimizing nitrogen management practices will be key for enhancing productivity, ensuring food security, and promoting environmental sustainability in wheat cultivation.

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