USE OF "FERTIEDGE" APPLICATION FOR OPTIMIZING WHEAT FERTILIZATION

#11646

[1]I. Sbai, [2]M. Hmimou, [1]A. Bouslimi, [1]M. Hannachi, [2]H. Baroudi, [2]F. Sehbaoui, [1]A. Bousselmi, [1]S Arfaoui
[1]National Institute of Field Crops; [2] AgriEdge SA, Benguerir, Morocco
e-mail: sbaibtihel@gmail.com; 0021628332795

ABSTRACT

Wheat is a crop of global importance, and effective fertilization is crucial to maximize yield and quality. Traditional methods of fertilization often result in under- or over-application of nutrients, resulting in environmental problems and suboptimal crop yields. FertiEdge is a digital application that provides accurate fertilization recommendations based on real-time data, it's an innovative tool designed to enhance the efficiency of wheat fertilization. This study evaluates its impact on optimizing nutrient management, improving crop yield, and promoting sustainable agricultural practices. The study included a comparative analysis of wheat fields managed with and without the FertiEdge application. Key metrics measured included soil nutrient levels, fertilizer application rates, and final yield. Plots using the 'FertiEdge' application showed a 22 % and 20.6 % increase in yield compared to those managed with the conventional method respectively for Site 1 and Site 2 in the North of Tunisia. In addition, the application has allowed to reduce the quantities of nitrogen fertilizer applied by 56 kg/ha and 113.7 kg/ha compared to those managed with the conventional method respectively for site 1 and site 2. The use of 'FertiEdge' significantly enhances the precision of wheat fertilization, leading to better resource use efficiency and higher yields. The application's ability to integrate diverse data sources and provide real-time recommendations is a key advantage over traditional methods. Furthermore, the reduction in excessive fertilizer use contributes to environmental sustainability by minimizing nutrient leaching and greenhouse gas emissions. FertiEdge is a valuable tool for farmers looking to optimize wheat fertilization. Its application leads to higher yields, better resource management, and sustainable farming practices. These results remain preliminary and must be proven by repeating the same experiment two more agricultural years.

INTRODUCTION

Wheat is one of the most widely cultivated cereal crops globally, serving as a staple food source for billions of people. The efficient management of nitrogen fertilization is critical to maximizing wheat yields and ensuring food security. Nitrogen is a vital nutrient for plant growth, influencing not only the productivity of wheat but also the quality of the grain. However, the application of nitrogen fertilizers must be carefully managed to avoid environmental degradation, such as nitrogen leaching, greenhouse gas emissions, and soil acidification, which can result from over-application or improper timing.

In recent years, precision farming technologies have emerged as transformative tools in agricultural practices, offering the potential to enhance nitrogen management in wheat cultivation. These technologies, including satellite imagery, soil sensors, and variable rate application systems, enable farmers to apply fertilizers more accurately, ensuring that nitrogen is supplied according to the

specific needs of the crop and the variability of the field. By integrating precision farming techniques, it is possible to optimize nitrogen use efficiency, reduce input costs, and minimize environmental impacts, ultimately leading to more sustainable and productive wheat farming systems.

At a firsthand, this paper reviews the critical role of nitrogen fertilization management in wheat production and examines the added value of precision farming technologies in enhancing nitrogen use efficiency. Secondly, this paper includes a comparative analysis of wheat fields managed with and without the FertiEdge application which is a precision farming technology developed by AgriEdge to enhance nitrogen fertilization management. The KPIs metrics measured included soil nutrient levels, fertilizer application rates, and final yield.

Importance of Nitrogen Fertilization Management

Nitrogen fertilization is a critical component in the management of wheat cultivation, directly influencing crop yield, quality, and environmental impact. The advancement of precision farming technologies has significantly enhanced the efficiency and effectiveness of nitrogen management in wheat farming, leading to substantial benefits for both agricultural productivity and sustainability.

Nitrogen is a vital nutrient for wheat, essential for protein synthesis and overall plant growth. Proper nitrogen management is crucial in optimizing wheat yield, improving grain quality, and minimizing environmental impacts such as nitrogen leaching and greenhouse gas emissions. Recent studies have emphasized the importance of precise nitrogen management strategies. For instance, long-term studies have shown that increased nitrogen application can significantly improve wheat yield and soil properties, particularly in systems combining nitrogen fertilization with organic practices such as straw return (Jaćimović et al., 2023).

Moreover, studies on winter wheat cultivation under waterlogged conditions have demonstrated that optimizing nitrogen fertilization rates can enhance plant growth and productivity, even in challenging environmental conditions (He et al., 2024). Similarly, optimal fertilization strategies, as observed in North China, have shown that tailored nitrogen management can significantly increase wheat yield and improve environmental sustainability (Jiang et al., 2023).

Added Value of Precision Farming Technologies

Precision farming technologies have revolutionized nitrogen management by allowing site-specific application, which tailors fertilization to the specific needs of different areas within a field. This approach not only optimizes nitrogen use efficiency but also reduces the overall amount of nitrogen required, thereby minimizing environmental impacts.

One of the key advancements in precision farming is the use of Variable Rate Technology (VRT). This technology incorporates soil property maps and management zones to apply nitrogen more accurately. Studies have shown that VRT can lead to a 25% reduction in nitrogen fertilizer usage in wheat cultivation while maintaining or even improving yield and quality characteristics such as grain protein and gluten content (Denora et al., 2022).

The potential of management zones and geospatial technologies to enhance wheat production by optimizing site-specific fertilization has been demonstrated in various studies (Haroon et al., 2023).

Remote sensing technologies, such as Sentinel-2 NDVI and hyperspectral imagery, have proven effective in monitoring crop nitrogen status and adjusting fertilization practices accordingly, further supporting sustainable intensification in wheat production (Santaga et al., 2021; Song et al., 2007). Additionally, integrating precision farming technologies with traditional farming practices, such as utilizing farmyard manure in conjunction with mineral nitrogen rates, has shown significant improvements in nitrogen use efficiency and crop productivity (Salama et al., 2021).

Summary table of the relevant references.

Study	Main Focus	Key Findings
Jaćimović et al., 2023	Long-term straw return and nitrogen fertilization	Enhanced wheat yield and soil properties with combined practices.
He et al., 2024	Nitrogen management under waterlogged conditions	Improved plant growth and productivity with optimized nitrogen rates.
Jiang et al., 2023	Optimal fertilization strategies in North China	Increased yield and sustainability with tailored nitrogen management.
Denora et al., 2022	Variable Rate Technology (VRT)	25% reduction in nitrogen use while maintaining yield and quality.
Haroon et al., 2023	Geospatial technologies and management zones	Enhanced wheat production with site-specific fertilization.
Santaga et al., 2021	Sentinel-2 NDVI in nitrogen management	Improved nitrogen use efficiency and sustainable wheat production.
Song et al., 2007	Hyperspectral imagery in nitrogen management	Optimization of fertilization strategies with precision technologies.
Salama et al., 2021	Integration of precision and traditional farming practices	Significant improvements in nitrogen use efficiency and productivity.

The integration of precision farming technologies into nitrogen fertilization management offers substantial benefits in terms of efficiency, sustainability, and crop productivity. These technologies enable more precise application of fertilizers, reduce environmental impacts, and support higher yields and better quality in wheat production. The ongoing advancements in this field suggest a promising future for sustainable agriculture, where precision management will play a pivotal role in addressing the challenges of food security and environmental conservation.

MATERIALS AND METHODS

Physical Environment

The experiment was conducted at two experimental stations of the National Institute of Major Crops (INGC) in Bousalem (Site 1), which has a superior semi-arid climate, and in Béjà (Site 2), which has a humid climate. Both sites are in the northwest of Tunisia with a rainfall regime.

Plant Material
The study focused on two varieties of durum wheat: the Inrat100 variety for Site 1 and the Maali variety for Site 2.

Experimental Design
For each site, the trial was conducted on a 1-hectare plot divided into two sections, each representing a different nitrogen fertilization treatment. Nitrogen was applied as ammonium nitrate (33.5%) in three fractions (at the 3-5 leaf stage, the tillering stage, and the booting stage) according to the recommendations of the FertiEdge application (Plot 1). The control (Plot 2) followed the recommendations of the balance method (Plot 2).

By the end of the season, at each plot for the two treatments, the actual yield was measured using a combine harvester.

RESULTS AND DISCUSSION

Nitrogen optimization
The results (Table 1) show that the nitrogen fertilization approach recommended by the FertiEdge application reduced the amounts of applied nitrogen fertilizers by 56 kg/ha and 113.7 kg/ha compared to those managed with the conventional method, respectively for site 1 and site 2.

Reducing the amount of nitrogen fertilizer helps lower production costs and mitigate the risk of pollution.

Table 1. Quantity of ammonium nitrate supplied.

	Site1		Site 2	
	Plot 1	**Plot 2**	**Plot 1**	**Plot 2**
Quantity of ammonium nitrate supplied (Kg/ha)	234	290	156.3	270

***** For Site 2, the first nitrogen application was missed due to the lack of rain.

Yield Enhancement
The results obtained (Table 2) show that plots using the 'FertiEdge' application experienced a yield increase of 22% and 20.6% compared to those managed with the conventional method, respectively for sites 1 and 2. This underscores the importance of precision fertilization, which ensures that crops receive the right amount of fertilizer at the right time and in the right place.

Table 2. Grain yield.

	Site1		Site 2	
	Plot 1	**Plot 2**	**Plot 1**	**Plot 2**
Grain Yield (qx/ha)	39.34	32.31	45.83	38

REFERENCES

Denora, M., Amato, M., Brunetti, G., De Mastro, F., & Perniola, M. (2022). Geophysical field zoning for nitrogen fertilization in durum wheat (Triticum durum Desf.). PLOS ONE, 17*(4)*, e0267219. https://dx.doi.org/10.1371/journal.pone.0267219

Haroon, Z., Cheema, M. J. M., Saleem, S., Amin, M., Anjum, M. N., Tahir, M., Hussain, S., Zahid, U., & Khan, F. (2023). Potential of precise fertilization through adoption of management zones strategy to enhance wheat production. Land, 12(3), 540. https://dx.doi.org/10.3390/land12030540

He, P., Yu, S., Ding, J., Ma, T., Li, J., Dai, Y., Chen, K., Peng, S., Zeng, G., & Guo, S. (2024). Multi-objective optimization of farmland water level and nitrogen fertilization management for winter wheat cultivation under waterlogging conditions based on TOPSIS-Entropy. Agricultural Water Management, 300, *108840*. https://dx.doi.org/10.1016/j.agwat.2024.108840

Jaćimović, G., Aćin, V., Mirosavljević, M., Brbaklić, L., Vujić, S., Dunđerski, D., & Šeremešić, S. (2023). Effects of Combined Long-Term Straw Return and Nitrogen Fertilization on Wheat Productivity and Soil Properties in the Wheat-Maize-Soybean Rotation System in the Pannonian Plain. Agronomy, 13(6), 1529. https://dx.doi.org/10.3390/agronomy13061529

Jiang, X., Li, J., An, Z., Liang, J.-M., Tian, X., Chen, Y., Sun, Y., & Li, Y. (2023). Optimal Fertilization Strategies for Winter Wheat Based on Yield Increase and Nitrogen Reduction on the North China Plain. Sustainability, 15(5), 4199. https://dx.doi.org/10.3390/su15054199

Salama, H. S. A., Nawar, A., Khalil, H., & Shaalan, A. (2021). Improvement of Maize Productivity and N Use Efficiency in a No-Tillage Irrigated Farming System: Effect of Cropping Sequence and Fertilization Management. Plants, 10*(7)*, 1459. https://dx.doi.org/10.3390/plants10071459

Santaga, F., Benincasa, P., Toscano, P., Antognelli, S., Ranieri, E., & Vizzari, M. (2021). Simplified and Advanced Sentinel-2-Based Precision Nitrogen Management of Wheat. Agronomy, 11(6), 1156. https://dx.doi.org/10.3390/AGRONOMY11061156

Song, X., Yan, G., Wang, J., Liu, L., Xue, X., Li, C., & Huang, W. (2007). Use of airborne hyperspectral imagery to investigate the influence of soil nitrogen supplies and variable-rate fertilization to winter wheat growth. Proceedings of SPIE, 6752, 67521Q. https://dx.doi.org/10.1117/12.736116