

Effects of Nitrogen Fertilization and Irrigation Regimes on Biodiesel Quality and Emission Performance of Winter Rapeseed (*Brassica napus* L.)

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INTRODUCTION & AIM

Biodiesel represents a promising eco-friendly alternative to petroleum diesel, offering reduced greenhouse gas emissions and enhanced biodegradability. Optimizing agricultural practices for feedstock production is critical to ensure high-quality biodiesel with minimal environmental impact. In this context, winter rapeseed (*Brassica napus* L.) is a key feedstock crop, whose oil yield and chemical composition—and consequently the quality of the derived biodiesel and its emission profile—are significantly influenced by nitrogen fertilization and water availability.

Research Aim:

To evaluate the effects of nitrogen fertilization and irrigation regimes on fuel properties and engine emissions of biodiesel produced from winter rapeseed (cv. Dexter).

Keywords: biodiesel, rapeseed, nitrogen fertilization, irrigation, emissions, zero-pollution solutions

METHOD

Location: Aiton, Cluj County, Romania (46°35'N, 23°47'E, 345-493 m elevation)

Year: 2023-2024

Cultivar: Dexter (winter variety)

Plot size: 10 m² (2×5 m), spaced 3 m apart

Factor	Treatments
Factor A: Irrigation	I ₀ : Non-irrigated
	I ₁ : 50% IUA (1100 m ³ /ha)
Factor B: Fertilization	N0: 0 kg N/ha
	N100: 100 kg N + 75 kg P + 20 kg S
	N150: 150 kg N + 75 kg P + 20 kg S
	N270: 270 kg N + 75 kg P + 20 kg S

Irrigation schedule: Autumn (300 m³/ha), Spring (400 m³/ha), Summer (500 m³/ha)

N application: 25% autumn, 60% spring, 15% after flowering

Biodiesel production: Methanol transesterification

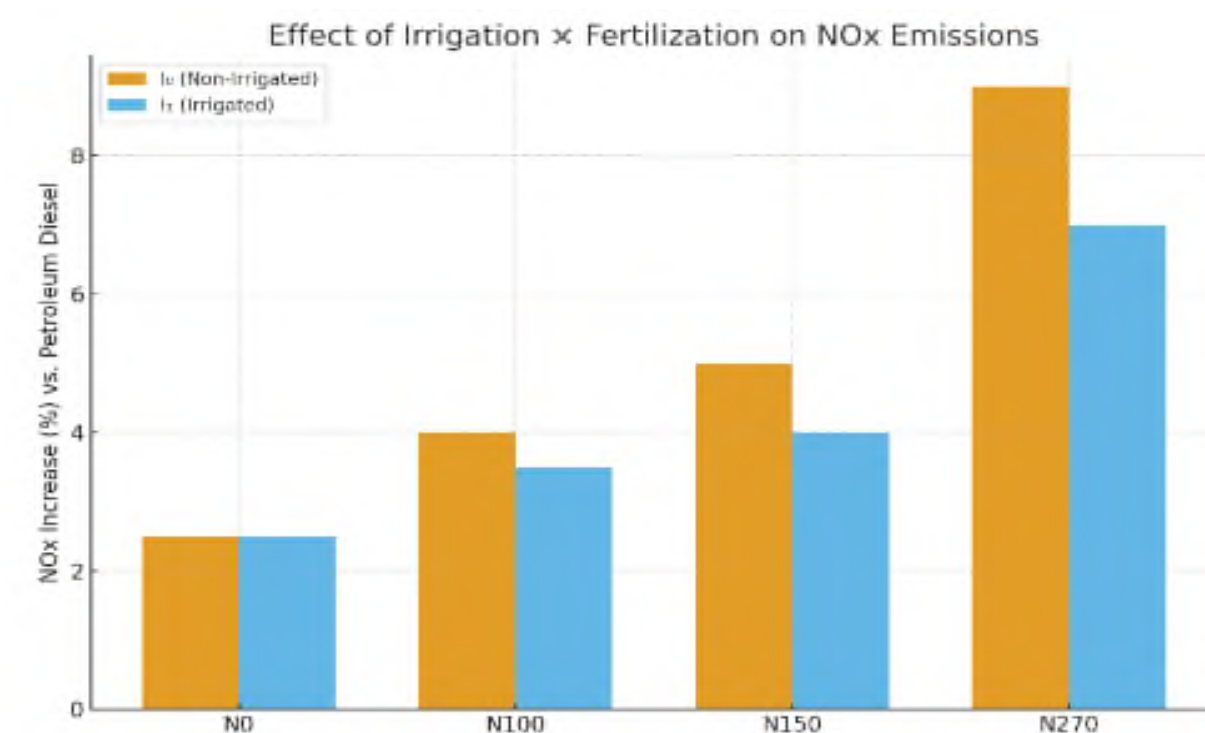
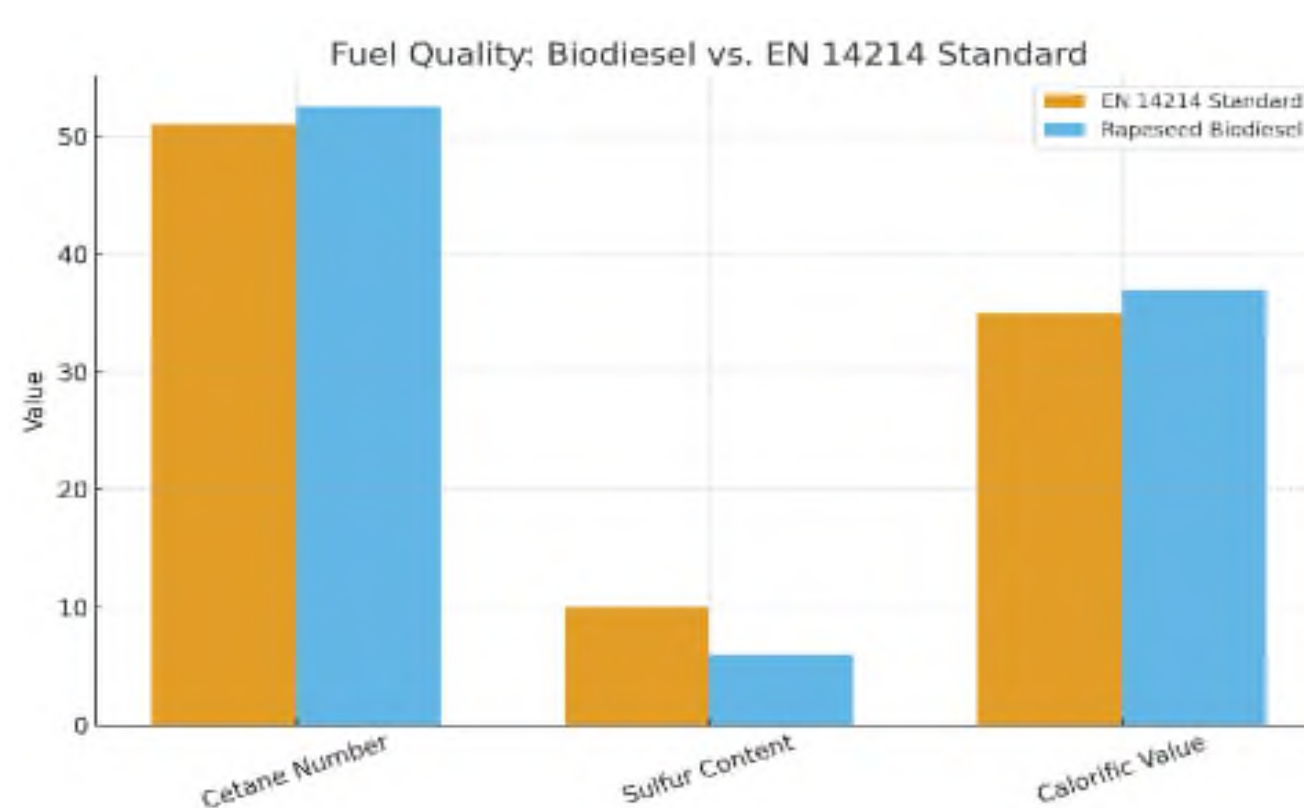
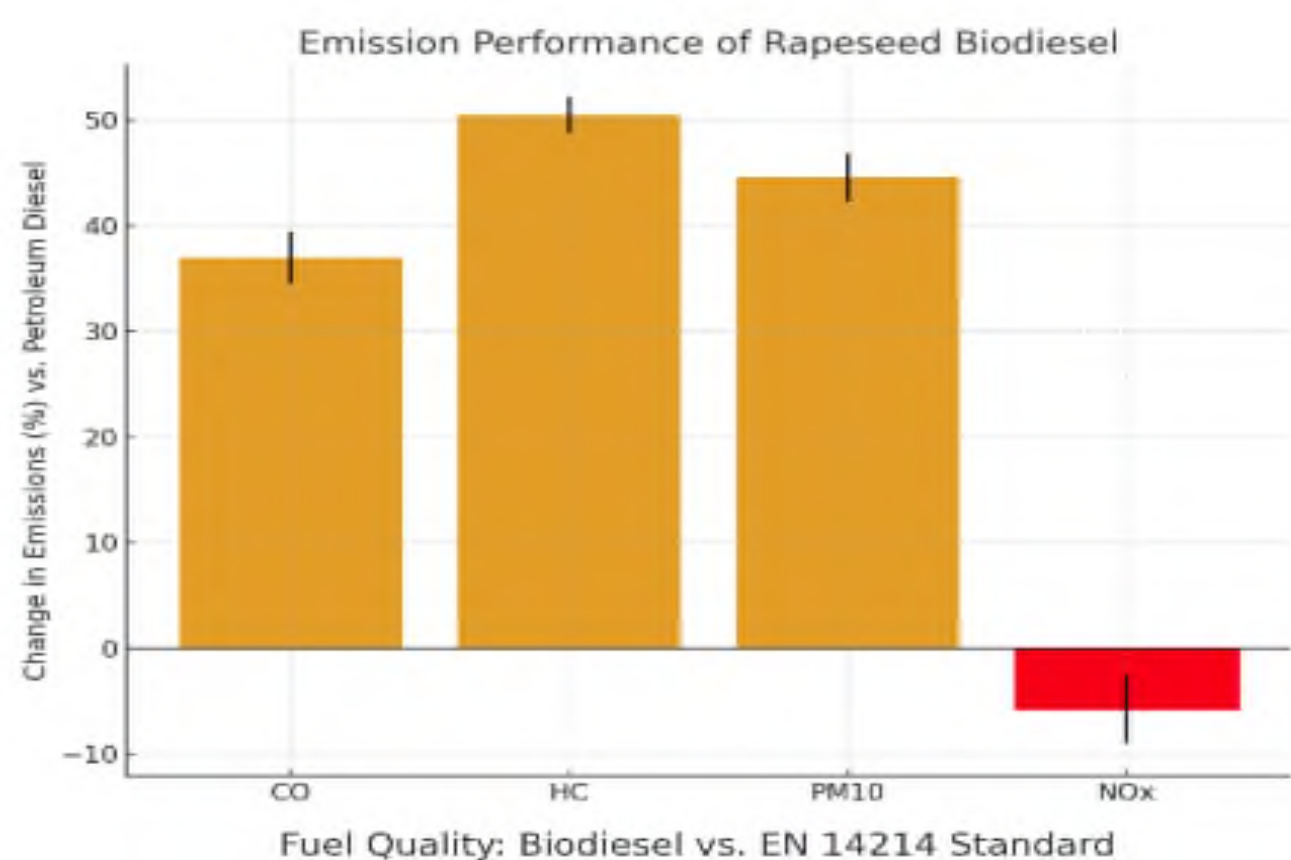
Analysis: Cetane number, sulfur content, calorific value (EN 14214); Emissions: CO, HC, PM₁₀, NO_x

RESULTS & DISCUSSION

Biodiesel Quality: All biodiesel samples met EN 14214 standards for cetane number, sulfur content, and calorific value, confirming excellent fuel properties.

Optimal Treatment: I₁ × N150

This combination produced biodiesel with the best quality characteristics and emissions performance.



•**CO emissions:** Reduced by 34.5–39.5% compared to petroleum diesel

•**HC emissions:** Reduced by 48.8–52.2%

•**PM₁₀ emissions:** Reduced by 42.3–46.9%

•**NO_x emissions:** Slight increase of 2.5–9% (linked to oxygen content and viscosity)

•**Irrigation effect:** Irrigated variants (I₁) consistently showed better biodiesel properties and lower emissions

•**High N rate:** N270 treatment increased NO_x emissions—over-fertilization should be avoided

CONCLUSION

•Rapeseed biodiesel is a viable renewable fuel with **favorable environmental characteristics**, meeting EN 14214 standards

•**Significant reductions** in CO, HC, and PM₁₀ emissions contribute to zero-pollution practices

•The **I₁ × N150 treatment** emerged as optimal for biodiesel quality and emissions

•**Proper nitrogen management** is crucial: excessive N (270 kg/ha) increases NO_x emissions

•**Irrigation at 50% IUA** consistently improved both fuel properties and emissions profile

•Feedstock properties directly influence biodiesel characteristics through oxygen content and viscosity

FUTURE WORK

•Investigate strategies to **mitigate NO_x emissions** while maintaining optimal fuel performance

•Explore **advanced engine technologies** and exhaust after-treatment systems

•Evaluate **different rapeseed varieties** under varying agro-climatic conditions

•Conduct **long-term field trials** for sustainability assessment

•Study the **carbon footprint** and life cycle analysis of biodiesel production

REFERENCES

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