THE EFFECT OF NITROGEN ON MAIN CHARACTERISTICS OF BIODIESEL OBTAINED FROM RAPESEED OIL

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ABSTRACT

The paper aims to establish the role of interaction of irrigation regime and nitrogen rates on main biodiesel characteristics and emissions. Four Nitrogen (N) fertilizer rates 0 (N_0), 100 (N_{100}), 150 (N_{150}) and 270 (N_{270}) kg/ha, two irrigation regime (non-irrigated (I_0) and irrigated at 50% from IUA (I_1) were established as feedstock treatments to obtain biodiesel through transesterification with methanol. The experiments were conducted in a randomized complete block design arrangement in split factorial with three replicates. Correlations between irrigation regime and nitrogen rates regarding the biodiesel main characteristics (cetane number, sulfur content and calorifique value) and emissions (carbon monoxide, hydrocarbons, particulate matter, nitrogen oxides) were established. The recorded results show that, except for nitrogen oxides (NO_x), the tested emissions are significantly lower than for conventional petroleum based diesel and the main characteristics respect the values of EN 14214 standard. Biodiesel emissions are significantly lower than the emissions from an engine burning normal diesel.

INTRODUCTION

Continuing near-record oil prices, fears of unaffordable and rapidly depleting sources of fossil fuel and the desire to achieve energy security and mitigate climate change have combined to heighten interest in biofuel production as a cost-effective, alternative source of energy (Biofuel in the European Union; http://www.ebb-eu.org/). Many governments have developed policies meant to promote affordable, alternative energy sources capable of maintaining current energy consumption standards, supporting further economic growth and reducing oil dependency (British Petroleum Company, http://www.thebioenergysite.com). Over the past decades, there has been an increase in effort to reduce the reliance on petroleum fuels for energy generation and transportation and the biofuels represent a true alternative to conventional fuels. Biodiesel has been gaining worldwide popularity being an eco-friendly, alternative fuel elaborated from domestic renewable resources, that runs in diesel engines (Stevens et al., 2004, http://www.biodiesel-intl.com,). One of the most attractive characteristics of the biodiesel is the reducing of greenhouse gas emissions (GHG) and the releasing of toxic pollutants, and its biodegradability (Demirbas, 2006; Demirbas et al, 2006, Fontaras et al, 2010).

The present research was undertaken to find information regarding the possible correlations between the raw material (with different rates of N fertilization and irrigation regime) and main biodiesel characteristics: cetane number, sulfur content, calorifique value and emissions (carbon monoxide, CO, hydrocarbons, HC, particulate matter, PM10 and nitrogen oxides, NO_x).

MATERIAL and METHODS

A bifactorial experiment was conducted in 2010 at SC COMCEREAL TURDA (46^0 35` N and $23^0$ 47` E, elevation 345 – 493 m above sea level) in Cluj county, Romania. The summary of the experimental factors is presented in Table 1. Experience scheme was realized to ensure the possibility for an uniform allocation and precise measurement of water and has ensured proper isolation of variants in space. Each plot consisted of 2x5 m (10 m^2), spaced 3 m apart.

Table 1 Summary of the experimental factors

Analyzed factors	Graduations
Factor A	I_0 –non-irrigated
Irrigation regime	I_1 –irrigated at 50% from IUA
Factor B	N_0 –non-fertilized
Fertilization	N_{100} –fertilized 100 N kg/ha + 75 kg /ha P + 20 kg S
	N_{150} –fertilized 150 N kg/ha + 75 kg /ha P + 20 kg S
	N_{270} –fertilized 270 N kg/ha + 75 kg /ha P + 20 kg S

Cultivar: Dexter, a winter variety. One were applied three watering: watering in autumn (emergence and rosette formation): 300 m^3/ha, a watering in the spring (flowering period): 400 m^3/ha, a watering in summer (fructification): 500 m^3/ha (irrigation norm = 1100 m3/ha). Nitrogen dose was administered in three stages: autumn 25%; spring - 60% (out of winter, on frozen ground); after flowering - 15% (after the appearance of the first internode). Foliar fertilization: FOLICARE 17/9/33 + Bor (Kemira), 5 kg/ha. Phasial fertilization: FOLICUR SOLO (Bayer CropScience), 0.5 l/ha.

The biodiesel was obtained at INCDO-INOE 2000, ICIA through transesterification with methanol. The main characteristics (cetane number, sulfur content and calorifique value) were determined at Laboratory for biofuel quality certification, CABIO (http://www.icia.ro). The obtained results were compared with the EN 14214 Standard values. The emissions were determined as follows: the biodiesel samples were run on a direct injection engine and tested for emissions with the equipment AF22M - Micro Monitoring Station (Environment SA, France) according to the norms in force (NOx; CO, HC) and PM10 with PDR 1200 (Thermo Andersen, SUA). The recorded values were compared with the emissions of a petroleum diesel sample purchased from PETROM Romania Company.

RESULTS

The results recorded are presented in Fig. 1-7.

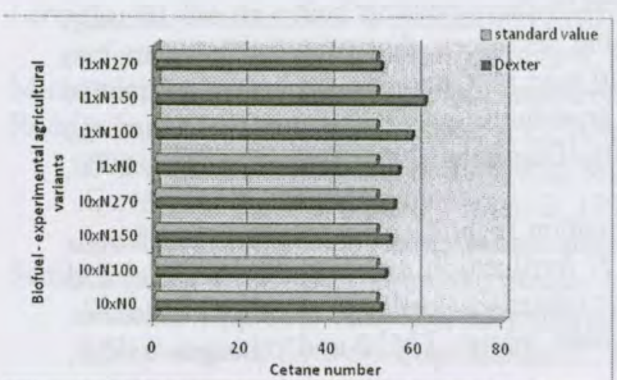

Fig. 1 Cetane number compared with standard value, (EN 14214)

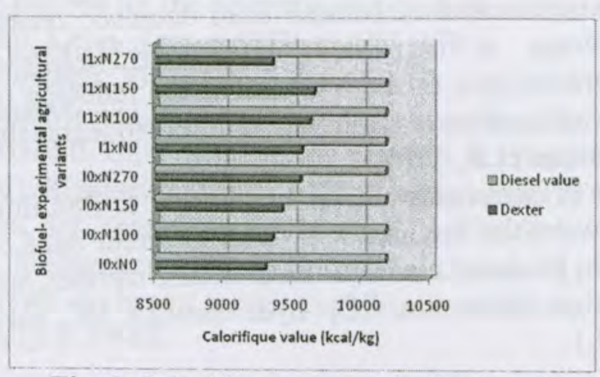

Fig. 2 Calorifique value, biodiesel and petroleum diesel

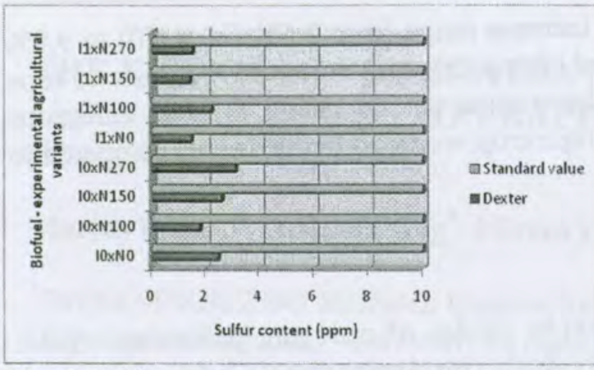

Fig. 3 Sulfur content, compared with standard value, (EN 14214)

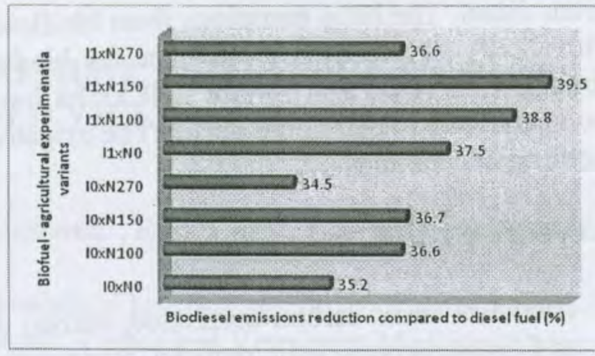

Fig. 4 Biodiesel CO emission reduction, comparated to petroleum diesel

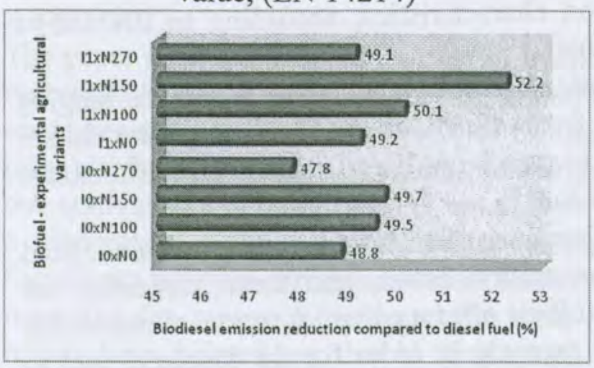

Fig. 5 Biodiesel Hydrocarbons emission reduction, compared to petroleum diesel

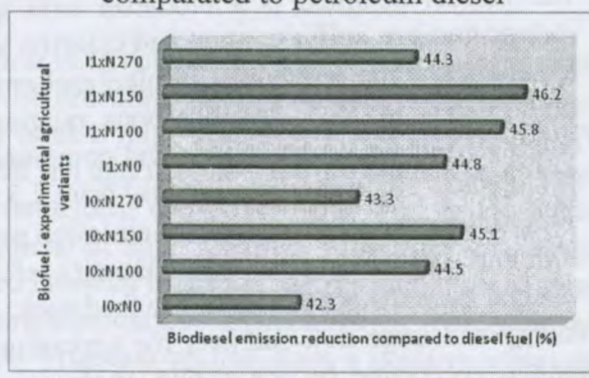

Fig. 6 Biodiesel Particulate matter, PM10, emission reduction, comparated to petroleum diesel

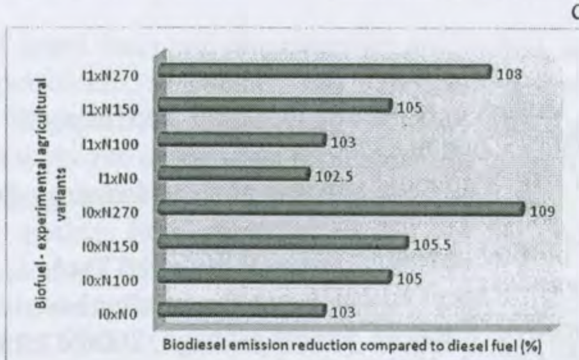

Fig. 7 Biodiesel NO_x emission reduction, compared to petroleum diesel

The cetane number for biodiesel ranges from 52 (I0xN0) to 62 (I1xN150). The best results are recorded for the agricultural variants I_1 x N_{100} (59) and I_1 x N_{150} (62). The calorifique value for biodiesel ranges from 9300 kcal/kg (I_0xN_0) and 9650 kcal/kg(I_1xN_{150}), comparatively with 10170 kcal/kg for petroleum diesel. The sulfur content has been recorded very good value, it ranges from 3.1 ppm (I_0xN_{270}) to 1.4 ppm (I1xN150).

About 11 percent of the weight of biodiesel is oxygen (http://www.biodiesel-intl.com). The presence of oxygen in biodiesel improves combustion and therefore reduces hydrocarbon, carbon monoxide, and particulate emissions; but oxygenated fuels also tend to increase nitrogen oxide emissions. Engine tests have confirmed the expected increases and decreases of each tested exhaust component. The carbon monoxide emissions are lower than carbon monoxide emissions from diesel; the recorded values range from 34.5% (I0xN270) to 39.5 % (I1xN150). The exhaust emissions of total hydrocarbons are reduced with 48.8 % (I0xN0) to 52.2 %(I1xN150). The exhaust emissions of particulate matter, PM10, from biodiesel are between 42.3 (I0xN0) and 46.2 (I1xN150) percent lower than particulate matter emissions from diesel. The NO_X emissions from biodiesel increase range from 2.5% (I1 x N0) to 9.0% (I0xN270). The feedstock influence the biodiesel characteristics, the better variants of rape crop is I_1 x N_{150}. The N rate 270 kg/ha has determined an increasing in NO_X emissions comparatively to petroleum diesel. The irrigated rape crop recorded better values compared to nonirrigated variants.

CONCLUSIONS

- Biodiesel emits carbon monoxide, carbon dioxide, oxides of nitrogen, particulate matter and hydrocarbons baut reduced comparatively with petroleum diesel, helping, through reduced pollution, in the safe keeping of the environment and ensuring of human health.
- The biofuel obtained is a biodiesel with good characteristics, according to EN 14214 (cetane number, sulfur content and calorific value).
- Results show the reductions in biodiesel emissions as follows: carbon monoxide ranging from 34.5% to 39.5; hydrocarbons ranging from 48.8% to 52.2%; particulate matter ranging from 42.3% to 46.9%; and compared to petroleum diesel. However, nitric oxides (NOx) show slight increase ranging from 2.5 % to 9 %.
- Reasons for the variations of the emission performance of each methyl ester are associated with the oxygen content and viscosity of the methyl esters, and these properties are resulted from the properties of the feedstock. Biofuels offer a potential source of renewable energy and large new markets for agricultural produce In order for the biodiesel fuel to remain acceptable by the public, more research is warranted to improve the emissions qualities.

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