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Triticale for Bioenergy Production

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Abstract

The promotion of renewable energy represents a target of the European 2020 strategy for growth.
Plant biomass and organic wastes from agriculture represent an effective resource to be exploited for a sustainable rural development, optimizing the land use, diversifying rural entrepreneurship.
Cereals are considered a promising biomass producing crop in temperate regions of Europe to be used for both fuel alcohol and biogas production.
In particular, triticale shows a number of advantages such as high grain yield even in marginal environments, tolerance to drought, tolerance to more acid soils, low susceptibility to biotic stresses and is known to have reduced production costs.
The characteristics of triticale were reviewed, focusing on bio-energy applications.
Furthermore, data from a two-year experiment carried out in Italy using nine triticale lines grown in marginal areas close to Bracciano, Italy, were reported. A bread wheat variety selected for bio-energy application, EW9, were also included for a more complete analysis. Traits such as day-to-heading, plant height, number of plants, number of spikes, grain yields were analysed. Preliminary results concerning biogas potential of biomass consisting of triticale hay harvested at milky-dough phase were also measured and results are reported.

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Keywords: triticale hay; biogas from biomass; anaerobic digestion.

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1. Introduction

The promotion of renewable energy represents a target of the European 2020 strategy for economical growth and sustainable competitiveness. Plant biomass and organic wastes from agriculture represent an effective resource to be exploited for a sustainable rural development, optimizing the land use, diversifying rural entrepreneurship and producing energy and new income.

Among crops, triticale is considered particularly promising as biomass source in temperate regions of Europe and protocols are developed for producing bio-alcohol and biogas.

Triticale (X Triticosecale Wittmack) is a human-made crop, being a hybrid small grain produced crossing wheat and rye. The name ‘‘triticale’’ derives from the combination of the scientific classifications of the two genera involved, that is, wheat (Triticum) and rye (Secale). The triticale hybrids are all amphidiploid, which means the plant is diploid for two crossed genomes, thus is an allotetraploid. The first crosses were attempted in Scotland in the late 1870s, the first true result was obtained by Rimpau in 1888, but the first commercial releases, available for producers, dates back 1960s. The CIMMYT Triticale Improvement Program started in 1964 and today CIMMYT is the principal supplier of improved germoplasm for national and international programmes worldwide.

Generally, triticale combines traits of the rye genome, as the rusticity, disease and environmental tolerance (including soil conditions), to traits of wheat, as the high yield potential the good grain quality. Therefore, it is a crop which is particularly suited for marginal environments characterized by high acidity “sub-standard” soils, water shortage and located at a high altitude or where disease pressure is high. Triticale is known to have lower production costs in comparison to other crops, lower susceptibility to biotic stresses, thus reducing requirements for chemical protection and fertilization, and results in high grain yield and large biomass production even in marginal environments not usable for food crops.

Furthermore, triticale improves the environment because of its ability to reduce leaching into groundwater acting as a soil improver, due to its extensive root system which is able to bind erosion-prone soil and provides a good substrate for conversion into subsoil organic carbon by soil microbes (Salmon et al., 2004). In addition, triticale is important as a rotation crop for the reduction of soil pests, (e.g. nematodes).

Although a new crop, the benefits of triticale production are enormous and an ever increasing acreage is used for growing it, in more than 30 countries. In these last 20 years, triticale is assuming more and more importance in relationship with the increasing needs to find new lands for agriculture and with the growing interest of possible industrial uses as feedstock in bio-energy production. Current production is concentrated in Europe with nearly 90% of the world production and ~7 million acres harvested annually. US production is nearly 1 million acres, with the majority of the planted acres used for forage and pastures (Mergoum et al., 2009).

In Italy, the first registered national variety was Mizar (1979), followed by Rigel (1983), both developed at ENEA. These two triticale varieties are characterized by high yields and high pest resistance and are still cultivated in Italy. Ever since, in Italy, new varieties have been released and more and more programmes for genetic improvement are underway by private seed producers.

Currently, it is grown mainly as a feeding crop, but increasing attention is given to bio-energy production. In particular, triticale is considered a good feedstock for ethanol production but increasing attention is paid to biogas production by anaerobic digestion. At global level limited sources of fuel and energy have given a strong input to study and develop biomass production and bio-energy crops (Cardona and Sanchez, 2007). Several protocols with different type of pre-treatment for de-restructuring plant biomass and recovering high yield of sugar and lignin-cellulose molecules have been studied to better design a specific and efficient protocol for triticale variety (Belkacemi et al., 1998; Chen et al., 2007).

The aim of this study was to compare the yields and some biochemical parameters related to the bio-energy production of eight triticale elite lines in a two-year experiment in marginal soil. These lines were constituted at CIMMYT (MX) and were growth in Italy for the first time. For comparison, an Italian triticale variety, Magistral, and an Italian bread wheat variety, EW9, constituted as energy crop, were also studied as Italian witnesses. Preliminary results concerning biogas potential of biomass consisting of triticale hay harvested at milky-dough phase were also measured and results are reported.