Soil & Tillage Research 223 (2022) 105478

Contents lists available at ScienceDirect

Soil & Tillage Research

journal homepage: www.elsevier.com/locate/still

Biosolids and conservation tillage for rainfed wheat farming in dry Mediterranean climates

William F. Schillinger *, Craig G. Cogger, Andy I. Bary

Department of Crop and Soil Sciences, Washington State University, 115 Johnson Hall, Pullman, WA, 99164, USA

ARTICLE INFO

Keywords:
Biosolids
Drought
Dryland farming
Mediterranean climate
Residue cover
Soil micronutrients
Winter wheat

ABSTRACT

Biosolids are used in dryland wheat (*Triticum aestivum* L.) production in eastern Washington and other regions of the world as a source of nutrients and to increase soil organic carbon (SOC). Moreover, conservation tillage is promoted to reduce erosion and soil degradation. We explored the impacts of biosolids vs synthetic fertilizer in combination with undercutter (UC) conservation tillage vs tandem disk (TD) traditional tillage in an 8-yr field experiment in drought-prone region near Lind, WA (244 mm avg. annual precipitation). There were two sets of plots to allow for data collection each year in a 2-yr winter wheat (WW)-fallow rotation. Biosolids were applied at 6.5 mt/ha dry weight to meet the nutrient needs of two WW crops. Synthetic fertilizer plots received 56 kg N plus 11 kg S/ha for every wheat crop. Biosolids increased WW grain yield vs synthetic fertilizer by 25% one year but with no differences in other years or the 8-yr avg. Tillage method had no effect on WW grain yield nor grain yield components. Wheat kernel weight was lower and grain protein higher than desirable in biosolids plots, indicating excessive N because the application rate was too high for such a dry environment. Consistent year-long surface residue cover > 30% was achieved with UC tillage for government farm program conservation compliance, but this was not attained with TD tillage. In addition to highly desirable levels of P, biosolids provided significant quantities of the important soil micronutrients Zn, Mn, Cu, Fe. Biosolids application did not increase SOC in the surface 30 cm. This study demonstrated the application of biosolids combined with low-disturbance UC conservation tillage is an agronomically- and environmentally sound practice for dryland wheat production. We believe this is the driest rainfed environment in which biosolids for crop production have yet been evaluated.

1. Introduction

1.1. Prior research on biosolids applications for dryland wheat

Biosolids are a source of plant nutrients and organic carbon used in agriculture around the world (Rigby et al., 2016; Brown et al., 2011; Collivignarelli, 2019). Biosolids are a by-product of municipal wastewater treatment that has been treated, stabilized, and analyzed to meet standards for agricultural application (USEPA, 1993). Biosolids applications have consistently produced equal or greater grain yields compared with commercial fertilizer applications for dryland wheat production in the PNW (Sullivan et al., 2009; Koenig et al., 2011), the US Great Plains (Barbarick et al., 2010, 2017), western Europe (Powlson et al., 2012), in tropical areas (Melo et al., 2018), and other regions of the world. However, during drought cycles, excessive application of biosolids may cause reduction in kernel weight of wheat (Cogger et al., 2013). In the state of Washington, 62% of biosolids produced each year is applied on about 10,000 ha of farm ground with the remainder applied mostly on government-owned forest land (Emily Kijjowski, WA Dep. of Ecology, personal communication).

Biosolids are a slow-release source of N, with N availability depending on their method of processing and environmental conditions (Rigby et al., 2016). Gilmour et al. (2003) integrated multiple field trials, laboratory incubations, and computer models to estimate available N from biosolids across a range of processing methods and environments and showed that N availability was similar across methods. The only exception was for biosolids that had undergone further stabilization by composting or long-term lagoon storage. Biosolids application rates for

Abbreviations: PNW, Inland Pacific Northwest of the United States; SOC, Soil organic carbon; TD, Tandem disk; UC, Undercutter; WW, winter wheat; WW-F, Winter wheat–fallow monoculture cropping system.

* Corresponding author.
E-mail address: william.schillinger@wsu.edu (W.F. Schillinger).

https://doi.org/10.1016/j.still.2022.105478
Received 2 December 2021; Received in revised form 9 June 2022; Accepted 30 June 2022
Available online 11 July 2022