Camelina: Long-term cropping systems research in a dry Mediterranean climate

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ABSTRACT

Camelina [Camelina sativa (L.) Crantz] is a short-season annual oilseed crop in the Brassicaceae family. Interest in camelina has increased substantially during the past 15 years because the oil is an excellent feedstock for producing low-carbon-emission biofuel and has a unique fatty acid profile as a potential edible oil. Camelina has been promoted as an alternative crop in low-precipitation dryland regions because of its low fertilizer requirement and drought tolerance. An 8-yr field experiment was conducted from 2010 to 2017 at the WSU Dryland Research Station near Lind, WA to compare a 3-yr winter wheat (WW)-spring camelina-summer fallow (SF) rotation with the traditional 2-yr WW-SF rotation. Annual crop-year (Sept. 1-Aug. 31) precipitation ranged from 193 to 375 mm and averaged 281 mm. Camelina seed yield ranged from 339 to 1175 kg/ha and averaged 643 kg/ha. Mean WW yield of 2692 kg/ha in the 3-yr rotation was significantly lower (p = 0.046) compared to 2862 kg/ha in the 2-yr rotation. Soil profile water was significantly lower (p < 0.001) after harvest of camelina compared to after WW harvest in the 2-yr rotation. This soil water reduction was consistently measured throughout the ensuing 13-month fallow cycle. There are no labeled in-crop broadleaf weed herbicides for camelina and populations of Russian thistle (Salsola tragus L.) and tumble mustard (Sisymbrium altissimum L.) were higher in camelina than in WW. This was likely a factor in the deep extraction of soil water in the camelina plots to a depth of 180 cm. Data from this study suggest that, with current cultivars and management practices, camelina is not yet agronomically or economically stable or viable in a 3-yr WW-camelina-SF rotation in the low-precipitation (< 300 mm annual) rainfed cropping region of the Inland Pacific Northwest (PNW).

1. Introduction

Camelina is a dicotyledonous oilseed crop in the Brassicaceae (Cruciferae) family. Although grown in Europe as early as 4000 BC (Larsson, 2013), camelina has only in recent decades received serious attention in the scientific literature. Camelina is a short-season crop that is widely reported in Europe, Canada, and the United States to have a relatively high tolerance to water stress (Hunsaker et al., 2011; Gao et al., 2018; Zanetti et al., 2013) as well as frost tolerance and disease resistance (Zanetti et al., 2017).

Camelina oil can be used as feedstock for biodiesel and jet fuel, food oil, and many other uses as summarized by Berti et al. (2016). After most of the oil is extracted from seeds by mechanical press, the remaining seed meal provides an excellent dietary ingredient to produce animal feed (Moriel et al., 2011). Some farmers both grow and press camelina seed themselves to produce raw oil which can be directly used in oil diesel engines without transmethylation (Keske et al., 2013).

Dependence on imported oil, atmospheric emissions, and other concerns with petroleum-based fuels has led to numerous scientific efforts to seek alternative and renewable energy. Jet fuel derived from camelina oil has undergone extensive testing by commercial airlines and the US military and results show that camelina-based hydrotreated jet fuel meets all jet engine performance expectations and significantly reduces greenhouse gas emissions compared to petroleum-based jet fuel (Shonnard et al., 2010; Corporan et al., 2011; Azami et al., 2017).

A monoculture 2-yr WW-SF rotation is practiced by most farmers on 1.5 million cropland hectares in the low-precipitation (< 300 mm annual) precipitation region of the PNW (Karimi et al., 2018). In recent years, winter pea (Pisum sativum L.) (Schillinger, 2017), winter canola (Brassica napus L.) (Pan et al., 2016), and winter triticale (X Triticosecale Wittmack) have gained popularity among farmers due to their relatively acceptable and stable yield performance; but, like WW, they require a preceding year of fallow to be agronomically and economically viable. Farmers and scientists in this dry region have experimented with many spring-planted cereal and broadleaf crops, but those so far tested are subject to water and heat stresses and have highly-variable yields that

Abbreviations: BCAP, Biomass Crop Assistance Program; PNW, Inland Pacific Northwest of the United States; SF, summer fallow; WW, winter wheat

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https://doi.org/10.1016/j.fcr.2019.02.023

Received 4 December 2018; Received in revised form 27 February 2019; Accepted 27 February 2019
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