Soil & Tillage Research 121 (2012) 68–73

Contents lists available at SciVerse ScienceDirect

Soil & Tillage Research

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

# Nematode and fungal diseases of food legumes under conservation cropping systems in northern Syria

Seid Ahmed [a,*], Colin Piggin [a], Atef Haddad [a], Shiv Kumar [a], Yaseen Khalil [a], Bejiga Geletu [b]

[a] International Center for Agricultural Research in the Dry Areas, P. O. Box 5466, Aleppo, Syria
[b] International Center for Agricultural Research in the Dry Areas, P. O. Box 5689, Addis Ababa, Ethiopia

ARTICLE INFO

*Article history:*
Received 27 September 2011
Received in revised form 7 January 2012
Accepted 29 January 2012

*Key words:*
Legumes
*Heterodera ciceri*
Cyst nematodes
Fusarium wilt
Ascochyta blight
Conservation tillage
Downy mildew

ABSTRACT

Conservation agriculture is becoming popular due to its potential for enhanced productivity and cost savings among small scale farmers in developing countries. The International Center for Agricultural Research in Dry Areas is promoting conservation cropping systems that involve cereal–legume rotation in West Asia and North Africa region. Studies were made on the impact of long-term rotation trial on diseases of chickpea and lentil as well as the evaluations of lentil genotypes for their reactions to Fusarium wilt and downy mildew under two tillage practices. In the long-term rotation trials, the two season results showed no significant differences between tillage practices, crops and planting dates and their interactions in affecting mean percent cyst nematode disease. The mean cyst nematode disease incidence ranged from 7.3% on early planted lentil on CT to 14.5% in late planted chickpea on ZT. Tillage practices significantly ($P \leq 0.05$) affected Ascochyta blight incidence but not its severity. The incidence ranged from 4% to 22.5% under early planted chickpea on both tillage practices. Moreover, the mean severity ranged from 3.2 to 5.5 rating in early planted CT and ZT, respectively. The combined analysis showed significant differences ($P \leq 0.05$) among genotypes but not their interactions with tillage for Fusarium wilt and downy mildew reactions. All the genotypes showed less than 10% Fusarium wilt mortality indicating high levels of resistance. The mean downy mildew severity ranged from 1.3 in ILL-7991 to 2.6 rating in ILL6994. This study showed that both soil borne and foliar diseases could be a problem in conservation cropping system and continuous monitoring of diseases is essential to prioritize management practices in relation to conservation agriculture in Mediterranean type environments. Moreover, cool-season legume genotypes with disease resistance and high yield can be developed under conservation agriculture that could also serve traditionally tilled production systems.



## 1. Introduction

In West Asia and North Africa (WANA) rainfed cropping areas, where rainfall is normally between 200 and 600 mm (Kassam, 1981), drought is of a major constraint for crop production. Rainfall varies seasonally and within seasons (Smith and Harris, 1981), and moisture stress is common at the end of the cropping season. Cropping systems in WANA region have traditionally centered on cereals in association with animal production (Cooper et al., 1987). Wheat tends to dominate where seasonal rainfall is above 350 mm, while barley predominates in the drier areas (200–350 mm). In recent years, the practice of fallow, which traditionally helps to stabilize cereal yields, has decreased due to land-use pressure. This trend has led to continuous cropping of barley or wheat (Jones and Singh, 2000). Rotations that involved a non-cereal host crops especially food and forage legumes are more sustainable than continuous cereal cropping (Karlen et al., 1994), but many farmers in marginal areas consider legumes too risky with low yields or crop failures and grain marketing difficulties.

Conservation agriculture (CA), or more specifically conservation cropping, based around zero tillage and stubble retention, is being increasingly used around the world (Paulitz, 2006; Derpsch and Friedrich, 2010). The strong benefits it brings come from the opportunity for early sowing; savings in time, machinery and fuel; better soil structure (organic matter); better soil–water dynamics (porosity); better nutrient recycling (NPK); improved trafficability; higher yield potential; less erosion; and higher carbon sequestration. Conservation cropping is mainly adopted in countries where the landholding is very large and the farmers can afford to apply inputs necessary for the system to be effective. However, there is a general agreement that CA can offers potential benefits to smallholder farmers in terms of labor, yields can be stabilized and arresting soil erosion (Giller et al., 2011). For example, use of

* Corresponding author. Tel.: +963 21 2213433/26912449; fax: +963 21 2213490.
*E-mail address:* s.a.kemal@cgiar.org (S. Ahmed).

0167-1987/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
doi:10.1016/j.still.2012.01.019

minimum tillage to grow an indigenous small cereal crop tef (*Eragrostis tef*) in the Ethiopian highlands was found to be a good option for small scale farmers (Tulema et al., 2008). In Tunisia, zero tillage was introduced for small cereal production without legume rotation and its uses are increasing in rainfed agriculture (Errouissi et al., 2011). In Turkey, reduced tillage was found to increase soil water holding capacity, water availability and emergence in lentil in comparison to conventional tillage (Sefa and Ahmet, 2011). In Spain, over 11 years of long-term trials, no-till increased the yield of faba bean during drought seasons where as conventional tillage gave high yield during favorable season (Lopez-Bellido et al., 2003). International organizations like FAO, CIRAD, CIMMYT, ICRISAT, and the African Conservation Tillage Network are actively promoting CA with smallholder farmers in Africa (Kassam et al., 2009). Conservation cropping is now being investigated at the International Center for Agricultural Research in the Dry Areas (ICARDA) as a means to increase yields, reduce costs and mitigate and/or adapt to climate change and variability.

Food legumes and oil seed crops are included as beneficial rotation crops in cereal-based cropping systems in many countries. Reduced tillage has been reported to increase or decrease the risks of foliar and soil-borne diseases in food and forage legumes (Krupinsky et al., 2002; Almeida et al., 2003; Noel and Wax, 2003; Kimber and Paull, 2011; Lamprecht et al., 2011). Many of the long-term cropping system trials showed that continuous cropping of wheat (Ryan et al., 2010) and barley (Jones and Singh, 1995) was lowest in terms of grain and straw yields, with reduced soil moisture cited as the reason for yield declines for wheat (Harris, 1995; Pala et al., 2007) and for barley (Harris, 1994). To verify and adapt conservation cropping systems in WANA, several long-term cropping system trials are being conducted at ICARDA, commencing in 2006. Moreover, the performance of different varieties/lines of cool-season cereals and food legumes under zero tillage and conventional cultivation is being evaluated in order to generate information to breeders and development practitioners in the dry areas. However, little or no consideration was given to the possible buildup of nematode and fungal diseases in continuous cereal cropping in such long-term trials despite the common assumption that diseases are one of the factors affecting yield stability.

In this paper, we tried to investigate (1) what impact (s) conservation cropping systems will have on nematode and fungal diseases of chickpea and lentil and (2) examine whether lentil genotypes changes their reactions to Fusarium wilt and downy mildew diseases under conservation cropping system.

## 2. Materials and methods

### 2.1. Long-term rotation trial

The long-termcropping system trial was established in 2005/06 cropping season at Tel Hadya (latitude 36°40′N, longitude 37°20′E and altitude of 390 m above seas level), ICARDA's main research station, Syria. Four crops were grown in rotation, in four sequences so that each crop was grown each year (for example, Year1–Year2–Year3–Year4 sequences were bread wheat (*Triticum aesitivum*)–chickpea (*Cicer arietinum*)–barley (*Hordeum vulgaris*)–lentil (*Lens culinaris*); barley–lentil–wheat–chickpea; lentil–wheat–chickpea–barley and chickpea–barley–lentil–wheat). Each crop was grown under two tillage systems, namely, zero tillage (ZT) and conventional tillage (CT) and two sowing dates (early and late). With ZT, crops were sown directly into uncultivated soil; with CT, there were two cultivations (2 tine cultivations for cereals on legume stubble and a mouldboard then tine cultivation for legumes after cereals) before sowing. The crop varieties used were bread wheat (cv. Babagha-3), barley (cv. Reem), lentil (cv. Idleb-3) and chickpea (cv. Ghab-4). The planting times varied but generally early planting was in early-mid November and late planting around 4–6 weeks later in early-mid December. The experiment was arranged in split-split plot design with four replications where tillage, crops and sowing dates were main, sub and sub-sub plots, respectively. Each experimental unit in the sub-sub plot was 780 $m^2$. Diammonium phosphate was applied for cereals at planting at the rate of 100 kg/ha. Triple super phosphate (TPS) was applied to legumes at 100 kg/ha. All plots were sown with an Indian Zero Till Seeder (National Agro Industries, Ludhiana) with crops sown 17.5 cm row spacing and a seed rate of 100 kg/ha. Weed control was done by different selective herbicides and sometimes an additional hand weeding was done especially for the legumes. Percent incidence of cyst nematode (*Heteredora ciceri*) infected plants of chickpea and lentil was recorded based on both below ground (presence of cysts) aboveground symptoms (stunting, yellowing and limited number of flowers and pods) in the 2008/09 and 2010/2011 cropping seasons at flowering-podding stages of the crops (Greco et al., 1992; Castillo et al., 2008) at the whole plot basis, but not in 2009/2010 cropping season due to cold damage of the crop that made disease assessment based on symptoms very difficult. In 2008/2009 cropping season Ascochyta blight (*Didymella rabiei*) percent disease incidence and severity (1–9 rating scale where 1 = resistant and 9 = susceptible) were recorded on chickpea. Disease development (cyst nematodes and Ascochyta blight) were depended on natural inoculum sources existing in the long-term trial plots. In the case of Ascochyta blight disease development; there could be additional primary inoculum sources mainly ascospores released from near by fields.

### 2.2. Tillage by lentil genotype interactions

Twelve lentil genotypes (ILL-4400, ILL-4401, ILL-2126, ILL-5883, ILL-6994, ILL-7199, ILL-7685, ILL-7947, ILL-7991, ILL-9889, ILL-9890 and ILL-9894) with varying levels of resistance to lentil Fusarium wilt (*Fusarium oxysporum* f. sp. *lentis*) were planted in randomized split plot block design, with ZT and CT as main plots and lentil genotypes as sub plots, in three replications in 2008/09 and four replications in 2009/10 and 2010/11 cropping seasons at ICARDA Tel Hadya Research Station, Syria. The CT was cultivated twice before sowing and the ZT treatment was drilled directly into the stubble of the previous wheat crop. The same ZT plot seeder was used to plant all treatments. Plantings were done on December 26, 2008; November 19, 2009 and November 25, 2010 with a seed rate of 100 kg/ha. A pre-planting application of glyphosate at the rate of 1 l/ha (450 g a.i./l) was done to control emerged weeds. Broomrape (*Orobanche* spp) infections on lentil genotypes was controlled with imazaquin (10–15 ml a.i./ha) applied two times (at early flowering and early podding stages) at two week intervals during the cropping seasons. Fusarium wilt and downy mildew disease development were initiated from natural inoculum sources.

Visual estimates of percent Fusarium wilt incidence and downy mildew (*Peronospora lentis*) severities (1–5 rating scale where 1 is highly resistant and 5 is highly susceptible) were taken at the whole plot level. The causal agent for from Fusarium wilt symptoms was confirmed by isolating the pathogen from 20 randomly collected wilted plants on potato dextrose agar. Statistical analyses were carried out using Genstat software (Payne, 2009) and transformation of percent disease incidences was carried out using arcsine and logarithm transformations as appropriate, but non-transformed vales are used in the tables for ease of presentations The combined analyses for the long-term rotation trial (percent cyst nematodes disease incidence) and tillage and lentil genotype effects on Fusarium wilt incidence and downy mildew severities were done by mixed models using the