Water productivity of lentil and chickpea genotypes under conventional and no-tillage systems

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Introduction

No-tillage practice (NT), principal component of conservation agriculture (CA), was introduced in Mediterranean rainfed conditions as a promising water conserving technology. Although the benefits of NT system have been fairly demonstrated, their implementation still limited, and required several changes in management practices (variety, agricultural machinery, weed management, irrigation,...), cropping system (no-tillage, crop residues and crop diversification), farming system (farm's resources, land, capital, labor, etc.), and various decisions made at the farm level.

The characterization of the CerealMed collections of chickpea and lentil genotypes and the evaluation of their capacity to enhance water productivity under conventional (CT) and no-tillage systems (NT) is one of the objectives of this study. In fact, several questions need to be addressed about plant genetic improvement for conservation agriculture (CA), mainly: which phenotypes/genotypes are suitable for CA? Under which agronomic practice? Which interaction Genotype x Environment x Management can we except? And what about reaction to diseases and pests attacks?

Methodology

Crop management

An experiment study was carried out at Sidi El Aidi experimental station of Settat, Morocco. 120 genotypes of lentil and 250 genotypes of chickpea were tested under two tillage systems, conventional tillage (CT) and no-tillage (NT), in the 2020-2021 season. The experimental design adopted was an augmented design. Each genotype was sown in a plot of 9 m² for lentil and 12 m² for chickpea.

Measured soil and plant traits

Water use efficiency (WUE) and water productivity (WP) were calculated as follows:

WUE (kg/mm/ha) = GY/ETc ; WP (kg/m3) = B/ETc

Where GY is the grain yield (kg/ha); B is the total biomass (kg/ha);

ETc is the crop evapotranspiration (mm) calculated by using the soil water balance equation: ETc = P+I-D+ΔS; where P is the total seasonal precipitation (mm); I is the amount of irrigation (mm); D is the soil water drainage (mm), and ΔS is the change of soil water content from sowing to harvest (mm).

Results and discussion

The results of water use efficiency (WUE) and water productivity (WP), respectively ranged around 3 kg/mm/ha and 0.2 kg/m3 for lentil crop (Fig. 1) and 2 kg/mm/ha and 1.4 kg/m3 for chickpea (Fig. 2), . By analyzing the data separately, high WUE under NT compared to CT was recorded for 37% of lentil genotypes and 39% of chickpea genotypes. And high WP was recorded for 24% of lentil genotypes and 30% of chickpea genotypes. In addition, around 20% of lentil and chickpea genotypes performed equally under both tillage systems (Figs. 3.

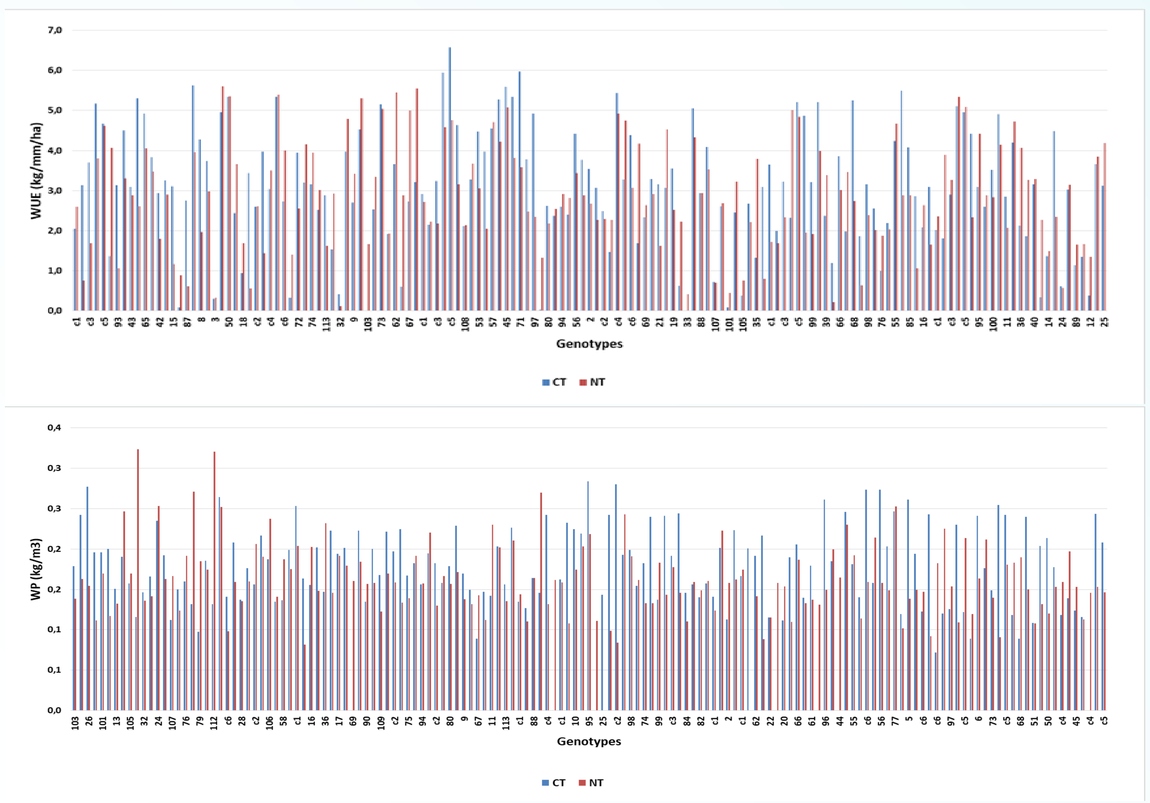

Figure 1. Water use efficiency (WUE) and water productivity (WP) variation under both tillage system (CT and NT) for lentil genotypes

The rainfall pattern under the cropping season was sufficient for crop growth, with a notable decrease in soil water content at the end of the cropping season, chickpea crop has overcome this stress under NT. Actually, in the tilled system, chickpea can extract more water in the 15–30 cm depth, than when it grows in the no-till systems (Gan et al., 2010; Kashiwagi et al., 2015; Devkota et al., 2021).

Figure 2. Water use efficiency (WUE) and water productivity (WP) variation under both tillage system (CT and NT) for chickpea genotypes

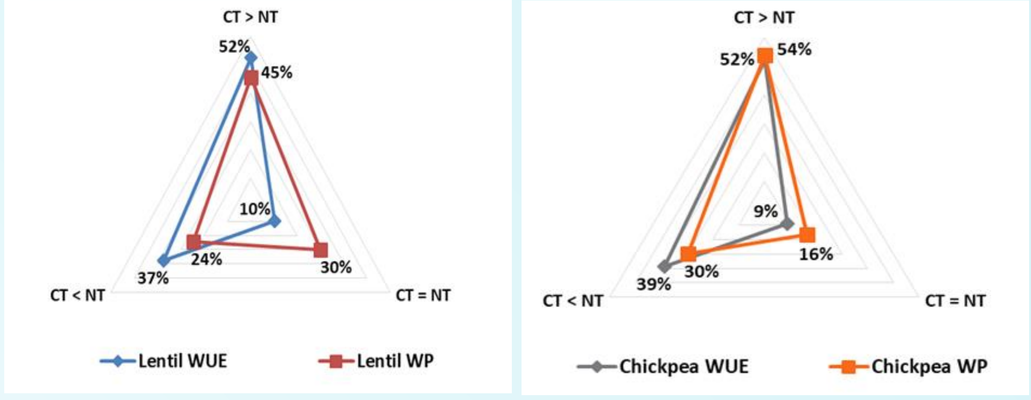

Figure 3. Genotypes distribution under both tillage system (CT and NT) for lentil and chickpea crops

The overall extent of chickpea crop to maintain more soil moisture under both tillage systems was higher compared to lentil. The difference can be explained by the difference in agronomic performance between both crops, mainly root systems functioning. In fact, under Mediterranean drought conditions lentil crop can escape drought stress by using its taproot to extract water from the soil (Sarker et al., 2005). Therefore, adopting conservation agriculture with more suitable resilient genotypes can be important in variable rainfall of Mediterranean conditions (Devkota et al., 2021).

Conclusion

In conclusion, this study constitutes an important step for the selection of genotypes appropriate to NT system. It provides a basis for the genetic improvement program for the selection of lines, which can be adapted to NT, and to develop new cultivars for conservation agriculture. Consequently, second year confirmation of genotype distribution under both tillage systems could confirm this hypothesis.

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