

Stability Analysis Of Winter Wheat Productivity In Conservation Agriculture Compared To Other Management Systems In Southern Italy

Domenico Ventrella¹, Alessandro Vittorio Vonella¹, Mirko Castellini¹, Pasquale Garofalo¹, Michele Rinaldi², Francesco Fornaro¹, Luisa Giglio¹

¹ Centro di Ricerca Agricoltura Ambiente (CREA-AA), Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria (CREA), sede di Bari, IT, domenico.ventrella@crea.gov.it

² Centro di Ricerca Cerealicoltura e Colture Industriali (CREA-CI), Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria (CREA), sede di Foggia, IT

Introduction

Two long-term experiments based on continuous cropping system of winter durum wheat and conservation agriculture (CA), compared to two different management systems based on conventional tillage (CT) and two-layer ploughing (TLP), were established in 2012 and 2002, respectively, in Foggia (Apulia region, Southern Italy) with the objective to investigate their long-term effects on soil fertility and productive responses of main parameters in a continuous cropping system of winter durum wheat. In this paper we assess the productive response of winter wheat to three management systems and analyse the annual temporal stability of yield, protein and hectolitic weight. This study was carried out in the framework of the Project "STRATEGA" (Sperimentazione e TRAsferimento di TEcniche innovative di aGricoltura conservativa) funded by Puglia Region.

Materials and Methods

The field experiments were established in 2012 at the experimental farm "Menichella" (MEN) of CREA-CI and in 2002 at the experimental farm "Podere 124" (P124) of CREA-AA. The two experimental layouts, about 1 km apart, are located in Foggia and consist of a simple comparison two main plots and a randomized block for P124 with three replications, respectively. In both layouts two treatments are compared: conservation agriculture (CA) vs. conventional tillage (CT) in MEN and CA vs. two-layer ploughing (TLP) in P124.

After durum winter wheat (*Triticum durum*, Desf.) harvesting straw and stubble of winter wheat are chopped to 10–15 cm lengths and spread back on the plots. Nitrogen and Phosphorus (36 and 92 kg ha⁻¹ of N and P₂O₅, respectively) are then applied as diammonium phosphate. Under CT, primary ploughing of 40 cm is carried out followed by secondary tillage consisting of tooth-harrow or disc-harrow for seedbed preparation. CA is a no-tillage based on direct sowing that allows for minimum disturbance of soil and maintenance of soil cover with residues and chemical treatment with Glyphosate (5 L ha⁻¹). TLP has been carried out by combined farm device with subsoiler and rotary cultivator. In all treatments, 68 kg ha⁻¹ of N are applied as top dressing (NH₄NO₃). Durum wheat is sown with the same sowing machine (Laseminasodo IGEA 2500 of La valle Verde S.r.l.) at rows 15 cm apart and 3–4 cm deep. During the research periods, different cultivars were sown: in MEN, Latinur (2010), Grecale (2011-12) and Claudio (2013-2016); in P124, Simeto (2002-12) and Claudio (2013-16). After harvesting, yield, grain protein content (PC) and hectolitic weight (HW, weight per unit volume) were determined.

Statistical analysis of variance (ANOVA), based on resolution of General Linear Model (GLM), was applied by MEN and P124, considering a strip-plot layout including the "year" (Y) as strip factor, treatment (T) and interaction "YxT". T included the comparison between CA and CT and CA and TLP for MEN and P124, respectively. The response variables of GLM were yield, PC and HW.

A comparative regression stability analysis was also carried out applying the methodology proposed by Borrelli et al. (2012) and Ventrella et al. (2016a). However because this study is based on the comparison between two thesys, mean response variable obtained with CA were regressed against those of CT and TLP.

Results

Temporal yield variability, that ranged between 2.5 to 5.5 t ha⁻¹, was mainly affected by meteorological factors (air temperature, rainfall and their interaction). This confirms the results obtained in similar agronomic studies (Ventrella et al., 2016b). Less variability was found for PC and HW, ranged from 12 to 17% (with an average of about 14%) and from 74 to 85 kg hl⁻¹, respectively.

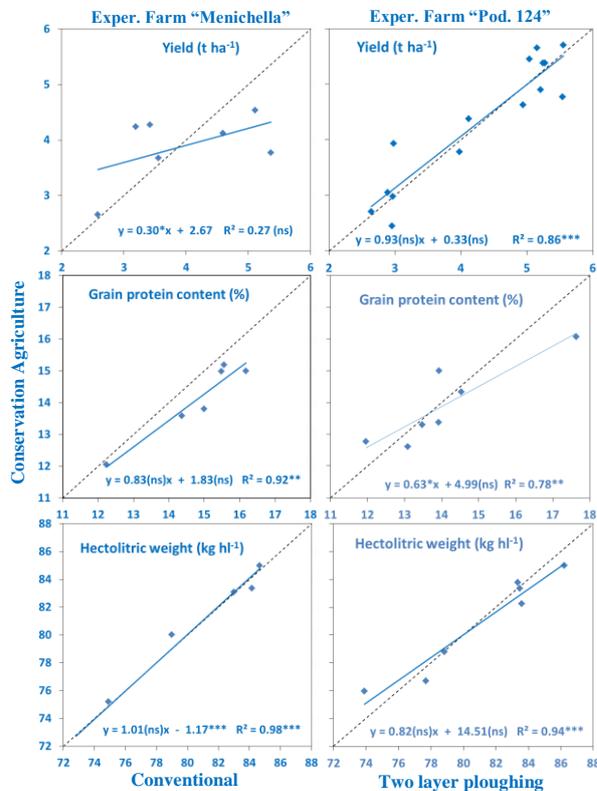


Figure 1. Regression analysis between productive parameters obtained in three tillage systems. Details are reported in the text.

ANOVA results were very similar for MEN and P124. Y was highly significant for all variables, while T was not significant for all six combinations. YxT was significant for yield in MEN ($P \leq 0.0001$), as well as for HW and yield in P124 ($P \leq 0.006$ and $P \leq 0.05$, respectively). This findings was confirmed by the results of stability analysis regression reported in Fig. 1, where the 1:1 dashed line and the six linear equations with the regression coefficient (R^2) were also reported. Moreover, significativities of intercept, slope and R^2 (different from 0, 1 and 0, respectively) are also reported. In MEN, except for the yield, the regression analysis were always significant or highly significant, while the six intercepts were not significant. In two cases out of 6, the slopes were statistically lower than one (i.e., yield in MEN and PC in P124).

With the slope statistically less than one for yield, a trend occurred in the comparison with the CT in MEN where CA performed better than CT in the most unfavourable years, contrary to favorable ones (yield higher than 3.6 t ha⁻¹). No difference among favourable and unfavourable years were detected between yields of CA and TLP. In P124, with a discriminant value of 13.5% of PC, CA performed better in unfavourable years and worse in favourable ones.

ones.

Conclusions

Field researches performed in Foggia during the 2002-2017 period on the applicability of Conservation Agriculture, here defined in terms of no-tillage to reduce soil disturbance, suggest that it is a valuable cropping system in cereal-based systems of Mediterranean environments with low rainfall and high temperature during the crop cycle. Reduced Tillage, as two-layer ploughing, determined no significant differences in productive indicators, whereas the comparison with Conventional Tillage highlighted best performances of Conservation Agriculture in less favourable years for the wheat productivity.

References

- Borrelli et al. 2014. Maize grain and silage yield and yield stability in a long-term cropping system experiment in Northern Italy. *Eur. J. Agronomy* 55:12-19.
- Ventrella et al. 2016a. Durum wheat yield and protein stability depending on residue management in a long term experiment in Southern Italy. *Proceeding of 14th ESA Congress 5–9th September 2016 Edinburgh, Scotland*: 17-18.
- Ventrella et al. 2016b. Effects of crop residue management on winter durum wheat productivity in a long term experiment in Southern Italy. *Eur. J. Agronomy* 77:188-198.



Società Italiana di Agronomia

Proceedings of the XLVII Conference of the Italian Society for Agronomy

***University of Palermo
Dipartimento di Scienze Agrarie, Alimentari e Forestali
Complesso Monumentale di San Pietro
Marsala (TP)
12-14 September 2018***



Società Italiana di Agronomia

A cura di
Edit by

Giovanna Seddaiu
Marcella Giuliani
Claudio Leto

Comitato Scientifico
Scientific Committee

Carlo Grignani
Michele Pisante
Giovanni Argenti
Paolo Benincasa
Raffaele Casa
Marcello Donatelli
Marcella Giuliani
Andrea Monti
Giovanna Seddaiu
Ruisi Paolo
Alfonso Salvatore Frenda
Agata Novara
Mauro Sarno
Mario Licata

Società Italiana di Agronomia
www.siagr.it

ISBN 978-88-904387-4-5