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Early Sowing Allows To Reduce Weed Pressure In No-Till Organic Durum Wheat Production

Dario Giambalvo, Gaetano Amato, Rosolino Ingraffia, Giuseppe Di Miceli, Alfonso S. Frenda, Paolo Ruisi

Dip. Scienze Agrarie, Alimentari e Forestali, Università di Palermo, IT, paolo.ruisi@unipa.it

Introduction

In organic farming, the adoption of the conventional tillage (CT) technique is considered by many farmers to be necessary to control weeds. Such tillage system, in fact, permits to bury weed seeds deep in the soil by means of soil inversion with moldboard plowing and to eliminate the weed plants that gradually emerge by means of the secondary tillage operations. However, it is also true that intensive tillage progressively reduces the soil organic matter content and the stability of soil aggregates, thus increasing the risk of soil erosion (Six et al. 2000). This is in contrast with one of the basic principles of organic agriculture, which is the conservation of soil fertility. Alternatively to CT, the no tillage (NT) technique can maintain or even enhance soil fertility by increasing C storage, soil biological activity, and soil aggregate stability, but, as a matter of fact, its application relies on herbicide use as the primary weed control mechanism (Gattinger et al. 2011). In the light of these considerations, efforts must be made to revisit the NT technique to make it applicable in organic farming. Without prejudice to the fact that this challenge should be addressed through a systemic approach (Peigné et al. 2007), one possible option could be to take advantage of the possibility given by the NT technique to sow the crop in an earlier period than what usually the farmer does when adopts the CT technique. Anticipating the sowing time would allow operating when most of the weed plants are still poorly developed, so that the sowing operation itself can kill many of them. Moreover, sowing early, when temperatures are still relatively mild, could accelerate the initial growth, thus reducing the period during which the crop is particularly vulnerable to weed competition. Usually, early sowing in the CT systems is not possible since a proper seedbed preparation needs time so that clods formed as a result of plowing could be broken down by natural weathering processes and by one or more secondary tillage operations. Therefore, an experiment was performed under organic management to study the effects of NT compared to CT on durum wheat (*Triticum durum* Desf.) grain yield, and to verify whether early sowing under NT conditions, compared to sowing at the ordinary time for the study area, can provide an advantage to the crop by increasing its competitiveness against weeds. Furthermore, the above effects were investigated on two durum wheat genotypes highly different for pheno-morphological and agronomic characteristics, assuming for them different competitiveness against weeds.

Materials and Methods

The experiment was performed in 2016–2017 growing season in Sicily, Italy (37°32′N, 13°31′E; 178 m a.s.l.) on a Vertic Haploxerept soil with the following characteristics: 525 g kg^{-1} clay, 227 g kg^{-1} silt, and 248 g kg^{-1} sand; pH 8.2; 16.8 g kg^{-1} total C and 1.78 g kg^{-1} total N. The trial was set up in a split-plot design with four replicates. Three tillage system/sowing date combinations (NT-early sowing, NT-ordinary sowing, and CT-ordinary sowing) acted as main plots and two durum wheat genotypes (cv. Orizzonte and landrace Scorsonera) as sub-plots. Sub-plot size was 70 m^2 (3.5 by 20.0 m). No tillage consisted of sowing by direct drilling whereas CT consisted in one moldboard plowing to a depth of 0.30 m in the summer (August), followed by one harrowing before planting. Ordinary sowing date corresponded to the time at which durum wheat is usually sown in the study area (mid-December) whereas early sowing plots were sown one month before the ordinary date. Orizzonte is a modern cultivar with short plant height, early heading and maturity, and high yield potential whereas Scorsonera is an old Sicilian landrace with tall plant attitude, medium-late heading and maturity, and moderate yield potential. Organic N fertilizer (hydrolyzed leather meal Dermazoto N11; 11% N, 40% organic C) was applied before planting to all plots at the rate of 400 kg ha^{-1}. Before planting, very shallow weed harrowing with a spring tine harrow was carried out in all NT plots to eliminate early-emerged weeds; one weed harrowing treatment was done in the NT-early sowing plots and two in the NT-ordinary sowing plots (one month apart). Wheat was planted in rows spaced 0.18 m apart at 400 viable seeds m^{-2}, using a no-till seed drill with hoe openers (Sider.Man) in all tillage treatments, making the appropriate adjustments to ensure a homogeneous planting depth; seeds were inoculated with a mixture of *Glomus* spp., *Trichoderma harzianum and PGPR (Ekoseed Cereals) at a dose of 200 g per 100 kg of seed*. At maturity, two sample areas (5.4 m^2) were identified within each sub-plot to assess grain yield of durum wheat and weed biomass. The data recorded were submitted to the analysis of the variance according to the experimental design. Treatment means were compared using Tukey's test (P < 0.05).

Results

The presented results are from a one-year experiment that is currently being replicated; hence, they are to be considered as preliminary results that will have to be validated once the database is complete. The two durum wheat genotypes used in the study produced different grain yields (on average 4.69 t ha^{-1} for the cv. Orizzonte and 2.49 t ha^{-1} for the landrace Scorsonera; Fig. 1A), but they responded in the same way to the type of tillage system applied.

Grain yield was significantly higher under CT than NT when the ordinary sowing date was used (3.96 vs 3.10 t ha^{-1} in CT and NT respectively; averaged values over the two genotypes). Considering the NT systems, early sowing increased grain yield by 20% on average compared to the ordinary sowing date. Moreover, early sowing in NT resulted in grain yields similar to those obtained in CT. The grain yield advantage of the early sowing over the ordinary sowing in the NT systems can be attributable, at least in part, to the effects determined by the sowing time on weed growth. Great reductions were in fact observed for weed biomass in the NT-early sown plots compared to the NT-ordinary sown plots (−42% on average; Fig. 1B), showing in this way how the anticipation of the sowing time has increased the competitive ability of the crop against weeds. The lowest weed biomass values were observed, however, in the CT plots, where the possibility of eliminating through the secondary tillage operations the weed plants that progressively emerged in autumn (before crop planting) resulted in a considerably lower weed biomass at crop harvesting time (0.78 t ha^{-1} in CT vs 3.55 t ha^{-1} in NT-ordinary sowing and 2.06 t ha^{-1} in NT-early sowing; averaged values over the two genotypes). Overall, a key role in determining the grain yield differences among treatments can certainly be attributed to the different level of weed infestation, although other factors (e.g. differences in duration of the crop cycle, amount and time of nutrient availability, etc.) may have also contributed to discriminate treatments.

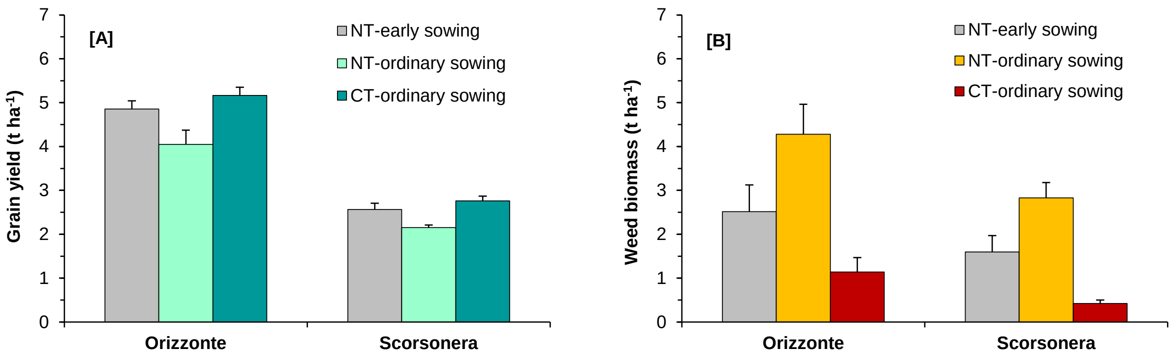

Fig. 1. Grain yield [A] and weed biomass [B] recorded in the two durum wheat genotypes Orizzonte and Scorsonera (G, "Genotype" treatment) grown under the three tillage system/sowing date combinations (T, "Tillage" treatment). NT, no-tillage; CT, conventional tillage. Each value is a mean of 8 data (2 samples × 4 replicates). Vertical bars indicate standard errors of each mean value. In [A], mean effects of both T and G treatments were significant at P < 0.001 ($LSD_{0.05}$ = 0.36 for T; and $LSD_{0.05}$ = 0.29 for G); in [B] mean effect of T was significant at P < 0.001 ($LSD_{0.05}$ = 0.83) and mean effect of G was significant at P = 0.004 ($LSD_{0.05}$ = 0.68). For both grain yield and weed biomass, the T × G interaction was never significant.

Conclusions

The results of the present study, although preliminary, highlight that the NT technique can be applied effectively within organic cereal-based systems of Mediterranean environments as long as it is associated to changes in other agronomic practices, such as the time of sowing. In fact, when NT was applied merely as a substitute of the CT, a 22% reduction in grain yield was observed, and, at the same time, a considerable increase in weed biomass (with a consequent increase in weed seed spreading) was recorded. On the other hand, when NT was associated to an early sowing, the negative effects were significantly attenuated, so much that grain yield was similar to that obtained in CT.

These results let us hope that a more effective and sustainable application of the NT technique within the organic farming systems could be achieved by acting on other factors of crop management (e.g. use of specially designed seed drills, choice of genotypes more responsive to early sowing, etc.).

References

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