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Yield And Competitive Ability Against Weeds Of Mixtures Between Old And Modern Wheat Varieties

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Introduction

Durum wheat is the keystone of the agro-ecosystems in the arable land of the Mediterranean environments and an important part of its area falls within organic farms. For this crop competition exerted by weeds for the use of resources (natural and auxiliary) can determine drastic yield and quality reductions (Ruisi et al., 2015). In organic farming such critical issue is often addressed through a remodelling of several techniques such as soil tillage management, sowing time, plant density and genotype choice. With regard to the latter, there is a growing interest by organic farmers towards the old varieties as they, compared to the modern varieties, have a definitely greater competitive weed abilities thanks to some morpho-physiological plant traits (establishment speed, tillering capacity, plant height) (Röös et al., 2018); moreover, the old varieties/landraces are often characterized by a greater protein and gluten content and for peculiar sensory properties (Newton et al., 2010; Vita et al., 2016). On the other hand, the new varieties have a much higher production potential and technological characteristics of the grain often more responsive to the needs of the processing industry (De Vita et al., 2007). This study, carried out in a organic farming system, aimed to answer the following questions: 1) can the mixture of old and modern durum wheat varieties offer advantages over the monovarietal crop, combining the qualities of the different genotypes? 2) Which mixing ratio should be used in order to maximize the potential advantages of the mixture?

Materials and Methods

The experiment was conducted during the 2016/2017 growing season at the experimental farm Pietranera, located about 30 km north of Agrigento, Italy (37°32'N, 13°31'E; 178 m above sea level). The soil has a clay texture (518 g kg^{-1} clay, 217 g kg^{-1} silt, and 265 g kg^{-1} sand; pH 8.2; 20.5 g kg^{-1} total carbon; and 1.17g kg^{-1} total nitrogen), and is classified as a Vertic haploxerepts. The climate of the experimental site is semiarid Mediterranean; during the growing season annual rainfall was 555 mm mostly in the autumn/winter (September-February; 85%) and in the spring (March-June; 15%). The mean air temperatures was 16.7 °C in autumn, 9.8 °C in winter, and 16.9 °C in spring.

The experiment was set up in a randomized block design with six replications. The size of each plot was 1.5 × 6.0 m (8 rows, spaced at 0.18 m). Plots were planted with 4 genotypes of durum wheat (2 old Sicilian genotypes [O]: Scorsonera and Perciasacchi; 2 modern varieties [M]: Iride and Simeto) that varied widely in their morpho-phenological traits. Twelve different binary mixtures (1 old and 1 modern genotype) with three substitutive intercropping ratios (25:75, 50:50 and 75:25) and four pure stands were evaluated. Here, for brevity, only the average data of the two old varieties, the two modern varieties, and their four mixing combinations are reported. The previous crop was berseem clover (*Trifolium alexandrinum* L.). Before the experiment began, the soil was plowed in August and harrowed after the first autumn rainfalls. Organic nitrogen fertilizer (N =11%, C/N = 3.64) was applied before sowing at 400 kg ha^{-1}. Plots were sown at the end of December, using 400 viable seeds m^{-2}. No weed and fungal diseases control was performed. At maturity, grain yield and aboveground weeds biomass were recorded. Nitrogen contents were determined in the grain flour using the Dumas methods. The data recorded and those derived from them were submitted to the analysis of the variance according to the experimental design. Treatment means were compared using Tukey's test ($P \leq 0.05$).

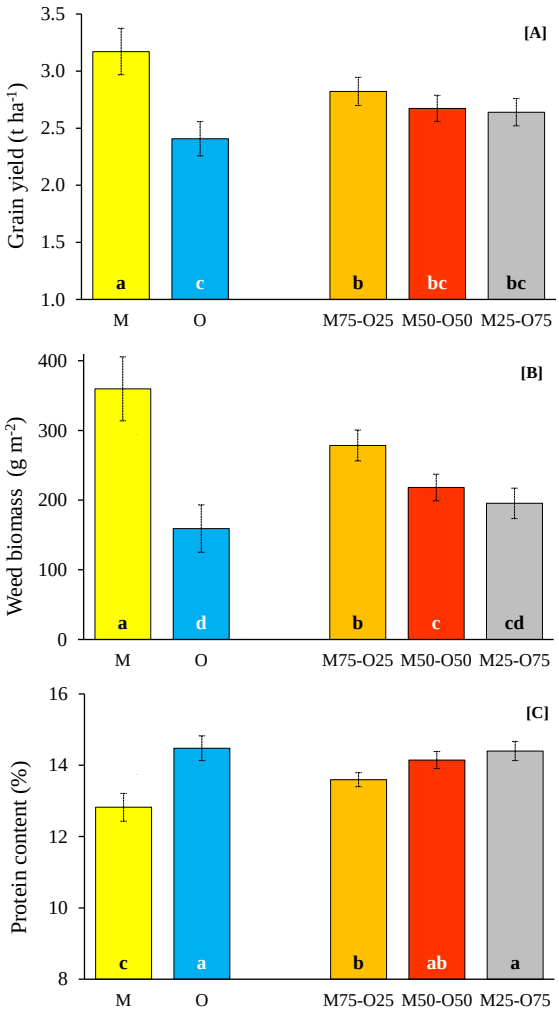

Fig. 9. Grain yield (A), weed biomass (B) and grain protein content (C). Mean values ± s.e.. M, modern varieties; O, old varieties; M75-O25, M50-O50 and M25-O75 indicate the mixtures between modern and old varieties and the percentage of each component. Different letters at the base of the histograms indicate significant differences at P<0.05.

Results

The old varieties, compared to the modern ones, showed a lower grain yield (on average, 2.41 *vs* 3.17 t ha^{-1}; Fig. 1A). Grain yields obtained with binary mixtures were proportionally reduced as the incidence of the old genotypes increased in the mixture (by 10, 16 and 18% compared to the average of modern varieties).

The weed biomass at wheat harvest was 1.59 t ha^{-1} in the pure crops of old genotypes and 3.61 t ha^{-1} in modern varieties (Fig. 1B). The competitiveness against weeds of the mixtures increased as the old varieties presence increased, so that in the mixture M25-O75 the weed biomass was statistically the same as the average of the pure crop of the old varieties.

Lastly, as expected, the grain protein content of the old varieties was significantly higher than the modern ones. (14.5 *vs* 12.8%; Fig. 1C). It is interesting to note that even when the incidence of the old genotypes was equal to 50%, the grain protein content was not significantly different to that observed in the pure stand of the old varieties.

Conclusions

The preliminary results of this study have shown that, in organic farming, wheat variety mixtures can represent a valid alternative to the monovarietal crops. In fact, the yield decreases were counterbalanced by: 1) a reduction in the incidence of weeds with obvious benefits for subsequent crops and for the efficiency and sustainability of the entire crop system and 2) the achievement of good grain quality. The latter assumes a particular relevance as often the organic cereal production is characterized by a low protein content and not suitable for the manufacture of high quality processed products.

References

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