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Strategies to improve the performances of bakery products made from ancient wheat's

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Abstract

The growing consumers' attention regarding the inclusion of foods able to provide health benefits in one's diet, is currently a theme of fundamental importance. Between these products, ancient wheat's and whole wheat flours seem to be the most appealing in the cereal industry thanks to their nutritional content. Nevertheless, ancient wheat's show worse rheological and technological performances compared to modern cultivars, in particular when using whole wheat flour. According to Migliorini, et al. (2016), the content of starch and protein is strongly influenced by annual variability and agronomic practices. This highlights the need for further investigation to understand the relationship between different agronomic practices and the rheological and technological properties of flours and dough's made from ancient wheat's. Furthermore, the greatest challenge for the bakery industry still remains the improvement of the technological properties of bakery products made from ancient wheat's. In this paper, some of the strategies aimed to face this challenge are proposed. Starting from the improvement of the rheological properties of dough's made from ancient wheat, Capella, et al. (2018) provided a rheological study which allows to identify the optimal water content to be added, through models represented by level curves diagrams. Moreover, regarding the improvement of bakery products based on ancient wheat, the sourdough fermentation (Sae, et al. 2017) and the reduction of free lipid in the doughs (Collar & Angelonia, 2014) seems to be the most interesting strategies. Finally, future strategies finalized to improve the technological properties of bakery products made from ancient wheat's are related to the assessment of suitability and bread-making aptitude of ancient wheat flours blended with the most interesting and innovative sources of proteins, i.e. legume and insect flours. Thanks to their low fertilization requirements and high consumer demand, ancient wheats and old durum wheat cultivars represent an attractive option for the marginal areas of Mediterranean environments no longer cultivated due to the low grain yields attainable using modern wheat cultivars. Dual-purpose utilization may increase their value in these cropping systems, but no information is available on the suitability of ancient wheat species to this type of utilization. To fill this gap, Khorasan, einkorn, and emmer wheats, clipped at the terminal spikelet stage or left unclipped, were compared in a two-year field trial. The grains were sown in the month of October, in Sardinia (41°N, 80 m asl), Italy, on low-fertility soils and with low-medium fertilization rates. Einkorn cultivars produced the highest biomass yield (2–3 t ha^{-1}), reflecting the longer time to the onset of the terminal spikelet stage (119–138 days). After clipping, all species recovered their ability to intercept radiation to the levels of the unclipped crops, but clipping lowered their radiation use-efficiency. Grain yield was not penalized by clipping: the increase in the harvest index compensated for the decrease in biomass. Here we show for the first time that ancient wheat species are suitable for dual-purpose utilization (herbage plus grain in the same season) rendering them valuable for marginal areas; this was because the early sowing adopted for dual-purpose utilization allowed them to take full advantage of their lateness in terms of herbage yield, and to bring flowering forward (i.e. make it earlier) so that a satisfactory grain yield was obtained, even under severe water stress. Dual-purpose utilization of ancient wheats increases the sustainability of mixed cropping systems, by making herbage available to animals in a critical period, without decreasing the grain yield attainable after grazing in the same season. The low grain yields attainable with modern wheat cultivars in marginal areas with low soil fertility levels is one

Breeding has led modern wheat cultivars towards a common phenology well suited to high inputs and grain-only production. The lateness of old durum wheat cultivars and ancient wheat species contributes to making them suitable to dual-purpose utilization, because it is generally associated with high final leaf numbers affects the capture and use of radiation and water – two processes associated with each other due to their common dependence on leaf area development. Species differences in leaf area development and recovery after grazing/clipping are expected to result in varying levels of grain yield reduction as a consequence of their reduced leaf area. Leaf area governs growth by affecting I) the radiation interception capacity and the photosynthetic rate, and ii) water utilization due to its direct effect upon transpiration and the transpiration/evaporation ratio. The efficiency in the use of these The suitability of three ancient wheat species – Khorasan, einkorn, and emmer – to both grain-only and dual-purpose utilization was evaluated in a cropping system characterized by low soil fertility and low-medium fertilization rates in a typical Mediterranean environment, and analysed in terms of resource use and capture, i.e. based on a framework that allows for an interpretation of the mechanisms through which leaf area development and removal influence grain yield. The old durum wheat cultivar Senators Capella was also included in the experiment as a control species because it is suited to the same marginal environments. Thus, the genotypic variation in

time to terminal spikelet appearance was so great that it cancelled out any other difference associated with the ability to capture radiation (e.g. number of leaves, number of tillers, growth habit), whereas the genotypic variability in water and radiation use efficiency were not relevant for biomass production by the terminal spikelet stage. This explains why cultivar x year interaction was not observed for biomass at clipping in spite of significant interaction for almost all the traits associated with capture and use of resources. Suitability to dual-purpose utilization can be evaluated by considering both the biomass and the grain yield, together with the extent of the reduction in grain yield brought about by grazing, since dual-purpose use can be a convenient management option if grain yield is not significantly reduced (Harrison et al. 2011). The most critical aspect in determining the impact of clipping on grain yield is the ability of crops to recover their leaf area and photosynthetic activity after clipping. In this experiment, clipping differentially affected the ability of crops to intercept radiation via its effects on phenology, plant height, and lodging incidence.

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