Reducing Plant Height Of Old Wheat Varieties Through Agronomic Means Under Organic Management

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Introduction

Since the beginning of the 20th century breeding in wheat crop has mainly focused on yield improvements, which in turn led to reduced genetic variability and high input requirements to sustain productivity of current varieties (Guarda et al., 2004). Old wheat varieties, currently preserved in germplasm banks, were progressively abandoned, as they had relevant negative agronomic traits, such as excessive stem height, low yield, variable protein content and poor gliadins and glutenins patterns (Sanchez-Garcia et al., 2015). There is currently increasing interest to bring back such old varieties to cultivation, particularly in low fertile marginal areas and in organic farming for low-input production systems. The flours derived from these genotypes are also being appreciated by consumers within local supply chains (Sacchi et al., 2019).

This study reports results of the PSR project REVAVILOVGRA financed by the Veneto Region and aimed at recovering old/ancient wheat varieties, by providing an agronomic protocol for their cultivation under organic farming. Here particular reference is given to the challenge of reducing culm height, in order to: i) prevent lodging and ii) maximize yield and quality.

Materials and Methods

The trial was carried out in open field at the organic experimental farm of the University of Padova at Pozzoveggiani (Padova, NE Italy) during the 2020-21 growing season following a completely randomized block design (n=3; 40-m^2 plot size). Three old varieties of *Triticum aestivum* L. (Piave, Canove and Guà 113) and *Triticum spelta* (spelt, viz 'farro') were sown on 30 October 2020 and harvested on 29 June 2021. Sowing density was 150 seeds m^{-2}, and wheat was fertilized with 20 kg N ha^{-1} with manure at sowing, and 50 kg N ha^{-1} in spring time with two applications of 20+30 kg (tillering and beginning of culm elongation) of liquid beet distiller's residue (overall amount of 70 kg N ha^{-1}). In order to reduce culm height, compared to an absolute control (no nitrogen application), various treatments were investigated: 1) control: no additional treatments; 2) early culm cutting (beginning of March, with the attention to preserve the small apical spike); 3) copper foliar spraying in early March (4 kg Cu ha^{-1}); 4) four applications (2-week interval) of laminarin, as a commercial extract (Vacciplant ®) of the brown algae *Laminaria digitata*.

The culm height and the vegetational index NDVI were revealed periodically during the crop cycle, while grain yield and quality parameters [i.e., grain protein content (GPC), specific weight, thousand kernel weight (TKW)] at harvest, which occurred with a plot combine harvester.

Results

As a result of culm height monitoring during the cycle, in all the tested varieties plant size could be significantly reduced by early shoot cutting, and even more avoiding any fertilization (Figure 1). The effects of shoot cutting was less effective in *T. spelta*, but evident quite soon after the treatment in *T. aestivum* varieties and differences maintained afterward. The tested varieties revealed different average height at harvest time: *T. spelta* was the highest (125 cm), followed by var. Canove (117 cm), Guà 113 (116 cm), and Piave (108 cm). Early shoot cutting reduced shoot height from 10 to 20 cm, while copper

had a slight instant effect that disappeared later, and laminarin sometimes increased plant height. These results resembled the dynamics of NDVI over time.
In two of the most yielding varieties, i.e., Piave and Canove, the early cutting did not reduce grain yield nor the protein content. Indeed, a slight yield increase was associated with the cutting in var. Piave (4,8 t ha^{-1} vs. 4.4 t ha^{-1} of control and 3.8 t ha^{-1} of the absolute control), and with no variation in Canove (3.9 t ha^{-1} vs. 3.5 t ha^{-1} of the absolut control). Var. Canove in turn took advange from shoot cutting by increasing the protein content from 13.6% to 14.3%.

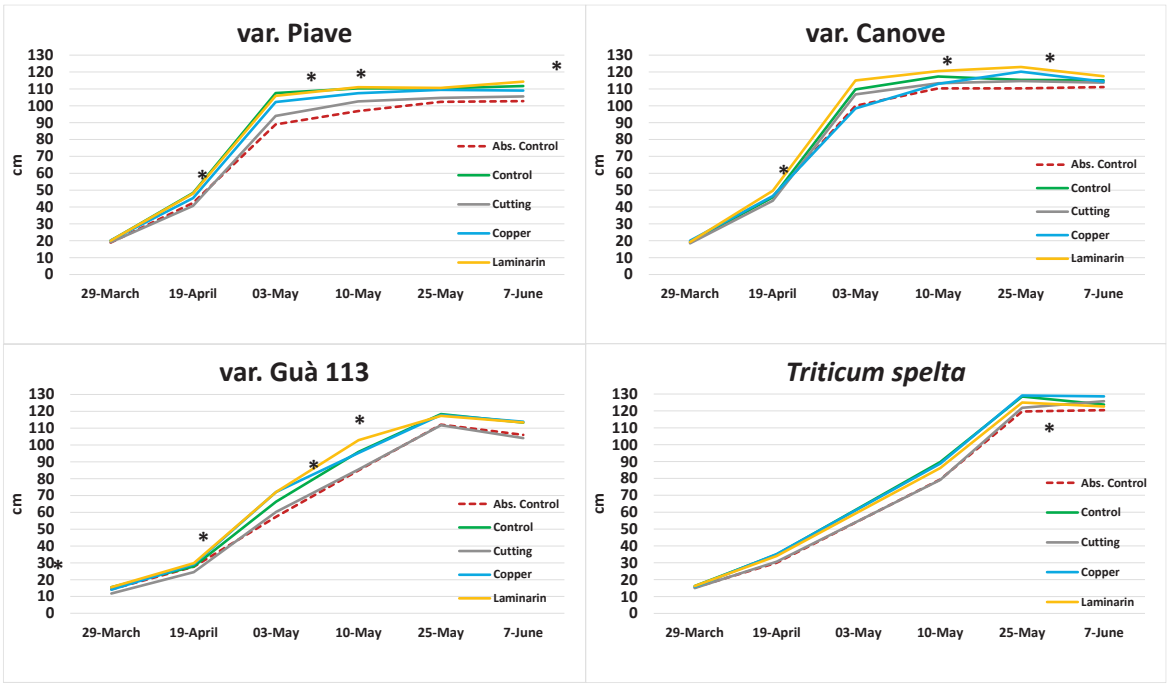

Figure 1. Dynamics of culm height in old wheat varieties with different treatments. Asterisks (*): significant differences among treatments (Newman-Keuls test, $p \leq 0.05$).

Conclusions

One of the main drawbacks of old wheat varieties is the elevated plant size, which cause high loadging risks under wind and storm events. Here we demonstrate that early canopy cutting, applied carefully in order to avoid any damage to the apex (with the small developing spike), can significantly reduce plant height without compromsing grain yield and protein contents. While copper and laminarin have a protection effects against pathogens in organic management, they had temporary (copper) or no effects (laminarin) on shoot vigour, althought on the contrary a biostimulant effect was sometimes observed by the algae extract laminarin. These results confirm preliminary effects of early shoot cutting during the 2019-20 growing season, proving robust data for accurate management of old wheats in organic management.

Literature

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