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Effects of foliar fertilization with micronutrients on the yield and grain quality of spring barley.

Summary

The aim of the study was to evaluate the effect of foliar application of selected micronutrients: copper (Cu), manganese (Mn), molybdenum (Mo) and zinc (Zn) on physiological processes, yield, and the technological value of grain of three spring malting barley cultivars (Baryłka, KWS Irina and RGT Planet). The doctoral dissertation consists of a series of three scientific publications based on the results of a field experiment conducted in 2019–2021 in south-eastern Poland.

The study evaluated canopy architecture indices, chlorophyll content in leaves, gas exchange parameters and chlorophyll fluorescence, plant biometrics, grain yield and yield components, as well as physical traits and chemical composition of grain and selected quality indicators of the obtained barley malt. The adopted experimental design made it possible to link plant responses at the physiological level with production effects and the evaluation of traits important from the perspective of the malting industry. This approach allowed the assessment of both the effects of individual micronutrients and the extent to which the observed changes were determined by genotype and environmental conditions.

In the experiment, the application of each micronutrient fertilizer significantly enhanced crop productivity and improved the harvest index. Among the studied cultivars, RGT Planet achieved the highest grain yield, with a mean of 5.81 t ha⁻¹ over three growing seasons.

The highest values of canopy architecture parameters (LAI and MTA) were recorded in plots where molybdenum was applied. The study demonstrated that foliar application of the tested fertilizers positively modified the functioning of the photosynthetic apparatus of barley plants. Plants treated with micronutrients were characterized by higher chlorophyll content in leaves. Beneficial changes were also observed in gas exchange parameters and chlorophyll fluorescence. The highest values of intercellular CO₂ concentration (Ci) and net photosynthesis rate (PN) were recorded following copper application, whereas the

transpiration rate (E) was highest after zinc application. Analysis of chlorophyll fluorescence highlighted the crucial role of molybdenum and zinc in plant physiological responses. The highest values of all analyzed chlorophyll fluorescence parameters were recorded after fertilization with products containing Mo and Zn.

The obtained results confirmed the existence of positive relationships between selected physiological indicators and grain yield, showing that improvement in the physiological efficiency of plants is an important factor in determining crop performance. Foliar micronutrient fertilization also influenced selected plant biometric traits and yield components, and the range of responses depended on the applied element, cultivar and weather conditions during the growing season.

Plants grown under micronutrient fertilization were shorter than those in control plots and had a higher number of productive tillers. Among the tested genotypes, the RGT Planet cultivar most frequently exhibited the favorable values of the analyzed traits. In the three-year research period, this cultivar had the longest spikes (on average 7.26 cm), the highest number of productive tillers (3.77), spike density (720 spikes m⁻²), and the number and weight of grains per spike (18.4 and 0.74 g, respectively). Manganese and molybdenum showed particularly beneficial effects on the 1000 grain weight (TGW). Following the use of preparations containing these elements, the average TGW value was 49.5 g. Among the studied cultivars, Baryłka and RGT Planet were characterized by better physical grain properties compared to the KWS Irina cultivar.

The study indicated that foliar treatments modified the chemical composition of the grain. However, it was primarily influenced by genotype and weather conditions during the growing season. The application of molybdenum-based fertilizer resulted in a significant increase in protein content – an important indicator of grain suitability for malt production – although the obtained value (10.5% d.m.) still met the standards required by the processing industry. Each of the tested fertilizers reduced the fat content in the grain. Nevertheless, these changes in chemical composition did not lead to a significant improvement in the analyzed malt quality parameters.

The conducted study showed that foliar application of Cu, Mn, Mo and Zn may constitute a useful element of malting barley agronomy, improving plant physiological efficiency and increasing yield. This confirms the first research hypothesis that foliar fertilization with micronutrients positively affects physiological processes and grain yield

formation. However, the quality traits of the raw material and the produced malt were to a much greater extent determined by genotype and variability of environmental conditions during the study years. The research did not fully confirm the hypothesis assuming an improvement in the technological suitability of grain as an effect of the application of the tested micronutrients. The obtained results confirm that the effectiveness of foliar micronutrient fertilization should be considered jointly in physiological, production and technological aspects.