QUANTIFICATION OF HYDROXAMIC ACID ALLELOCHEMICALS IN WHEAT VARIETIES GROWN UNDER VARYING CONDITIONS

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INTRODUCTION

Wheat plants contain a variety of chemical compounds, which are known to have allelopatic properties. As part of the project FATEALLCHEM we quantified the content of the hydroxamic acids DIMBOA and DIBOA and their transformation products MBOA, HMBOA, HBOA and BOA in the plants. The structures of the compounds are identified in the abstract by (1). The aim of the study was to quantify the content of allelochemicals in various varieties of wheat, cultivated under various conditions. This presentation displays results from the first of two growing seasons.

MATERIALS AND METHODS

Plant material

6 varieties of wheat (Astron, Bill, Portal, Ritmo, Solist and Stakado) were cultivated in 2001-2002 in two countries (Denmark and Spain) in a conventional and an organic farming. The experimental plots were divided into 12 sub-plots. Each variety was cultivated in two sub-plots randomly distributed within the plot: The Danish fields were located in Flakkebjerg on Zealand. The organic field was a sandy loam soil while the conventional soil was a clay loam soil. The Spanish fields were located near Lleida. Samples of wheat plants were collected at four growth stages: 9-10, 12, 21 and 31. Duplicate samples were collected from each plot at each sampling date.

Foliage and roots were separated except for the first sampling in Denmark. The samples were frozen and stored at -20^{o}C until analysis. Due to failure in power supply, some of the Spanish samples thawed during storage and had to be discarded.

Analysis

Plants cultivated in Denmark were analysed at NERI while plants cultivated in Spain were analysed at CSIC. The analytical principles applied in the two laboratories were the same as described by (1). The principles are outlined below.

Plant samples were freeze-dried and extracted with acidified methanol using pressurised liquid extraction. The extracts were cleaned up on C-18 solid phase cartridges and analysed by LC-MS.

The detection included DIMBOA, BOA, MBOA (Denmark and Spain) DIBOA, HBOA and HMBOA (Spain).

RESULTS AND DISCUSSION

The concentration of the allelochemical compounds in the wheat plants was highest at growth stage 9-10. Figures 1-2 display the concentration of DIMBOA, MBOA and BOA in plant samples from this growth stage cultivated in Denmark under conventional and organic conditions.

In general the concentration of allelochemicals was higher in wheat varieties grown in the organic farming system than in wheat grown in the conventional farming system. However, the soil types also differed which might influence on the concentration as well. The concentration of DIMBOA was significantly higher in Stakado followed by Ritmo and Solist. The concentration of MBOA was lower and at t the same level in all samples. The concentration of BOA was very low.

Figures 3-4 display the concentration of HMBOA, HBOA, MBOA and DIMBOA in foliage and roots of conventionally cultivated wheat from Spain. The concentration of BOA was very low and is not displayed. The concentration of HBOA was also low while the concentration of HMBOA was of the same magnitude as DIMBOA

The concentration of DIMBOA is significantly higher in plants from Denmark compared to plants from Spain. However, this may be explained by differences in the analytical procedure.

Figures 5-6 display the concentration of DIMBOA, BOA and MBOA in foliage from later growth stages of two of the varieties cultivated in Denmark under conventional and organic conditions. It seems that the concentration of allelochemicals generally decreases from stage 12 to stage 21 and increases in stage 31. The concentration of BOA is very low in all samples.

Results from the second growing season will show if the trends observed in the first growing season are consistent from year to year.

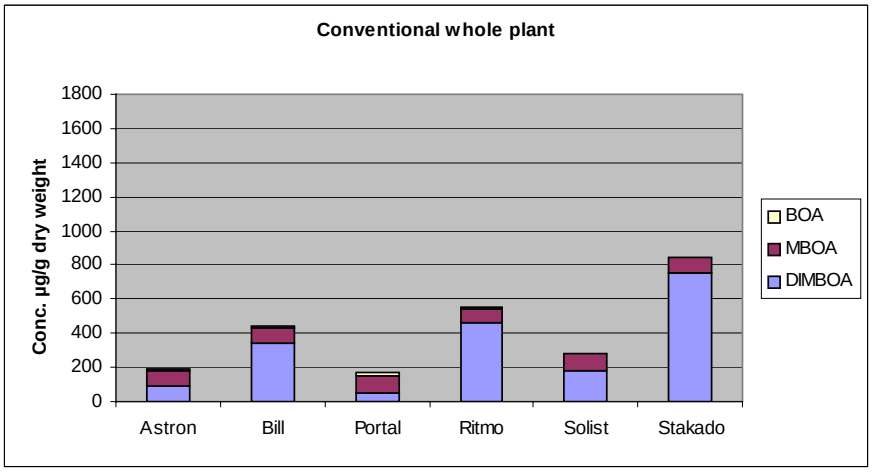

Figure 1. Concentration of BOA, MBOA and DIMBOA in whole wheat plants cultivatedin Denmark under conventional conditions. Grow stage 9-10

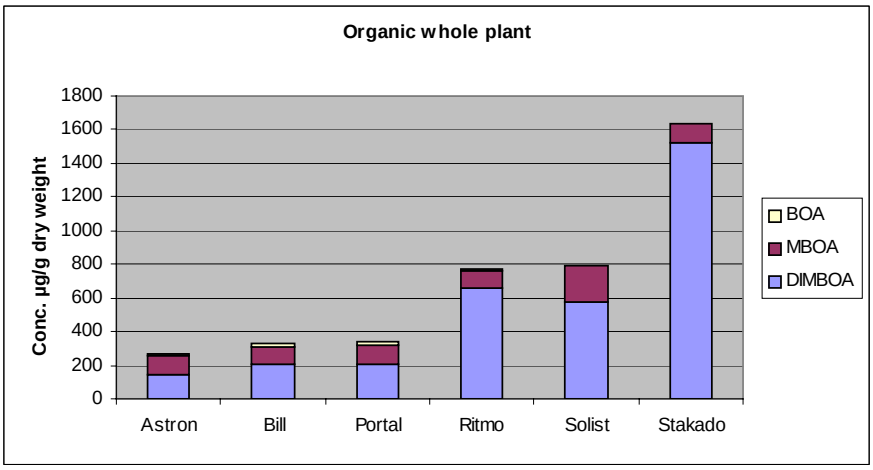

Figure 2. Concentration of BOA, MBOA and DIMBOA in whole wheat plants cultivatedin Denmark under organic conditions. Grow stage 9-10

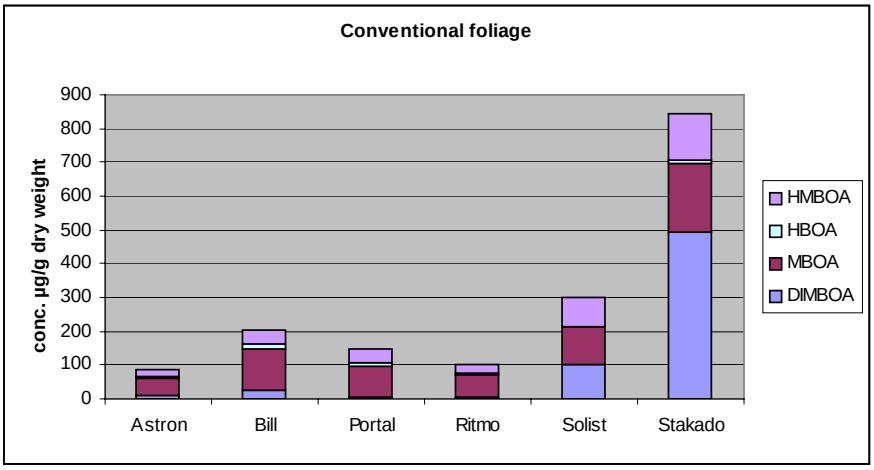

Figure 3. Concentration of HMBOA, HBOA, MBOA and DIMBOA in foliage of wheat plants cultivated in Spain under conventional conditions. Grow stage 9-10

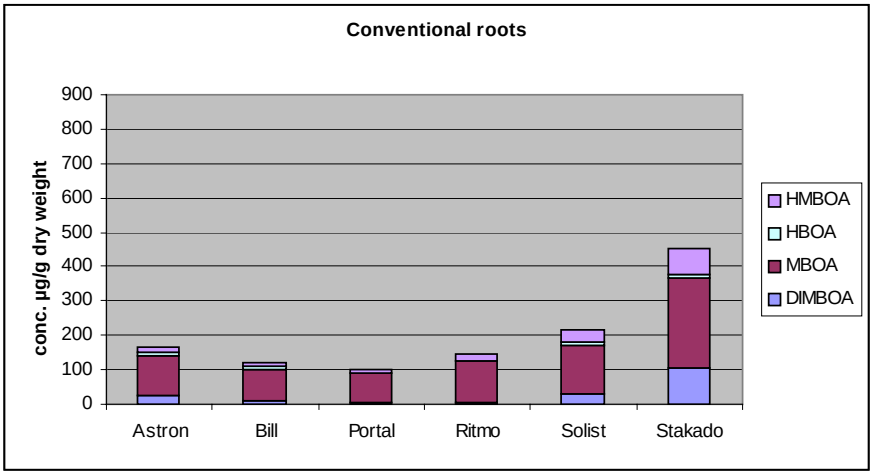

Figure 4. Concentration of HMBOA, HBOA, MBOA and DIMBOA in roots of wheat plants cultivated in Spain under conventional conditions. Grow stage 9-10

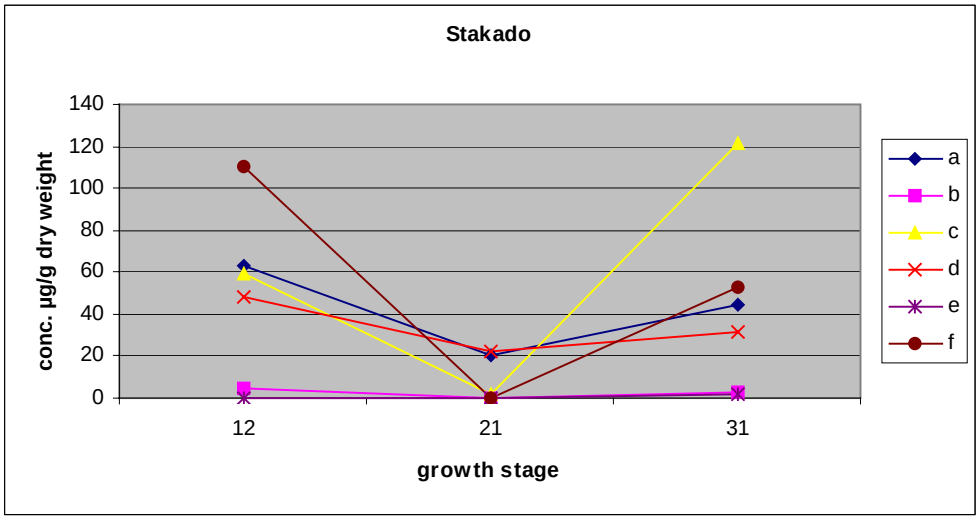

Figure 5. Concentration of DIMBOA, BOA and MBOA in foliage of Stakado at 3 growth stages.a) DIMBOA conv. b) BOA conv. c) MBOA conv. d) DIMBOA organic e) BOA organic. f) MBOA organic

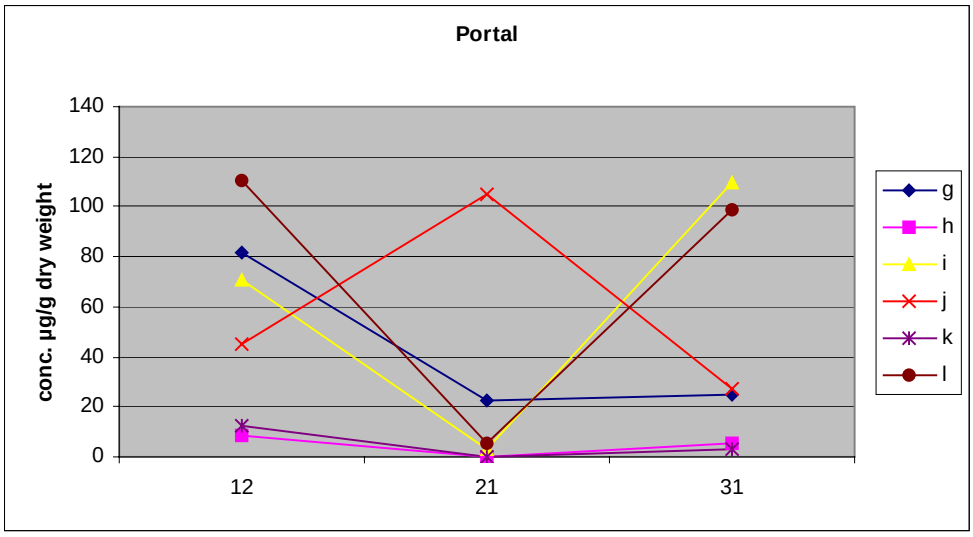

Figure 6 Concentration of DIMBOA, BOA and MBOA in foliage of Portal at 3 growth stages.g) DIMBOA conv. h) BOA conv. i) MBOA conv. j) DIMBOA organic. k) BOA organic. l) MBOA organic

ACKNOWLEDGMENTS

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REFERENCES

1. Villagrasa M., Guillamón M., Eljarrat E., Barceló D., Sample handling and analysis of benzoxazinones and further degradation products in plants and soil. Proceedings of the FATEALLCHEM Workshop ("Fate and Toxicity of Allelochemicals (Natural Plant Toxins) in Relation to Environment and Consumer"), Pulawy, Poland, June 4, 2004.