# TOLERANCE OF TRITICALE, WHEAT AND RYE TO COPPER AND ZINC DEFICIENCY IN SOILS OF LOW AND HIGH pH

by

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A thesis submitted for the degree of

MASTER OF AGRICULTURAL SCIENCE

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September, 1982

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## ABSTRACT

The tolerance of triticale to soils of low copper status and low zinc status over a range of pH, both natural and artificially induced, was determined in three glasshouse experiments and compared with its parent species, wheat and rye.

In the first experiment, the tolerance of triticale to low copper status was determined in a neutral soil adjusted to both acid and alkaline pH. Intermediate tolerance of triticale was demonstrated, in that triticale was tolerant like rye at pH 5.0, but sensitive at pH 8.4 like wheat. Rye maintained the highest concentrations of copper and wheat the lowest, and concentration decreased with increasing pH. Uptake of copper showed the same pH dependence as concentration, and again rye had highest uptake of copper and wheat the least.

The second experiment was identical in design to the first experiment, but examined the tolerance of triticale to soil of low zinc status. Again, intermediate tolerance of triticale was demonstrated. At the alkaline pH in this experiment, where zinc was limiting, triticale was sensitive like wheat, although maintaining both a total shoot yield and grain yield intermediate between wheat (least) and rye (highest). Rye was tolerant of zinc deficiency. The concentration and absolute content of zinc in all plant parts of rye and triticale were higher than those of wheat at maturity, irrespective of the zinc status of the soil and in all pH environments.

Three natural soils (pH 5.0, 7.1, and 8.8) deficient in copper and zinc, were chosen for the third experiment in which growth responses of triticale, wheat and rye were compared at low and high levels of the limiting trace elements. Results further established the tolerance of rye to extremes of pH, and to both copper and zinc deficiency whether separately

or together, the relatively greater sensitivity of wheat, and the intermediate performance of triticale. Typically positive interactions between zinc and copper were observed in vegetative yield and grain yield and most strikingly in pollen viability on which the patterns of grain yield were based. A basic difference in the physiological effects of copper and zinc deficiency was on pollen viability: adding zinc alone aggravated copper deficiency and decreased pollen viability and yield, whilst adding copper alone generally increased pollen viability and yield. Genotypic differences in the copper-zinc interaction showed up strongly at higher pH where grain was produced only by rye and triticale in the unfertilised treatment.

Although there were marked differences among genotypes in their sensitivity to a single deficiency of copper or zinc, the copper-zinc interaction was physiologically similar for all genotypes in each soil.

Results of all three experiments were consistent in that rye was most tolerant of copper and zinc deficiency in all soils and that wheat was most sensitive. It was also evident that effects of copper were more on grain yield, whilst effects of zinc were mediated more through effects on general vigour and vegetative yield. Thus, artificial pH adjustment led to the same conclusion as natural extremes of pH.

This study showed conclusively that pH did indeed effect the uptake of copper and zinc, however, pH had a larger influence on the availability of zinc than of copper. This was contrary to the findings of Piper and Beckwith (1949), who found that pH had no effect on the availability of copper.

## DECLARATION

This thesis contains no material that has been accepted for the award of any other degree or diploma in any University and, to the best of my knowledge and belief, it contains no material previously published or written by another person, except when due reference is made in the text.

S. P. HARRY

ACKNOWLEDGEMENTS

These studies were carried out in the Department of Agronomy at the Waite Agricultural Research Institute, University of Adelaide. I would like to thank Professor C.J. Driscoll, Chairman of the Department of Agronomy for permission to undertake the study (part time) within the Department.

I wish to express my sincere thanks to my main supervisor, Dr. R.D. Graham, Department of Agronomy, Waite Agricultural Research Institute for his invaluable advice and encouragement throughout the course of my studies and on preparation of this thesis. I also thank Dr. D. Puckridge, Department of Agronomy, Waite Agricultural Research Institute and Dr. B. Cartwright, Soils Division, CSIRO for supervising my studies while Dr. R.D. Graham was on study leave interstate.

I would like also to express sincere thanks to:

- Emeritus Professor C.M. Donald, Waite Agricultural Research Institute, for his encouragement, understanding and useful discussions throughout these studies.
- Dr. A.M. Alston, Department of Soil Science, Waite Agricultural Research Institute for contributions to discussions throughout the course of my studies.
- Miss J. Ascher, Department of Agronomy for expert technical assistance in all facets of the study and for being such a good friend.
- Mr. T.W. Hancock, Biometry Section, Waite Agricultural Research Institute for assistance in statistical analysis.
- Mr. B.A. Palk for photographic work in this thesis and throughout these studies.
- Mrs. J. Howe for typing the text.
- Mr. J.D. Rump and Mr. R. Dawson from whose properties the soil for these studies was collected.

I am greatly indebted to:

My family for encouraging my studies.

My husband John for being so understanding, and helping and encouraging me throughout my studies, particularly during difficult moments.