Genetic Aspects of Plant Mineral Nutrition

Edited by
N. EL BASSAM
M. DAMBROTH
Institute of Crop Science and Plant Breeding
Federal Research Centre of Agriculture
Bundesallee 50
D-3300 Braunschweig, FRG

and

B.C. LOUGHMAN
Department of Plant Sciences
University of Oxford
Park Road
Oxford OX1 3PF, UK

Contributions indicated with an asterisk in the table of contents were first published in Plant and Soil, Volume 123 (1990)
Contents

Preface xi

M. Dambroth and N. El Bassam, Genotypic variation in plant productivity and consequences for breeding of “low input cultivars” 1

Session 1: Physiological and biochemical mechanisms associated with genetic variation in utilization of a) nitrogen, b) phosphorus and c) other major nutrients

D. R. Sauerbeck and H. M. Helal, Factors affecting the nutritional efficiency of plants 11

E. L. Klimashevsky, Physiological basis of genotypic plant distinctions in mineral nutrition 19

B. Krstić and R. M. Sarić, Concentrations of N, P, and K and dry matter mass in maize inbred lines 25

G. Pommer, Accumulation and translocation of nitrogen in cultivars of winter wheat with different demands for nutrition 33

M. Mattson, M. Larsson, T. Lundborg and C. M. Larsson, Uptake and partitioning of nitrogen in nitrogen-limited barley: Dependence of age and genotype 39

H. Perby and P. Jensén, Dry weight production and nitrogen efficiency in cultivars of barley and rye 45

N. Petrović and R. Kastori, Nitrate reductase in sugar beet genotypes supplied with different nitrate levels 51

* B. Sattelmacher, F. Klotz and H. Marschner, Influence of the nitrogen level on root growth and morphology of two potato varieties differing in nitrogen acquisition 57

* J. Wieneke, Phosphorus efficiency and phosphorus remobilization in two sorghum (Sorghum bicolor (L.) Moench) cultivars 65

J. Caradus, A. D. Mackay and G. S. Wewala, Responses to phosphate fertilizers of differing solubilities by white clover cultivars 73

* V. Römheld and H. Marschner, Genotypical differences among graminaceous species in release of phytosiderophores and uptake of iron phytosiderophores 77

* Contributions indicated with an asterisk were first published in Plant and Soil, Volume 123 (1990).
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>K. Schaller and O. Löhnertz, Investigations on the nutrient uptake efficiency of different grape root-stock species and cultivars</td>
<td>85</td>
</tr>
<tr>
<td>J. H. Edwards, J. F. Pedersen and R. C. Kingery, Heritability of root characteristics affecting mineral uptake in tall fescue</td>
<td>93</td>
</tr>
<tr>
<td>* B. Feil, R. Thiraporn, G. Geisler and P. Stamp, Root traits of maize seedlings – indicators of nitrogen efficiency?</td>
<td>97</td>
</tr>
<tr>
<td>* H. M. Helal, Varietal differences in root phosphatase activity as related to the utilization of organic phosphates</td>
<td>103</td>
</tr>
<tr>
<td>* J. R. Caradus, The effect of shoot and root genotype on phosphorus concentrations of shoots and roots</td>
<td>107</td>
</tr>
<tr>
<td>* P. Burauel, J. Wieneke and F. Führ, Carbohydrate status in roots of two soybean cultivars: A possible parameter to explain different efficiencies concerning phosphate uptake</td>
<td>111</td>
</tr>
<tr>
<td>* R. Pinton, Z. Varanini and A. Maggioni, Properties of potassium uptake by seedling roots of grape cultivars</td>
<td>117</td>
</tr>
<tr>
<td>* S. Bottacin, M. Saccomani and G. Ferrari, Sterol content and efficiency of ion uptake by roots of maize genotypes</td>
<td>123</td>
</tr>
<tr>
<td>* R. Baas and M. L. van Beusichem, Genetic differentiation in Plantago major L. in growth and P uptake under conditions of P limitation</td>
<td>127</td>
</tr>
</tbody>
</table>

**Session 2: Genotypic responses to a) water stress, b) salinity and c) acidity and deficiency or excess of elements**

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Rodriguez-Maribona, J. L. Tenorio, J. R. Conde and L. Ayerbe, Physiological characteristics responsible for drought resistance in different pea cultivars</td>
<td>137</td>
</tr>
<tr>
<td>J.-H. Weng, Effects of water deficit on osmotic adjustment, photosynthesis and dry matter production of rice (Oryza sativa L.) genotypes</td>
<td>145</td>
</tr>
<tr>
<td>* C. J. T. Spitters and A. H. C. M. Schapendonk, Evaluation of breeding strategies for drought tolerance in potato by means of crop growth simulation</td>
<td>151</td>
</tr>
<tr>
<td>P. P. Andonova, Influence of genotype and water stress on the uptake of potassium and nitrogen in maize</td>
<td>163</td>
</tr>
<tr>
<td>S.-W. Breckle, Salinity tolerance of different halophyte types</td>
<td>167</td>
</tr>
<tr>
<td>J. M. Stassart and J. Bogemans, Physiological differences between barley cultivars under salt stress – xylem exudation and phloem flow of different cations</td>
<td>177</td>
</tr>
<tr>
<td>* S. Schubert and A. Läuchli, Sodium exclusion mechanisms at the root surface of two maize cultivars</td>
<td>183</td>
</tr>
<tr>
<td>J. Baus and J. Cabrera, Cation accumulation related to adaptation of maize populations to salinity</td>
<td>189</td>
</tr>
</tbody>
</table>
A. Alzubaidi, A. Aljanabi and A. A. Al-Rawi, Interaction between nitrogen and phosphorus fertilizers and soil salinity and its effect on growth and ionic composition of corn (*Zea mays* L.)

*L. M. Gourley, S. A. Rogers, C. Ruiz-Gomez and R. B. Clark, Genetic aspects of aluminum tolerance in sorghum*

*Y. I. Mladenova, Influence of salt stress on primary metabolism of *Zea mays* L. seedlings of model genotypes*

P. R. Furlani and C. R. Bastos, Genetic control of aluminium tolerance in sorghum

*A. Aniol, Genetics of tolerance to aluminium in wheat (*Triticum aestivum* L. Thell)*

*H. M. Helal, H. Arisha and E. Rietz, The uptake of trace elements by spinach and bean varieties of different root parameters*

A. H. Schotz, C. J. Asher, F. P. C. Blamey and K. E. Basford, Manganese toxicity in sunflower lines

*F. J. M. Maathuis and H. B. A. Prins, Electrophysiological membrane characteristics of the salt tolerant *Plantago maritima* and the salt sensitive *Plantago media**

R. O. Nable, B. Cartwright and R. C. M. Lance, Genotypic differences in boron accumulation in barley: Relative susceptibilities to boron deficiency and toxicity

H. Singh and V. Kumar, Behaviour of different wheat genotypes under various irrigation conditions in semi-arid tropics of Haryana, India

N. K. Fageria, R. J. Wright and V. C. Baligar, Iron tolerance of rice cultivars

R. E. Wilkinson, E. L. Ramseur, R. R. Duncan and L. M. Shuman, Relationship between metolachlor sensitivity and Mn toxicity tolerance in sorghum cultivars

*E. Alcantara, M. Fernandez and M. D. de la Guardia, Genetic studies on the acidification capacity of sunflower roots induced under iron stress*


Session 3: Screening techniques for detection of nutritional deficiencies and abiotic stress under genetic control

P. Vose, Screening techniques for plant nutrient efficiency: Philosophy and methods

G. Rühl, K.-H. Standke and K. Marmulla, Biochemical techniques for genotype characterization

A. H. C. M. Schapendonk, C. J. T. Spitters, A. L. F. de Vos, Comparison of nitrogen utilization of diploid and tetraploid perennial ryegrass genotypes using a hydroponic system
viii  Contents

* D. Kuiper, J. Schuit and P. J. C. Kuiper, Actual cytokinin concentrations in plant tissue as an indicator for salt resistance in cereals 307

R. H. Qureshi, A. Rashid and N. Ahmad, A procedure for quick screening of wheat cultivars for salt tolerance 315

C. Sommer and M. Schwarz, A method for investigating the influence of soil water potential on yield and water use efficiency of spring wheat cultivars 325

T. Worku and L. Tanasch, Water potential as a selection criterium for drought tolerance by different durum wheat genotypes 331

G. Mix, Application of in vitro techniques for screening plant genetic variability 339

* N. J. Nuernberg, C. A. Bissani, T. A. Campbell and C. D. Foy, Screening pasture plants for aluminium tolerance 345

W. J. Horst and F. Klotz, Screening soybean for aluminium tolerance and adaptation to acid soils 355

J. G. Paull, A. J. Rathjen, B. Cartwright and R. O. Nable, Selection parameters for assessing the tolerance of wheat to high concentrations of boron 361

Session 4: Genetic variation in symbiotic systems

M. Sarić, Z. Sarić and M. Govedarica, Variability of molecular nitrogen fixation and its dependence on plant genotype and diazotroph strains 373

* M. C. Saxena, R. S. Malhotra and K. B. Singh, Iron deficiency in chickpea in the Mediterranean region and its control through resistant genotypes and nutrient application 381

Z. Sarić, N. Mrkovački and V. Milić, N₂ fixation by R. japonicum strains during vegetation of different soybean cultivars 385

* G. Jagnow, Differences between cereal crop cultivars in root-associated nitrogen fixation, possible causes of variable yield response to seed inoculation 391

G. G. B. Manske, Genetical analysis of the efficiency of VA mycorrhiza with spring wheat. I. Genotypical differences and a reciprocal cross between an efficient and non-efficient variety 397

* C. Diederichs, Improved growth of Cajanus cajan (L.) Millsp. in an unsterile tropical soil by three mycorrhizal fungi 407

* N. S. Wilhelm, R. D. Graham and A. D. Rovira, Control of Mn status and infection rate by genotype of both host and pathogen in the wheat take-all interaction 413
Session 5: Germplasm resources and creation of genotypes for specific environmental including low input systems

A. B. Damania and J. P. Srivastava, Genetic resources for optimal input technology – ICARDA’s perspectives

*S. Akita and G. S. Cabuslay, Physiological basis of differential response to salinity in rice cultivars

B. Schinkel and W. Mechelke, A method to estimate the prospect of specific breeding for nutrient efficiency

A. Spanakakis, Grain yield and quality characters of genotypes in F$_5$-generation under low and high nitrogen input

A. Spanakakis and A. Viedt, Performance of winter wheat cultivars under reduced nitrogen conditions

H. Stöppler, E. Kölsch and H. Vogtmann, Suitability of varieties of winter wheat in low external input systems in West Germany

J. Sneyd, Comparison between land races and high yielding cultivars of winter wheat in extensive, integrated and intensive farming over several years

S. Rajaram and E. Villegas, Breeding wheat (Triticum aestivum) for aluminium toxicity tolerance at CIMMYT

I. Kreft and Z. Luthar, Buckwheat – A low input plant

M. Thung, Phosphorus: A limiting nutrient in bean (Phaseolus vulgaris L.) production in Latin America and field screening for efficiency and response

H. U. Neue, R. S. Lantin, M. T. C. Cayton and N. U. Autor, Screening of rices for adverse soil tolerance

V. C. Baligar, J. H. Elgin Jr., R. J. Wright and N. K. Fageria, Genetic diversity for nutrient use efficiency in cultivars and exotic germplasm lines of alfalfa

R. R. Duncan, R. E. Wilkinson and L. M. Shuman, Breeding for low level acid soil tolerance as a component of overall acid soil field tolerance in sorghum

J. Dunlop, M. G. Lambert, J. van den Bosch, J. R. Caradus, A. L. Hart, G. S. Wewala, A. D. Mackay and M. J. M. Hay, A programme to breed a cultivar of Trifolium repens L. for more efficient use of phosphate

A. D. Mackay, J. R. Caradus J. Dunlop, G. S. Wewala, M. C. H. Mouat, M. G. Lambert, A. L. Hart and J. van den Bosch, Response to phosphorus of a world collection of white clover cultivars