

Contents

Local Organising Committee	XXXV
Symposium Conveners	XXXV
Sponsors	XXXVI
International Council on Plant Nutrition	XXXVII
Preface	XXXVIII

Plenary papers

Plant nutrition: Its role in sustainability of simple and complex agro-ecosystems M. van Noordwijk	2
Plant nutrition research: Priorities to meet human needs for food in sustainable ways I. Cakmak	4

1. Genetics and molecular biology of plant nutrition

Molecular mechanisms of potassium and sodium transport in plants J. Schroeder, P. Buschmann, B. Eckelman, E. Kim, M. Sussman, N. Uozumi and P. Mäser	10
Molecular biology of inducible high-affinity nitrate transport in higher plants G. Leggewie, B. G. Forde, K. Piepenburg and M. Udvardi	12
Genetic engineering of transgenic rice with barley strategy-II genes S. Mori, H. Nakanishi, M. Takahashi, K. Higuchi and N.-K. Nishizawa	14
Isolation and characterisation of Arabidopsis mutants related to boron nutrition T. Fujiwara, J. Takano, M. Yasumori, M. Kobayashi, Z. Gajdos, K. Noguchi, N. Aoki, H. Hayashi, S. Naito and M. Chino	16
Phosphorus transport mechanisms in vascular plants: Supply meets complementarity C. Rausch, P. Daram, S. Brunner, N. Amrhein and M. Bucher	18
Molecular characterization of the effects of phosphorus on the development of root hairs in Arabidopsis L. Herrera-Estrella, J. Lopez-Bucio and C. Grierson	20
Confirmation and characterization of a major QTL for P uptake in rice M. Wissuwa and N. Ae	22
Regulatory levels of ammonium transport in response to varied N nutrition in tomato S. Wilken, P. Walch-Liu, W. Jost, I. Borel, W. B. Frommer and N. von Wirén	24
Identification of members of the MIP family as urea transporters in Arabidopsis thaliana L. H. Liu and N. von Wirén	26
N use efficiency and amino acid transport in rape (Brassica napus L.) J. Tilsner and G. Lohaus	28
Overexpression of an endogenous citrate synthase gene in tobacco F. U. Hoeren, A. E. Richardson, P. Hocking, E. Delhaize	30

Isolation and characterization of white lupin proteoid root expressed sequence tags (ESTs) associated with plant hormones	32
C. Uhde-Stone, A. Li, M. J. H. Daemen, D. L. Allan and C. P. Vance	
Cloning and characterization of two secreted acid phosphatases from rice calli	34
T. Fukuda, M. Osaki, T. Shinano and J. Wasaki	
Characterization of secretory acid phosphatase gene of lupin roots and the transformation of the gene into tobacco plants	36
J. Wasaki, H. Dateki, T. Shinano, M. Osaki, and T. Tadano	
Function of the sulfate transporter Sultr2;1 in seeds of <i>Arabidopsis thaliana</i>	38
M. Awazuwara, H. Takahashi, A. Watanabe-Takahashi, H. Hayashi, T. Fujiwara, K. Saito	
Using macroarrays containing sugarcane ESTs to identify aluminium-induced genes in maize	40
J. Felix, R. D. Duarte, R. A. Jorge, P. Arruda and M. Menossi	
Physiological characterisation of genes contributing to enhanced aluminium resistance in yeast	42
A. Staß and E. Delhaize	
Effect of citrate overproduction on iron nutrition in plants	44
V. Ramírez- Rodríguez, M. F. Nieto-Jacobo, J. López-Bucio and L. Herrera-Estrella	
Production of citrate-overproducing transgenic maize	46
A. L. Stival da Silva, D. Becke and H. Lörz	
Isolation and characterization of <i>Arabidopsis thaliana</i> mutants sensitive to boron deficiency	48
J. Takano, K. Noguchi, H. Hayashi and T. Fujiwara	
Molecular analysis of nicotianamine synthesis in Strategy I and II plants.	50
N. K. Nishizawa, K. Higuchi, K. Suzuki, S. Watanabe, D. Mizuno, H. Nakanishi and S. Mori	
Fe sensing in <i>Arabidopsis thaliana</i>	52
K. I. Köhl, V. Römheld and T. Altmann	
Increased iron efficiency in transgenic plants due to ectopic expression of nicotianamine synthase	54
D. Douchkovl., R. Hell, U. W. Stephan and H. Bäumlein	
Heavy-metal tolerant transgenic plants - Expression of the yeast metallothionein gene CUP1 in plants and evaluation of heavy-metal tolerance in transgenic plants at the stage of callus	56
M. Watanabe, I. Hasegawa, A. Noguchi and J. Yazaki	
Molecular insights into maize Na⁺/H⁺ antiport	58
C. Zörb, J. Wiese and S. Schubert	
Nitrogen efficiency of contrasting rape ideotypes	60
F. Wiesler, T. Behrens and W. J. Horst	
Effect of drought stress and drought tolerance heredity on nitrogen efficiency of winter wheat	62
X. L. Fan and Y. K. Li	
Genotypic variation in morphological traits of barley as affected by nitrogen supply	64
J. A. Okeno	
Sorghum nitrogen use efficiency in colombia	66
J. H. Bernal, G. E. Navas and R. B. Clark	
Nitrogen uptake and remobilization in maize hybrids differing in leaf senescence	68
G. Mi, J. Li, F. Chen, F. Zhang, Z. Cui and X. Liu	

Phosphorus (P) uptake efficiency of doubled haploid lines of spring wheat derived from parents with different P uptake efficiency	70
Y.-G. Zhu, S. E. Smith, N. K. Howes and F. A. Smith	
Genetic variability in sorghum for P efficiency and responsiveness	72
R. E. Schaffert, V. M. C. Alves, G. V. E. Pitta, A. F. C. Bahia and F. G. Santos	
Variability in soybean germplasm for phosphorus uptake and use efficiency for dry matter yield	74
A. M. C. Furlani, P. R. Furlani, R. T. Tanaka, H. A. A. Mascarenhas and M. D. P. Delgado	
Identification and interaction analysis of QTL for phosphorus use efficiency in wheat seedlings	76
C. Weidong, J. Jizeng and J. Jiyun	
Inheritance of sulfur status in grain of maize (<i>Zea mays</i> L.) genotypes	78
D. Simic, I. Brkic, V. Kovacevic and I. Kadar	
Analysis of accumulation of mRNAs in response to S or Si nutrition using microarray	80
N. Ohkama, S. Watanabe, T. Yoneyama, H. Hayashi, and T. Fujiwara	
Overcoming wheat sterility problem with boron efficiency	82
B. Rerkasem and S. Jamjod	
Mapping of chromosome regions associated with increased vegetative zinc accumulation using a barley doubled haploid population	84
P. F. Lonergan, R. D. Graham, S. J. Barker and J. G. Paull	
Characterisation of maize cultivars in their adaptation to acid soils on the single plant level	86
L. Collet and W. J. Horst	
Differential response and genetic analysis of acidic stress tolerance, with particular reference to aluminium stress tolerance in triticale	88
X. G. Zhang, R. S. Jessop and F. Ellison	
Influences of genotype and soil properties on corn potassium and magnesium status	90
V. Kovacevic, D. Banaj, M. Antunovic and G. Bukvic	
Genetic variability in mineral accumulation of apple fruit	92
R. K. Volz, P. A. Alspach, A. G. White and I. B. Ferguson	
Genetic variation in rubber tree progenies: Macronutrients contents	94
R. C. M. Furlani, E. Furlani Jr., R. C. Moreira and M. L. T. Moraes	
Genetic differences for nutrients utilization efficiencies in winter triticale and spring wheat	96
J. Cieply and T. Oracka	
 2. Nutrient functions	
 Possible functions of copper ions in cell wall loosening	100
S. C. Fry, J. G. Miller and J. C. Dumville	
Inhibitor-dependent stimulation of photosynthetic electron transport by far-red light in NO₃⁻ - and NH₄⁺ -grown plants of <i>Phaseolus vulgaris</i> L.	102
K. Schinner, B. Sattelmacher and U.-P. Hansen	
A role for stomatal conductance in nitrogen-limited growth?	104
I. G. Burns, M. A. Escobar-Gutierrez and A. J. Broadley	
Importance of Fe^{III} reduction in the apoplast for meristematic growth and chlorosis	106
K. Mengel and H. Kosegarten	

Recent advances on boron in wheat reproduction - A mini-review L. Huang, R. W. Bell and B. Dell	108
How to include mineral nutrition in crop growth models? The example of phosphorus on maize S. Pellerin and A. Mollier	110
Influence of Mo on the metabolism of nitrogen in winter wheat cultivars with different Mo efficiency M. Yu, C. X. Hu and Y. H. Wang	112
Regulation of growth by phosphorus supply in whole tomato plants C. C. de Groot, L. F. M. Marcelis, R. van den Boogaard and H. Lambers	114
The effect of sulphur deficiency on ion accumulation with special reference to 15N and 35S transport in chickpea. Md. Badruddin and J. L. Karmoker	116
Determination of Mn and Cu efficiency of crop plants in pot experiments R. Krähmer and B. Sattelmacher	118
Cytosolic glutamine synthetase (GS : posttranslational regulation and role in nitrogen remobilization from leaves of non-transgenic and GS1 –over-expressing oilseed rape plants J. K. Schjoerring, C. Möllers and J. Finnemann	120
Effect of nitrogen supply on individual kernel weight and 14C partitioning in kernels of maize during lag phase and grain filling I. A. Paponov, Y. V. Bondarenko, G. Neumann and C. Engels	122
Dynamic of root uptake of ammonium and nitrate by pear (<i>Pyrus communis</i> L.) trees after growth resumption in spring D. Malaguti, M. Tagliavini, A. Masia, B. Marangoni, P. Gioacchini, L. Vittori Antisari and P. Millard	124
Nitrogen nutrition of bromeliads L. Endres and H. Mercier	126
Cytokinin, nitrate reductase, and nitric oxide (NO): New insights into regulatory processes in nitrogen metabolism N. N. Tun, A. Holk and G. F. E. Scherer	128
Induction and growth of potato tubers as affected by nitrate G. Maeck and J. Schjørring	130
Regulation of the accumulation of β-Subunit of β-Conglycinin in nitrogen starved soybean (<i>Glycine max</i> L.) seed by amino acids and organic acids N. Ohtake, S. Okano, T. Kawachi, H. Fujikake, K. Sueyoshi and T. Ohyama	132
Effects of long-term and short-term supply of NO₃⁻ or NH₄⁺ on Cytokinin levels and leaf expansion rate in tomato (<i>Lycopersicon esculentum</i> L. cv. Moneymaker) Y. S. Rahayu, P. Walch-Liu, G. Neumann, N. v. Wirén, V. Römheld and F. Bangerth	134
Nitrate availability influence on the growth components of young peach trees S. Médiène, L. Pagés, M. O. Jordan, S. Adamowicz and J. Le Bot	136
Induction of protein markers in tomato by calcium deficiency L. Baboulene, P. Morard, J. Silvestre, G. Dechamp-Guillaume and G. Barrault	138
Effects of temperature, relative humidity and light on the absorption and translocation of 45Ca in the grafted tomato seedlings H. D. Chung and Y. J. Choi	140

Calcium localization in root cells, phosphorylation and water transport of root system influenced by low root temperature	142
S. H. Lee, G. C. Chung and B. H. Cho	
A simple method for studying the early effects of nutrient deficiencies on root metabolism in small-seeded plants	144
K. A. Schuller and S. Cu	
Influence of phosphate fertilisation on the mineral nutrition and yield of barley on a soil with low plant-available phosphorus	146
P. Castillon	
Phosphate deficiency induced oxidative stress in bean (<i>Phaseolus vulgaris</i> L.)	148
I. M. Juszczuk, M. Malusa and A. M. Rychter	
Chlorosis induced by iron deficiency is more severe in gibberellin-deficient dwarf plants	150
H. Sekimoto, A. Kato, T. Nomura and T. Yokota	
Inhibited leaf growth of plants grown in alkaline solution and on calcareous soils is a more sensitive Fe-deficiency symptom than leaf chlorosis	152
B. Gruber and H. Kosegarten	
The influence of IAA and TIBA on iron concentration of maize seedlings	154
L. Lévai and B. Kovács	
Assimilation and translocation of Mn applied to the leaf surface of barley grown at different Mn-deficiency levels	156
S. Husted, S. Mattsson and M. Brockstedt	
Rapid responses of cytoskeleton to short-term boron deprivation in maize and zucchini root apices	158
Q. Yu, F. Baluška, D. Volkmann and H. Goldbach	
Short-term boron deprivation induces increased levels of cytoskeletal proteins in <i>Arabidopsis</i> roots	160
Q. Yu, R. Wingender, M. Schulz, F. Baluška and H. Goldbach	
Characteristics of boron uptake in roots of sunflower by a putative boron transporter	162
F. Dannel, H. Pfeffer, P. Walch-Liu and V. Römheld	
Characterization of the boron compartmentation in roots of sunflower using two independent approaches	164
H. Pfeffer, F. Dannel, P. Walch-Liu and V. Römheld	
Effect of boron deficiency on the growth and carbohydrate metabolism of cotton	166
D. M. Oosterhuis and D. Zhao	
The role of boron in below-ground and above-ground growth of Norway spruce (<i>Picea abies</i>) trees and seedlings	168
M. Möttönen, T. Lehto and P. J. Aphalo	
Adaptive strategy of plants for survival under N, P, K limitation	170
T. S. Shirvani, A. D. Samedova, Sh. G. Jangirova, Kh. L. Salayeva, I. T. Piriyeu and N. B. Huseinova	
Characterization of <i>Brassica napus</i> L. lines showing differences in total sulfur contents and cysteine desulhydrase activities on the molecular level	172
P. Burandt, J. Papenbrock, A. Schmidt, E. Bloem, S. Haneklaus and E. Schnug	
Effects of silicon nutrition on metabolism and translocation of nutrients in rice plants	174
S. Watanabe, T. Fujiwara, T. Yoneyama and H. Hayashi	

Influence of zeastimulin and laser irradiation on the contents of mineral elements in <i>Zea mays</i> L. seedlings	176
N. D. Romaniuk, G. M. Buchko, N. M. Buchko and O. I. Terek	

Influence of aluminium from $AlCl_3$ on differentiation and growth of <i>Dendrobium kingianum</i> Bidwill in in vitro conditions	178
R. Pražák	

3. Nutrient uptake and translocation: Ion channels and ion pumps

Roles of pumps, carriers and channels in plant cation nutrition	182
D. Sanders	

Involvement of plasma membrane H^+-ATPase in nitrate uptake by maize genotypes	184
G. Locci, S. Santi, R. Monte, R. Pinton and Z. Varanini	

Adaptation of plasma membrane H^+-ATPase of proteoid roots of white lupin (<i>Lupinus albus</i> L.) to phosphorus deficiency	186
F. Yan, Y. Zhu, C. Müller and S. Schubert	

The sulphate transporter gene family	188
M. J. Hawkesford and P. Buchner	

Permeability and channel-mediated transport of boric acid across plant membranes. An explanation for differential B uptake in plants	190
C. Dordas and P. H. Brown	

Two pieces of the zinc efficiency puzzle: Root-Zn influx and Zn compartmentation in the shoot	192
G. Hacısalihoglu and J. Hart	

A metal-binding LEA protein trafficks micronutrients in the phloem of <i>Ricinus communis</i> L.	194
C. Krüger, R. Hell and U. W. Stephan	

VIC channels: Their contribution to mineral element uptake and toxicity	196
M. R. Broadley and P. J. White	

Influence of membrane surface charge on nutrient uptake by plants	198
R. J. Reid, Q. Zhang and H. Sekimoto	

Interaction of ion-transport mechanisms at the plasmalemma of plant cells	200
A. I. Sokolik, Zh. Visotskaya, E. Krytynskaya and V. Yurin	

Adaptive mechanisms in response to external sulfate deprivation before onset of intracellular sulfur starvation	202
R. Jost, C. Bork and R. Hell	

Effect of calcium channel blocker on the growth dynamics of plants studied by laser interference auxanometry	204
N. V. Budagovskaya and V. I. Guliaev	

Mechanism of nitrogen release from roots of intact wheat plants (<i>Triticum aestivum</i> L.)	206
E. Rroço, H. Kosegarten and K. Mengel	

Identification of organic forms of nitrogen in soils and possible direct uptake by plants	208
S. Matsumoto, Yamagata M., Koga, N. and Ae N.	

Effects of N deprivation and nitrate pulses on NRT1 and NRT2 transcript levels and nitrate influx rate in <i>Brassica napus</i> L.	210
S. Faure, E. Le Deunff, P. Lainé, J. H. Macduff and A. Ourry	

Evidence for direct organic nitrogen uptake by plants using specific tracer proteins N. Koga, M. Yamagata, S. Matsumoto and N. Ae	212
Assimilation and remobilization of ^{15}N by <i>Pisum sativum</i> S. Atta, and S. Maltese	214
Allocation of ^{11}C-labelled photosynthates in wheat plants G. W. Roeb	216
Distribution of micronutrients in maize grain and their mobilisation during germination N. Bityutskii, S. Magnitski, I. Lapshina, E. Lukina, A. Soloviova and V. Patsevitch	218
Effect of nitrogen form on water, N, and K uptake of <i>Phaseolus vulgaris</i> L. grown in a split-root system S. Guo, H. Brück, J. Gerendás and B. Sattelmacher	220
Bottle-necks for nutrient acquisition of maize at low root temperatures C. Engels, A. Sponner and G. Zglimbea	222
Retranslocation of zinc from older leaves to younger leaves and roots in wheat cultivars differing in zinc efficiency B. Erenoglu ¹ , V. Römheld and I. Cakmak	224
Retranslocation of Zn from leaves as important factor for zinc efficiency of rice genotypes R. Hajiboland, B. Singh and V. Römheld	226
Release of water-dissolved nitrous oxide by plants: Does the transpiration water flow contribute to the emission of dissolved N_2O by sunflower? N. J. Ferch and V. Römheld	228
Sugar palm, a novel model plant for phloem sap analysis A. Watanabe, S. Nakamura, H. Hattori and M. Chino	230
Nutrient concentrations of phloem sap of aromatic coconut grown under various nutrient conditions P. Chongpraditnun, P. Limsmuthchaiporn, H. Hattori, S. Nakamura, A. Watanabe and M. Chino	232
Detection of antioxidant enzyme activities in the phloem sap of sugar palm S. Nakamura, A. Watanabe, H. Hattori and M. Chino	234
Chemical movements in the above-ground part of Japanese morning-glory (<i>Ipomoea nil</i>) during flowering N. Ikeue, T. M. Nakanishi and H. Hayashi	236

4. The role of the apoplast in plant mineral nutrition

What mutations and alterations in pectins might tell us about architecture and function in plant cell walls N. C. Carpita	240
Apoplastic pH in roots of <i>Lupinus angustifolius</i> L. in response to pH > 6 Q. Yu, C. Tang and J. Kuo	242
The leaf apoplast: a central compartment in plant nitrogen utilisation J. K. Schjoerring, N. Pearson, S. Husted, K. Høier Nielsen and M. Mattsson	244
Can leaf apoplastic manganese and silicon concentrations explain Si-enhanced manganese tolerance of <i>Vigna unguiculata</i> (L.) Walp.? K. Iwasaki, M. Fecht, P. Maier and W. J. Horst	246

Apoplastic factors regulate the AKT2/3-type potassium channels R. Deeken, P. Ache, K. Philippar and R. Hedrich	248
Changes in the xylem sap composition and variations in the nutrient translocation rate of poplar dependent on the nutrient supply and the time of the day S. Siebrecht and R. Tischner	250
Engineering plants expressing calcium and pH indicators in the cytoplasm and the apoplast C. Plieth, B. Sattelmacher, A. J. Trewavas, U. P. Hansen, and M. R. Knight	252
The significance of the apoplast for the nutrient acquisition of ectomycorrhizal root systems H. Bücking, A. J. Kuhn, W. H. Schröder and W. Heyser	254
Uptake of mineral cations into <i>Bactris gasipaes</i> roots and structure of the rhizodermis A. J. Kuhn, I. Göllnitz, S. Emmerich, W. H. Schröder, R. Lösch and R. Lieberei	256
Mechanism of silicon-mediated manganese tolerance of <i>Cucumis sativus</i> L.: Effect of silicon nutrition on manganese concentration in the intercellular washing fluid H. Rogalla and V. Römheld	258
Aluminium inhibits the apoplastic solute by-pass-flow in <i>Zea mays</i> L. M. Sivaguru, W. J. Horst, N. Schmohl, Z. Yang and H. Matsumoto	260
Cell-wall composition modulates aluminium toxicity N. Schmohl and W. J. Horst	262
Peroxidase activity in the leaf apoplast is a sensitive marker for Mn toxicity and Mn tolerance in <i>Vigna unguiculata</i> (L.) Walp. M. Fecht, P. Maier and W. J. Horst	264
Cation-specific exchange capacity of cell wall material isolated from roots of plant species differing in Al resistance M. Klein and W. J. Horst	266
Axial and lateral transport of calcium, magnesium and potassium in <i>Ricinus communis</i> K. W. T. Herdel, A. Kuhn, F. Gilmer, W. Schröder and U. Schurr	268
Nutrient transport in the xylem of intact plants - diurnal variation and response to nutrient availability F. Gilmer, K. W. T. Herdel and U. Schurr	270
Nitrogenous compounds in the xylem sap affected by grapevine rootstocks B. P. Holzapfel, J. P. Smith, J. A. Wade and M. Keller	272
The role of the leaf apoplast in iron nutrition of plants M. Nikolic and V. Römheld	274
Potassium transport in bundle sheath cells of maize and its role for plant nutrition M. Keunecke and U.-P. Hansen	276
Sugar metabolism in expanding husk leaf of flint corn (<i>Zea mays</i> L.) genotypes differing in husk leaf size K. Fujita, H. El-Shemy, N. Sakurai and S. Sendo	278
Distribution of ions within leaves after application to the leaf blade K. Hüve, D. Lüttschwager, R. Remus and W. Merbach	280

5. Mineral nutrition: Plant quality and plant health

Impact of mineral nutrients in plants on human nutrition on a worldwide scale R. M. Welch	284
Micronutrient interactions in humans: Setting goals for plant breeders and agronomists R. D. Graham and R. M. Welch	286
Rice plant nutritional and human nutritional characteristics role in human Cd toxicity R. L. Chaney, P. G. Reeves and J. S. Angle	288
Influence of the field water management on accumulation of arsenic and cadmium in paddy rice D. Daum, K. Bogdan, M. K. Schenk and D. Merkel	290
Screening of genotypes with low cadmium content in soybean seed and rice grains T. Arao and N. Ae	292
Influence of sulphur and nitrogen supply on flavour and health-affecting compounds in Brassicaceae A. Krumbein, I. Schonhof, J. Rühlmann and S. Widell	294
Mother plant nutrition and growing conditions affect assimilates and emergence quality of hybrid sweet pepper seeds G. Xu, U. Kafkafi, S. Wolf and Y. Sugimoto	296
Effect of nitrogen supply on yield and quality of broccoli R. Karıtonas	298
Yield and quality of greenhouse lettuce as affected by form of N fertiliser and light supply Z. Premuzic, A. Gárate and I. Bonilla	300
Relationship between oxalate synthesis and nitrate reduction in spinach (<i>Spinacia oleracea</i> L.) plants tracing by ^{13}C and ^{15}N F. Tanaka, T. H. Kim and T. Yoneyama	302
Influence of N form (NO_3^- vs. NH_4^+) and salinity on tomato yield and fruit composition M. Khamis, J. Abbadi, B. Sattelmacher, J. Gerendás and U. Kafkafi	304
Influence of N form on growth and water status of tomato plants I. Lugert, J. Gerendás, H. Brück and B. Sattelmacher	306
Different water supply influences growth and fruit quality in tomato (<i>Lycopersicon esculentum</i> L.) U. Veit-Köhler, A. Krumbein and H. Kosegarten	308
Fruit growth and Ca and K accumulation in the fruits of tomato grown under a spectral filter S. J. Tabatabaei, P. Hadley and P. J. Gregory	310
Reduced N and K application increases the uptake of Ca and improves the quality of Poinsettia (<i>Euphorbia pulcherrima</i> Willd. Ex Klotzsch). K. R. Starkey and N. E. Nielsen	312
Reduced phosphorus availability as a method to reduce chemical growth regulation and to improve plant quality C. W. Hansen and K. L. Nielsen	314
Mineral nutrition in tissue culture: Influence on propagation and quality of the plantlets H. Bouman and A. Tiekstra	316
Effect of fertilisation schedules on sugar storage in roots of an ornamental shrub (<i>Ligustrum ovalifolium</i>). V. Guérin, M. Salaün, L. Thélér-Huché and S. Charpentier	318

Absorption, storage and mobilisation of nitrogen and phosphorus in an ornamental shrub (<i>Ligustrum ovalifolium</i>) during a two year fertilisation experiment.	320
L. Huché-Thélier, V. Guérin, M. Salaün and S. Charpentier	
Nutritional aspects of high quality production of Arabica coffee	322
M. Ross and F. Nogueira	
Productivity and quality response of tea to balanced nutrient management - Examples from China tea gardens	324
J. Ruan and R. Härdter	
Response of mulberry to nitrogen and sulphate of potash on yield and quality of leaf, in relation to sustainable cocoon production and grainage parameters	326
M. A. Shankar, Rajegowda, M. Jayaramaiah, B. T. Rangaswamy and W. Maibaum	
A preliminary nutritional explanation for variations in resin quality from wild frankincense (<i>Boswellia sacra</i>) trees in the Dhofar region of the Sultanate of Oman	328
M. Al-Amri and P. Cookson	
Influence of rootstock on malate and tartrate accumulation during grape (<i>Vitis vinifera</i> L. CVS. cot and negrette) berry development	330
H. Ibrahim, F. Dedieu and M. Garcia	
Effect of different fertilisation management on photosynthesis, yield and fruit quality of peach	332
E. Malusà, G. Buffa and J. Ciesielska	
Lipid biosynthesis in rapeseed as influenced by sulphur nutrition	334
A. Ahmad, I. Khan, M. Z. Abdin, Y. P. Abrol and G. C. Srivastava	
Nitrogen fertilisation of transgenic winter oilseed rape	336
C. Schuster and G.-W. Rathke	
Remote sensing - a tool for site-specific N management in sugar beet production without impacts on technical beet quality?	338
M. Bauer, S. Reusch, T. Engels and F. Wiesler	
The effect of split nitrogen application on grain protein concentration of wheat	340
M. Lotfollahi and M. J. Malakouti	
Grain yield and quality of winter wheat varieties as affected by different nutrient supply	342
K. Berez	
Physiological aspects of wheat genotypes differing in protein content	344
X. Liu, J. Jin, Q. Zhang, S. Yang and G. Wang	
Effect of location and variety on the content of minerals in German and Polish potato cultivars	346
E. Delgado, E. Pawelzik, J. Poberezny and I. Rogozinska	
The effect of different environmental conditions on the starch quality of Polish and German potato cultivars.	348
I. Rogozinska, E. Pawelzik, J. Poberezny and E. Delgado	
Grain iron concentration in Thai rice germplasm	350
C. Prom-u-thai and B. Rerkasem	
Short term transport of iron and copper to various parts of wheat grains	352
T. P. Garnett, R. D. Graham and C. F. Jenner	
Influence of micronutrients on growth and yield of banana (<i>Musa</i> sp.) cv. Robusta (AAA)	354
N. Kumar and P. Jeyakumar	

Effects of zinc and boron fertilisation on improving fruit yields in papaya (<i>Carica papaya</i> L.) cv. Co5 P. Jeyakumar, D. Durgadevi and N. Kumar	356
Yield and nutritional qualities of two tomato (<i>Lycopersicon lycopersicum</i> Karst) varieties as influenced by boron fertilisation in a tropical environment V. O. Chude and E. Y. Oyinlola	358
Translocation of heavy metals in soil-plant system T. M. Minkina, A. P. Samokhin and O. G. Nazarenko	360
Effect of the application of spent flue gas desulfurization absorbent residue on the development of potato gangrene J. Ushiki, F. Kondo, Y. Fukuda and S. Naito	362
Seasonal nutrient variation in the phloem tissue of chestnut and its susceptibility to blight E. Portela	364
Possible factors involved in the establishment of chemically induced systemic acquired resistance in barley J. Wiese and S. Schubert	366
 6. Salinity and plant-soil-water relations	
Avenues for increasing salt tolerance of crops R. Munns	370
Increasing the drought tolerance in tropical maize - from research on plant-water relations to impacts in farmers' fields M. Bänziger, J. Bolaños and G. O. Edmeades	372
Osmotic adjustment in different leaf structures of semileafless pea (<i>Pisum sativum</i> L.) subjected to water stress E. M. González, C. Arrese-Igor, P. M. Aparicio-Tejo, M. Royuela and H.-W. Koyro	374
Quantification of root water extraction under salinity and drought M. Homaee and R. A. Feddes	376
Physiological traits of sodium toxicity and salt tolerance K. H. Mühling and E. Läuchli	378
Response of leaf elongation and nutrient status in growing leaves of wheat to salinity Y. Hu and U. Schmidhalter	380
Vegetative approach to manage poor water quality in central California G. S. Bañuelos and S. Sharmasarkar	382
Photosynthetic activity and the change of sugar content in stressed rye and triticale genotypes B. Hoffmann, I. Kerepesi and G. Galiba	384
Comparison of two methods for the determination of plant-induced gradients in soil osmotic potential - TDR-technique versus micro suction cups D. Vetterlein and R. Jahn	386
Variability of soil water and nitrogen as causes of yield variability in heterogeneous fields D. Geesing, R. Gutser and U. Schmidhalter	388
Characterizing site specific differences in water availability R. Duda, R. Gutser and U. Schmidhalter	390

Development of a non-contacting method for the determination of the plant water status F. Ruthenkolk, R. Gutser and U. Schmidhalter	392
Effect of fertiliser application on the growth and water use efficiency of wheat in semi-arid area in North China Plain M. Liu, H. Liu and T. Toshiaki	394
Effects of water quality and nitrogen on yield, yield components and water use efficiency of barley K. Nagaz and N. Ben Mechlia	396
Interaction of N supply and water relations in <i>Eucalyptus globulus</i> Labill. I. Krockenberger, D. White, R. W. Bell and B. Dell	398
Why is physiological water-use efficiency lower under low nitrogen supply ? H. Brück, I. Lugert, W. Zhou and B. Sattelmacher	400
The effect of low nitrogen supply on yield and water-use efficiency of sweet potato (<i>Ipomoea batatas</i> L.) M. Kelm, H. Brück, M. Hermann and B. Sattelmacher	402
Salt resistance of maize: Recent developments S. Schubert, Ch. Zörb and A. Sümer	404
Salt tolerance in <i>Sesuvium portulacastrum</i> D. Messeddi, N. Sleimi and C. Abdelly	406
Physiological behaviour of two chickpea Tunisian varieties irrigated with saline nutrient solution N. Sleïmi, M. Lachaâl, C. Andelly, A. Soltani and M. Hajji	408
The effects of salinity on five banana genotypes (<i>Musa</i> spp) E. W. F. Gomes, L. Willadino, L. S. S. Martins and T. R. Camara	410
Salt sensitivity of the common bean <i>Phaseolus vulgaris</i> x <i>Rhizobium</i> symbiosis in relation to the ionic status of nodules M. Lachaâl, S. Boughribil, A. Soltani and M. Hajji	412
Comparison of strategies of halophytes from different plant families to avoid salt injury H.-W. Koyro, B. Huchzermeyer and M. C. Harrouni	414
Large accumulation of sodium in leaves may be compatible with normal growth M. Hajji, M. Lachaâl, A. Soltani and Grignon C	416
Salt sensitivity and K/Na selectivity in <i>Setaria verticillata</i> H. Ben Ahmed, E. Zid and C. Grignon	418
K/Na selectivity for secretion into the xylem in triticale (<i>X-Triticosecale</i> Wittmack) N. Karray Bouraoui, E. Zid and C. Grignon	420
Micronutrient sprays as a tool to increase tolerance of faba bean and wheat plants to salinity M. M. El Fouly, M. M. Zeinab and A. S. Zeinab	422
Wheat seedlings response to interactive effects of Cu and salinity A. E. El-Enany	424
Interaction of salinity and boron toxicity in wheat (<i>Triticum aestivum</i> L.) M. A. Wimmer, K. H. Muehling, A. Läuchli, P. H. Brown and H. E. Goldbach	426
Root cultures for elucidating tomato root reactions to NaCl stress K. Kouki, A. Mougou and R. Paul	428

Stomatal regulation in long-term salt-treated <i>Medicago arborea</i> and <i>Medicago citrina</i>	430
J. V. Sibole, M. C. García, C. Cabot, Ch. Poschenrieder and J. Barceló	
Nutrient solution concentration effects on growth and photosynthesis of tomato grown hydroponically	432
D. Schwarz, M. W. van Iersel, K. T. Ingram and H. P. Kläring	
Investigation of sulfolipid contents and their rate of biosynthesis in halophytes treated with different salt concentrations	434
R. Balasubramanian, A. Schmidt and J. Papenbrock	
Interactive effects of plant hormones (GA3 or ABA) and salinity on growth and some metabolites of wheat seedlings	436
A. F. Radi, M. A. K. Shaddad, A. E. El-Enany and F. M. Omran	
Nutrition of vigna plants on a gypsum amended saline-sodic soil	438
T. Muraoka and R. V. dos Santos	

7. Mineral element toxicity and resistance

Aluminium and heavy metal toxicity and resistance - Lessons to be learnt from similarities and differences	442
L. V. Kochian	
Some mechanisms of zinc and cadmium detoxification in a zinc and cadmium hyper-accumulating plant species (<i>Thlaspi</i>)	444
X. E. Yang, M. J. Yang, Z.Y. Shen, J. R. Bacon, E. Paterson and J.M. Wilson	
Mechanisms of heavy metal resistance in <i>Silene vulgaris</i>	446
J. A. C. Verkleij, N. A. L. M. Van Hoof, A. N. Chardonens, P. L. M. Koevoets, H. Hakvoort, W. M. ten Bookum, H. Schat and W. H. O. Ernst	
Physiological characterisation of root cell Cd²⁺ absorption and translocation to shoots in Brassica	448
I. Hasegawa, F. Shinmachi, A. Noguchi and J. Yazaki	
Aluminium resistance of Norway spruce: Root exudation versus immobilisation in roots	450
A. Heim, I. Brunner, B. Frey, E. Frossard and J. Luster	
Avoidance of aluminium toxicity: Role of root border cells	452
L. A. Brigham, M. C. Hawes and S. C. Miyasaka	
Mechanisms of higher tolerance of Al stress in phosphorus deficient maize seedlings: The significance of phenolics in Al resistance	454
T. Wagatsuma, S. Ishikawa, T. Akimoto, K. Tawaraya and P. Ofei-Manu	
Copper resistance in <i>Silene armeria</i> ecotypes: Does co-tolerance play a role?	456
A. Lombini, Ch. Poschenrieder, M. Llugany, E. Dinelli and J. Barceló	
Copper uptake and transport patterns in pseudometallophytes from soils with a large range of Cu concentrations.	458
C. Poschenrieder, M. Llugany, J. Bech and J. Barceló	
Metal accumulation by different plant species grown in contaminated media	460
E. Alcántara, A. M. Ginhas, M. A. Ojeda, M. J. Benítez and M. Benlloch	
Growth, cadmium, and zinc contents of wheat grown on various soils enriched with cadmium and zinc	462
H. Hattori and M. Chino	

Comparison of nickel toxicity and resistance strategies of cabbage plants grown in soil with addition of inorganic and organic Ni (II) complexes J. Molas	464
The responses of <i>Eucalyptus camaldulensis</i> to elevated concentrations of Mn S. M. Reichman, N. W. Menzies, C. J. Asher and D. M. Mulligan	466
Effect of citrate on the uptake of copper and cadmium by <i>Lupinus albus</i>, <i>Lupinus luteus</i> and <i>Lupinus angustifolius</i> K. Egle, M. F. Soliman, W. Römer and J. Gerke	468
Effect of different cultivation techniques on thallium uptake of the Tl hyperaccumulator candytuft (<i>Iberis intermedia</i>) and Tl binding forms in the soil H. Al-Najar, R. Schulz and V. Römheld	470
Plant growth and cadmium distribution in plants of Brazilian tobacco cultivars as affected by cadmium in nutrient solution A. M. Salviano, R. L. F. Fontes, P. C. R. Fontes and J. C. L. Neves	472
Accumulation of selenium and chromium in seeds of haricot bean V. N. Rodionova	474
Physiological and biochemical traits of rice (<i>Oryza sativa</i> L.) genotypes associated with tolerance of iron toxicity K. K. Baruah, B. C. Nath and N. Gogoi	476
The effect of different stains of AMF on growth and heavy metal uptake of cucumber (<i>Cucumis sativus</i>) I. Vörös and T. Takács	478
Arbuscular mycorrhizal effect on heavy metal uptake of ryegrass (<i>Lolium perenne</i> L.) in pot culture with polluted soils T. Takács, B. Biró and I. Vörös	480
Effect of farmyard manure on relative sorption of copper, zinc, cobalt, and cadmium in soils from semi-arid and humid regions of India S. R. Poonia and A. K. Deka	482
Humic soil reclamators as depressors of heavy metal (radionuclide) accumulation by plants A. M. Abramets and E. N. Rovdan	484
Regulatory mechanisms of Al-induced secretion of organic acids anions -Involvement of ABA in the Al-induced secretion of oxalate in buckwheat J. F. Ma, W. Zhang and Z. Zhao	486
Differential regulation of Al-induced release of malate and K⁺ in the root apex of wheat H. Osawa and H. Matsumoto	488
Exudation of organic acid anions by different maize cultivars as affected by phosphorus deficiency and aluminium toxicity M. Kamh, P. Roppel and W. J. Horst	490
Aluminium-induced exudation of citrate from the root tip of <i>Zea mays</i> (L.): Are differential impacts of Al on citrate metabolism involved in genotypical differences? M. Kollmeier and W. J. Horst	492
Exudation of organic acid anions from root apices as an aluminium resistance mechanism in maize E. D. Mariano and W. G. Keltjens	494

The use of nutrient-film technique for monitoring Al (Al citrate) effects on root development and nutrient uptake in roots of <i>Triticum aestivum</i> L.	496
J. W. M. Postma and W. G. Keltjens	
Organic acid-anion exudation and aluminium: The role of plant species, pH, biodegradation and time	498
M. Schöttelndreier	
Characteristics of citrate secretion under aluminium stress in soybean (<i>Glycine max</i> L.)	500
Z. M. Yang, H. Nian, M. Sivaguru and H. Matsumoto	
Erbium-activated malate efflux supports the “malate hypothesis” of differential aluminium resistance in wheat	502
T. Kataoka,, A. Stekelenburg, E. Delhaize and P. R. Ryan	
Does root exudation of phenolics play a role in aluminium resistance in maize (<i>Zea mays</i> L.)?	504
P. S. Kidd, C. Poschenrieder and J. Barceló	
Organic acid root-tip tissue-concentration in <i>Brachiaria decumbens</i> and <i>Brachiaria ruziziensis</i>	506
S. P. Grundy, D. L. Jones and D. L. Godbold	
Effect of aluminium on exudation of organic acid anions in tea plants	508
A. Morita, Y Fujii, and H. Yokota	
Effects of temporary contact with Al ions on the plasma-membrane permeability of root-tip cells in seven plant species	510
S. Ishikawa, T. Wagatsuma and K. Tawaraya	
The significance of phenolic compounds in roots of different age on Al resistance of some common woody plants	512
P. Ofei-Manu, T. Wagatsuma and S. Ishikawa	
Study on aluminium resistance in relation to organic-acid anion exudation from roots of PEPC transgenic rice plants	514
M. Osaki, D. Nursyamsi, H. H. Begum and T. Watanabe	
Effect of aluminium on root morphology of <i>Hydrangea macrophylla</i>	516
A. Naumann, U. Kunz, H. Lehmann, R. Stelzer and W. J. Horst	
Changes in protein content and protease activity in roots of <i>Zea mays</i> (L.) in response to short-term aluminium treatment	518
V. M. Ali-zade, T. S. Shirvani, N. Schmohl, E. G. Alirzayeva, M. A. Annagiyeva, M. Fecht and W. J. Horst	
Effects of heterogeneous Al and P supply on root growth and screening of maize cultivars differing in Al resistance	520
L. Collet and W. J. Horst	
The influence of aluminium and manganese toxicity in the soil on the bio-accumulation of Al and Mn in two cultivars of wheat (<i>Triticum aestivum</i> L.)	522
A. Grenda and A. Badora	
Effect of lanthanum on growth and composition of mineral nutrients of <i>Phaseolus vulgaris</i> L var. nanus and <i>Zea mays</i> L. conv. <i>saccharata</i>	524
S. von Tucher, C. Goy and U. Schmidhalter	

8. Nutrient acquisition: Mechanisms and modelling

Use of modelling to understand plant nutrient acquisition	528
G. J. D. Kirk	

Phosphorus Efficiency of Wheat, Maize and Groundnut Grown in Low Phosphorus-Supplying Soil P. B. S. Bhadoria, S. Singh and N. Claassen	530
Identification of phosphorus solubilizing active components (PSAC) from root cell wall of groundnut having better growth on an infertile soil among several legume crops N. Ae, Y. Kato, R. F. Shen and B. Magno	532
Measuring and modelling phosphorus uptake by root hairs T. S. Gahoonia and N. E. Nielsen	534
Experimental approaches for studying rhizosphere chemistry and nutrient uptake of tree roots by in-situ methods A. Göttlein, J. Lindenmair and A. J. Kuhn	536
Control of root epidermal patterning: Effects of Fe- and P-deficiency W. Schmidt and A. Schikora	538
Use of influx kinetic equations of nitrate transport systems and field experiment data for modelling N uptake in winter oilseed rape (<i>Brassica napus</i> L.) P. Malagoli, S. Faure, P. Lainé, E. Ledeunff and A. Ourry	540
Phosphorus efficiency of cabbage varieties D. Eticha and M. K. Schenk	542
Root exudation of organic anions by cabbage, carrot and potato plants as affected by P supply N. Dechassa and M. K. Schenk	544
Use of plasma membrane vesicles for examination of phosphorus deficiency-induced root excretion of citrate in cluster roots of white lupin (<i>Lupinus albus</i> L.) A. Kania, G. Neumann, S. Cesco, R. Pinton and V. Römheld	546
Better growth and phosphorus nutrition of sorghum and wheat following organic acid secreting crops P. J. Hocking and P. J. Randall	548
Ethylene regulates common bean root growth in adaptation to P deficiency H. Liao, Y. Zhuang, X. Yan, K. M. Brown and J. P. Lynch	550
Acquisition of phosphorus in potato (<i>Solanum tuberosum</i> L. cv. Déirée) with altered carbohydrate partitioning between shoot and roots G. Neumann, C. Schulze, E. George and V. Römheld	552
Mobilization of soil phosphorus by low-molecular-weight organic acids W. Lu, F. Zhang and Y. Cao	554
Exudation of organic acids by spinach and the mobilization of Cu, Zn and Cd in soil W. Römer and H. Keller	556
Regulation of phosphorus solubilization by light conditions on shoot in legumes T. P. Rao, K. Yano, A. Yamauchi, J. Tatsumi and M. Iijima,	558
Phytate as a source of phosphorus for the growth of transgenic <i>Trifolium subterraneum</i> A. E. Richardson, P. A. Hadobas and R. J. Simpson	560
Utilization of acid phosphatase for recycling-use of phosphorus T. Yamamura, J. Wasaki, H. Dateki, T. Shinano and T. Tadano	562
Organic acid exudation by roots of Norway spruce grown in hydroponic culture or in soil J. Zhang, G. Neumann and E. George	564

Mechanisms of phosphorus efficiency in maize	566
V. M. C. Alves, S. N. Parentoni, C. A. Vasconcellos, A. F. C. Bahia Filho, G. V. E. Pitta and R. E. Schaffert	
Ion exchange and water uptake of coarse roots of mature Norway spruce trees (<i>Picea abies</i> L. Karst.)	568
J. Lindenmair, E. Matzner, A. Göttlein, A. J. Kuhn and W. H. Schröder	
Effect of potassium uptake by crop species on solubilization of silicate in a soil	570
M. Sugiyama and N. Ae	
Non-destructive method for sampling the soil solution in the rhizosphere	572
N. Moritsuka, J. Yanai and T. Kosaki	
Effect of Fe plaque on Zn uptake and rhizosphere Zn acquisition of rice lines with different Zn efficiency	574
P. Thongbai., C. Q. Guerta and G Kirk	
Modeling for growth and distribution of maize (<i>Zea mays</i> L.) roots under field conditions in the eastern plains of Colombia	576
G. Roveda-Hoyos, J. L. Chopart, J. E. Baquero and L. A. Rojas	
Internal phosphorus concentration modifies the initiation, growth and functioning of cluster roots in <i>Hakea prostrata</i> R. Br.	578
M. de Vos., M. W. Shane, G. R. Cawthray, E. J. Veneklaas and H. Lambers,	
Analysis of influence of nutrient concentration on root growth dynamics by means of digital image sequence processing	580
S. Terjung, A. Walter, R. Küsters, H. Spies, N. Kirchgeßner and U. Schurr	
Use of a mechanistic model to predict potassium uptake in the field by sugar beet and wheat and its depletion in the rhizosphere	582
H. I. El Dessougi and N. Claassen	
Quantification of root growth of young corn plants (<i>Zea mays</i> L.) at a transparent surface under the influence of soil bulk density	584
R. O. Kuchenbuch and K. T. Ingram	
Exotically long and prolific root hairs of <i>Arabidopsis</i>, corn and wheat grown in a phosphate nutrient buffer system	586
G. Liu, J. Dunlop and T. Phung	
Root growth dynamics of <i>Vicia faba</i> and its implication with the K supply	588
B. Steingrobe	
The role of root architecture in P acquisition efficiency of different root systems: a case study with common bean and rice	590
X. Yan, H. Liao, A. Cao and Y. He	
Root weight as a principal factor responsible for difference in nitrogen absorption among Orchardgrass (<i>Dactylis glomerata</i> L.), Meadow Fescue (<i>Festuca elatior</i> L.) and Timothy (<i>Phleum pratense</i> L.) during first growing period	592
T. Matsunaka and H. Takahasi	
Evaluation of the rhizosphere pH of two sorghum genotypes in presence of three aluminium saturations and three potassium levels in soil	594
G. V. E. Pitta, V. C. Baligar, R. B. Clark, V. M. C. Alves and C. A. Vasconcellos	
Rhizosphere chemistry and soil exploration by seedlings of beech and spruce in a rhizotrone experiment	596
Z. Wang and A. Göttlein	

Model calculations of the rhizosphere aluminium chemistry in acid forest soils H. Niefeld	598
A mechanistic model to describe the effect of complexing root exudates on transport and uptake of soil nutrients. N. Claassen, B. Steingrobe and K.-M. Syring	600
Modelling the effects of soil and fertilizer-P on crop growth, P-uptake and soil-P in arable farming T. V. Karpinets, D. J. Greenwood and D. A. Stone	602
A two dimensional simulation model of phosphorus uptake including crop growth and P response A. Mollier, P. de Willigen, S. Pellerin and M. Heinen	604
Physiological responses of pea to iron deficiency induced by bicarbonate M. Gharsalli, K. Zribi, and M. Hajji	606
Effects of bicarbonate and anaerobiosis on both ferric reducing capacity and ethylene production by roots of Fe-deficient cucumber plants F. J. Romera, E. Alcántara and M. D. de la Guardia	608
Nondestructive imaging of water uptake and development of a living root by neutron beam Y. Okuni, J. Furukawa, T. Nakanishi and M. Matsubayashi	610
Boron effects on rhizosphere acidification in canola J. C. R. Stangoulis, H. S. Grewal and R. D. Graham	612
 9. Soil organisms/plant interactions	
Molecular control of carbon-nitrogen interactions in symbiotic nitrogen fixation C. P. Vance, R. H. G. M. Litjens, J. Schulze, B. Bucciarelli, G. Trepp, D. Samac, D. Allan and M. Tesfaye	616
Molecular biology of signal exchange in the Rhizobium/Sino-rhizobium/Mesorhizobium legume symbiosis D. Werner, H. Steele, C. Bolaños-Vasquez and P. Vinuesa	618
Effect of arbuscular mycorrhizal application on the distribution of phosphorus and iron in the rhizosphere soils of sunflower (<i>Helianthus annuus</i> L.) K. Sakurai, N. Tanaka, K. Iwasaki and S. Tanaka	620
Nutrient requirements (N, P, S) of microbial biomass formation in a regosol of Japan K. Kouno, M. A. H. Chowdhury, T. Nagaoka and T. Ando	622
Evolution of soluble organic carbon in the rhizosphere and in corresponding non-rhizosphere soil in field-grown oilseed rape and barley. Immobilisation and turn-over of sulphur-35 in the rhizosphere soil F. Lasserre-Joulin, P. C. Vong and A. Guckert	624
Effects of root exudates on nutrient availability in the rhizosphere A. Gransee	626
Xylem and phloem transport of micronutrients Z. Rengel	628
Colonisation with the arbuscular mycorrhizal fungus <i>Glomus mossae</i> enhanced phosphorus uptake from dry soil in <i>Sorghum bicolor</i> L E. Neumann, H. Barus and E. George	630

Influence of arbuscular mycorrhizae inoculation on growth of maize and green pepper plants in phosphorus- and zinc-deficient soil I. Ortas, Z. Kaya and I. Çakmak	632
Survival of <i>Azotobacter chroococcum</i> in the rhizosphere of three different wheat crosses: Effect of AM fungi H. Sharma, V. Kumar, R. Kumar Behl and N. Narula	634
Utilisation of iron from the fungal hydroxamate siderophores Fe fusarinines and Fe dimerum acid by strategy I and strategy II plants W. Hördt, V. Römheld and G. Winkelmann	636
Uptake of metal cations by the extraradical mycelium of an arbuscular mycorrhizal fungus from calcareous soil supplied with high and low levels of phosphorus Y. J. Lee and E. George	638
A test of the significance of mycorrhizal hyphae in utilising native organic phosphorus in soils from different farming systems M. L. Li, V. Römheld and E. George	640
Studying magnesium transport across and via mycorrhiza of Norway spruce roots A. J. Kuhn, G. Jentschke, A. Stettien, B. Brandes, D. G. Godbold and W. H. Schröder	642
Arbuscular mycorrhizal fungi improve early forest-tree establishment M. Habte, S. C. Miyasaka and D. T. Matsuyama	644
Effect of phosphorus application and ectomycorrhizal fungal inoculation on biomass production of <i>Eucalyptus urophylla</i> plantation in South China D. Xu,, B. Dell, N. Malajczuk and M. Gong	646
Growth of mycorrhizal <i>Phoenix canariensis</i> plants under three different cultivation systems B. Dreyer, A. Morte and M. Honrubia	648
Differential expression of hexose-regulated fungal genes within <i>Amanita muscaria</i>/<i>Populus tremula</i> × <i>tremuloides</i> ectomycorrhizas U. Nehls, A. Bock and R. Hampp	650
Metabolite transport in indeterminate <i>Vicia faba</i> L. nodules: Structural and functional studies E. Peiter, F. Yan and S. Schubert	652
N₂ fixation estimated by ¹⁵N natural abundance can be erroneous because of changes in ¹⁵N discrimination during N uptake H. Heuvelink, R. Gutser, N. Claassen and U. Schmidhalter	654
A study of the effect of soil-available N and indigenous rhizobial population on the growth and yield of soybean and prediction by models of the necessity to inoculate H. A. Rahmani and N. S. Rastin	656
Effect of rhizobial inoculants and soil-available nitrogen on strain effectiveness and competition for nodulation in some legumes R. A. Abdel-Aziz	658
Nitrogen fixation potential of rhizobium strains associated with two cultivars of chickpea A. Asgharzadeh, N. S. Rastin and M. Mohammadi	660
The use of associative diazotrophs with different rates of N fertilisation and compost to enhance N₂ fixation and growth of wheat M. S. A. Safwat and M. A. O. El-Mohandes	662

The influence of some Bradyrhizobium and Rhizobium strains as plant growth promoting rhizobacteria on the growth and yield of sorghum (<i>Sorghum bicolor</i> L.) plants under drought stress M. H. Rashad, A. A. Ragab and S. M. Salem	664
Stimulation of wheat growth and N fixation through Azospirillum and Rhizobium inoculation: A field trial with ¹⁵N techniques Y. G. M. Galal, I. A. El-Ghandour and E. A. El-Akel	666
Phosphate mobilising microorganisms and their influence on the productivity of plants L. A. Chaykovskaya, V. P. Patyka and T. M. Melnychuk	668
Phosphorus use-efficiency of soybean as affected by phosphorus application and inoculation P. Shah, K. M. Kakar and K. Zada	670
Evaluation of some carriers for Thiobacillus inoculants used along with sulphur to increase uptake of some nutrients by corn and improve its performance H. Besharaty, K. Khavazi and N. Saleh-Rastin	672
Influence of growth-promoting bacteria from Uzbekistan and Germany on the growth and nutrient uptake of cotton and wheat on different soils D. Egamberdiyeva, K.D. Davranov and G. Höflich	674
Nitrogen release of wheat roots grown under semi-sterile in comparison to unsterile conditions A. Deubel, M. Richert, and W. Merbach	676
Exudation of nitrogenous compounds by clover and ryegrass in sterile and non-sterile micro-lysimeters F. Paynel, C. Clement, J. Bigot and J. B. Cliquet	678
Uptake of organic labelled sulphur by oilseed rape and barley in the rhizosphere and in corresponding non-rhizosphere soil P. C. Vong, F. Lasserre-Joulin and A. Guckert	680
Allelopathy versus competition between plants and microbes E. Wiegard and S. Jutzi	682
Effect of rhizosphere indole-3-acetic acid on growth and phosphorus nutrition of maize plants (<i>Zea mays</i> L.) L. Wittenmayer	684
Effect of long-term fertilisation and cropping systems on selected soil enzyme activities F. Eivazi and M. R. Bayan	686
Root production and turnover in Populus grown under elevated CO₂ using a free air enrichment system POPFACE M. Lukac, C. Calfapietra and D. L. Godbold	688
 10. Fertiliser use with regard to optimum yield and environment	
Precision agriculture: A challenge for crop nutrition management P. C. Robert	692
Tractor based remote sensing for variable nitrogen fertilizer application J. Lammel, J. Wollring† and S. Reusch	694
Bioassays to improve the determination of P and K availability in soil for fertilization recommendations D. J. Bonfil, I. Mufradi, S. Asido and B. Dolgin	696

Uptake of fresh and residual P fertilisers by <i>Lolium perenne</i> in two Swiss agricultural soils	698
A. Gallet, S. Sinaj, R. Flisch., J. P. Ryser and E. Frossard	
Fluid fertilisers - A better solution for growing wheat in alkaline soils?	700
I. Bertrand, R. E. Holloway and M. J. McLaughlin	
The new nitrification inhibitor DMPP (ENTECâ) – Comparisons with DCD in model studies and field applications	702
A. H. Wissemeier, W. Linzmeier, R. Gutser, W. Weigelt and U. Schmidhalter	
Efficiency of foliar Zn fertilizers in coffee and citrus	704
C. A. Rosolem and L. V. S. Sacramento	
Determining P and N status of a tropical timber species (teak): Assessment of 'quick' chemical tests and a root phosphatase assay	706
M. J. Webb, P. Reddell, S. Nath and R. J. Srivastava	
Corn stalk nitrate concentration profile: Implications for the end-of-season stalk nitrate test	708
W. W. Wilhelm, G. E. Varvel, and J. S. Schepers	
Diagnosing nitrogen requirements of potatoes in farmers' crops	710
I. Papastylianou and S. Gregoriou	
Nutrition diagnosis of potato (<i>Solanum tuberosum</i> L.) using leaf petiole sap	712
M. Takebe, Y. Kasahara and T. Karasawa	
Critical phosphate (P) and inorganic phosphate (Pi) concentrations for the growth of winter oilseed rape (<i>Brassica napus</i>)	714
B. J. Major and P. B. Barraclough	
Suitability of the SPAD meter and the petiole nitrate test for nitrogen management in nursery potatoes	716
J. Gerendás and I. Pieper	
Nitrogen levels and its correlation with the chlorophyll content in three coffee cultivars	718
E. Furlani Jr., E. Lazarini, E. M. Paulo and R. C. M. Furlani	
Chlorophyll content distribution in leaves, stems, and ears in winter wheat	720
I. Karele	
Effect of water stress on chlorophyll meter readings in winter wheat	722
P. B. Barraclough and J. Kyte	
Modelling conversion factors for leaf analyses from fruiting and nonfruiting terminals of citrus to asses the nutrient status of trees	724
I. A. Khan, A. Srikandakumar and T. W. Embleton	
Laser-induced chlorophyll fluorescence to determine the nitrogen status of plants	726
C. Bredemeier and U. Schmidhalter	
Reference populations for evaluation of the nutritional status of coffee by DRIS	728
O. C. Bataglia, W. R. Santos and J. A. Quaggio	
Towards a simple, generic modelling approach for developing site-specific nitrogen management strategies in irrigated rice	730
C. Witt, J. M. Arah and P. Siband	
Field scale variability of N₂-fixation in legume and grass mixtures	732
F. Locher, H. Heuwinkele, R. Gutser, U. Schmidhalter	

Use of xylem sap to determine differences in the availability of mineral elements in soils A. Noguchi, I. Hasegawa and J. Yazaki	734
Soil properties and plant elemental compositions of faba bean at the flowering stage S. Z. Labuda	736
Using resin-extraction of soil nutrients for genotype selection and fertility management A. Olness	738
The attempt to utilize chemical composition of soil solution in fertilization diagnostics J. Labętowicz and B. Rutkowska	740
Potassium availability indices and plant response M. Shenker and X. Huang	742
Soil potassium determination in pasture soils in the basque country A. Aizpurua, S. Alava, A. Castellón, A. Alonso and G. Besga	744
Nitrogen fertilizer recommendation for sugar beet according to the EUF soil testing system D. Horn and F. Fürstenfeld	746
Net mineralization of organic N in soils related to EUF (Electro-ultrafiltration) extractable organic N, organic C, nitrate and growth A. Maci and K. Mengel	748
Importance of EUF-extractable organic C for soil N mineralization and for N management of sugar beet F. Kempl, D. Steffens, D. Horn and S. Schubert	750
NIR-Spectroscopy to estimate soil nitrogen supply B. Wagner, R. Gutser and U. Schmidhalter	752
The new nitrification inhibitor DMPP (ENTEC®) for use in agricultural and horticultural crops – an overview W. Zerulla, G. Pasda, R. Hähndel and A. H. Wissemeier	754
Influence of soil parameters on the efficiency of the new nitrification inhibitor DMPP (ENTEC®) G. Barth, S. v. Tucher, and U. Schmidhalter	756
The new nitrification inhibitor DMPP (ENTEC®) – Effects on yield and quality of agricultural and horticultural crops G. Pasda, R. Hähndel, W. Zerulla	758
The new nitrification inhibitor DMPP (ENTEC®) allows increased N-efficiency with simplified fertilizing strategies W. Linzmeier, R. Gutser and U. Schmidhalter	760
A new nitrification inhibitor (DMPP) improves the nitrogen fertilizer efficiency in citrus-growing systems J. Bañuls, A. Quiñones, E. Primo-Millo and F. Legaz	762
Field evaluation of DMPP as a nitrification inhibitor in the area irrigated by the Canal d'Urgell (Northeast Spain) I. Carrascol, and J. M. Villar	764
The new nitrification inhibitor DMPP – effects on gaseous emissions (N₂O, CO₂, CH₄) from soil under field conditions A. Weiske, G. Benckiser and J. C. G. Ottow	766

Nitrous oxide emissions from injected 15N-labelled cattle slurry into grassland soil as affected by DMPP nitrification inhibitor	768
K. Dittert, R. Bol, D. Chadwick and D. Hatch	
The effect of nitrogen supply by NH₄-beaker-deposits on tomatoes	770
K. R. Chang and Sommer K.	
Effect of calcareous irrigation water and N-management on the Ca²⁺ and SO₄²⁻ distribution in sunflower (<i>Helianthus annuus</i> L.)	772
B. Jaeger, H. Goldbach and K. Sommer	
Effect of acetylene generated from carbide on nitrification in soil, yield of irrigated maize and growth of maize seedlings.	774
P. J. Randall, J. R. Freney, J. Hodgkin and T. C. Morton	
Release of nitrogen from two controlled release fertilizers	776
L. Andersen	
Fertiliser and irrigation best management practices (BMPs) for optimal citrus production and water quality in sandy entisols of Florida	778
S. Paramasivam, A. K. Alva, K. S. Sajwan, J. P. Syvertsen, T. A. Wheaton and D. P. H. Tucker	
Effect of N fertilisation in a young ‘Lane Late’ orchard fertigated by drip irrigation	780
M. R. Menino, J. C. Tomás, C. Carranca, M. L. Fernandes and A. de Varennes	
Effect of fertigation timing and aeration on nitrogen dynamics in Chinese cabbage cultivation	782
H. T. Heuberger, S. von Tucher and W. H. Schnitzler	
Optimization of Anthurium andreanum mineral nutrition in soilless culture under tropical conditions	784
L. Dufour	
Effect of fertigation timetable on growth and nitrogen content of an ornamental shrub (<i>Ligustrum ovalifolium</i> L.)	786
M. Salaün, S. Charpentier, V. Guérin and L. Huché-Thélier	
Effect of foliar fertilisation with magnesium, sulfur, manganese and boron to sugar beet, oilseed rape, and cereals	788
K. Orlovius	
Effect of different methods of fertilisation on grape yield in Qazvin	790
M. Shahabian, M. Mostashari and M. J. Malakouti	
Effects of foilar applied K on California cotton	792
B. L. Weir, B. A. Roberts and S. Stoddard	
Response of broad bean (<i>Vicia faba</i>) to method of phosphorus application and foliar application of micronutrients	794
A. T. Thalooth, G. M. Yakout and A. O. M. Saad	
Immobilization of fertilizer nitrogen and consequences for nitrogen fertilization of cereals	796
K. Blankenau, H.-W. Olf and H. Kuhlmann	
Yield and quality of winter oilseed rape related to nitrogen supply	798
G.-W. Rathke and C. Schuster	
Effect of rate, timing and form of nitrogen application on yield formation and nitrogen balance in oilseed rape production	800
T. Behrens, W.J. Horst and F. Wiesler	

Tanzania grass: Nitrogen distribution in shoots and utilization F. A. Monteiro, I. Benetti and Q. A. C. Carmello	802
Agro-physiological responses of tropical maize cultivars to nitrogen fertilization in the moist savanna of West Africa S. O. Oikeh and W. J. Horst	804
Nitrogen and chlormequatchloride on cotton cultivar P. K. Karthikeyan and R. Jayakumar	806
Nitrogen dynamics in irrigated grapevines (<i>Vitis vinifera</i>) M. T. Treeby and D. M. Wheatley,	808
Effect of plant population density and nitrogen fertilization on yield and yield components of some white and yellow maize hybrids under drip irrigation system in sandy soil M. H. Griesh and G. M. Yakout	810
Effectiveness of mineral fertilizer use on calcareous chernozems N. E. Kravtsova, O. A. Birukova and I. A. Nagabedian	812
Influence of weed competition and fertilizer application on soil nutrients and performance of weeds and maize G. O. Iremiren, D. O. Ikhu-Omoregbee, E. Oserogho and E. O. Odile	814
Effect of S and N nutrition on N-accumulation and N-harvest in rapeseed-mustard (<i>Brassica juncea</i> L. and <i>Brassica campestris</i> L.) M. Z. Abdin, A. Ahmad, I. Khan, M. I. Qureshi and Y. P. Abrol	816
Effect of increasing N and P application rates on grain yield of winter wheat in long-term fertilization experiments K. Debreczeni and T. Kismányoky	818
Response of selected crops to K fertilization on major soil types in South Vietnam P. Cong, C. Sat and R. Hårdter	820
Potassium distribution and use efficiency in <i>Brachiaria decumbens</i> W. T. Mattos, F. A. Monteiro and A. R. Dechen	822
Corn yield and potassium accumulation related to potassium fertilizer rates Z. Khademi, M. R. Balali and M. J. Malakouti	824
Direct, cumulative and residual effect of P-fertilizer applied at different times to wheat and barley under the dryland conditions of Turkey B. Firat, S. Gümüş (†)	826
Physiological and biochemical responses of two precocious varieties of wheat to phosphate rock and TSP fertilisation in semi-arid land C. Rahmoune, S. Maâlem, F. Redjel, S. Hioun and M. Bennaceur	828
Role of phosphorus on mineral nutrient concentrations and their ratios in rice M. A. Saleque, K. M. Akther and G. M. Panaullah	830
Fluid fertilisers - An efficient source of P for calcareous soils R. E. Holloway, I. Bertrand, A. J. Frischke, D. M. Brace, M. J. McLaughlin, W. Shepperd and R. D. Graham	832
Manganese nutrition of wheat as affected by phosphorus and manganese application to a calcareous soil N. Karimian and S. M. Hashemi	834

Sulphur supply and the optimisation of the yield of wheat R. V. Palmer, F. J. Zhao, S. P. McGrath and M. J. Hawkesford	836
Yield losses in groundnut due to micronutrient deficiencies in calcareous soils of India A. L. Singh	838
Effects of Fe, Mn, Zn and Cu fertilization on the yield and grain quality of wheat in the calcareous soils of Iran A. H. Ziaeeian and M. J. Malakouti	840
Influence of N, P, K, Ca and Mg rates on leaf micronutrient concentration of 'Navaho' blackberry J. M. Spiers and J. H. Braswell	842
Plant availability of sulfur from organic fertilisers R. Gutser and S. von Tucher	844
Phosphorus availability to maize plants from sewage sludge treated with Fe compounds I. F. Samie and W. Römer	846
Degradation of chlorinated aromatic acids from sludge compost in soils T. Nagaoka, J. Tanaka, K. Kouno and T. Ando	848
Response of faba bean crop to phosphatic, foliar and bio-fertilization under new reclaimed sandy soil conditions G. M. Yakout and M.H.Greish	850
Boron uptake by plants as affected by organic matter U. Yermiyahu, R Keren and Y. Chen	852
Influence of different fertilization systems on the sulphur content of podzoluvisols and wheat grains A. Kanal	854
Prominent nitrogen uptake response to cattle feces by specific plant species M. Yamagata, S. Matsumoto, N. Koga and N. Ae	856
Mineralization patterns of nitrogen in waste-compost and responses of rice crop S. Matsumura, M. Kato, T. Motobayashi and H. Isshiki	858
Root partial contact with localized organic matter increased ⁵⁹Fe uptake and alleviated lime-induced chlorosis of young apple trees S. M. Samar, M. J. Malakouti, H. Siadat, A. Sadjadi and H. Ghafourian	860
Non-root nutrition with vermicompost extracts as the way of ecological optimisation A. V. Gamaley, M. A. Nadporozhskaya, A. I. Popov, O. G. Chertov, N. V. Kovsh and O. A. Gromova	862
Mineral fertiliser consumption and crop yields in Slovakia in the period 1989-1999 S. Torma	864
Nutrient cycling and management in different agro-eco regions of China J. Zhou, J. Xie, X. Chen and R. Härdter	866
Nutrient balances and present state of available nutrients in the soil P. Cermak	868
Nutrient uptake and crop productivity on Podzolic soils (Alfisols) G. Y. Elkina	870
Effects of reduced tillage intensity on soil Nmin dynamics following Oilseed rape cultivation T. Lickfett	872

Effect of ammonium levels and pH on nitrite accumulation in soils	874
Q. R. Shen, W. Ran and Z. H. Cao	
Spatial variability of available phosphorus and site specific P fertilizer recommendations in a wheat field	876
M. R. Karaman, S. Ersahin and A. Durak	
Remote sensing of soil properties to support site specific farming	878
T. Selige and U. Schmidhalter	
N loss by denitrification from potted ornamental plants	880
H. Agner and M. K. Schenk	
Effects of various nitrogen fertilisers on nitrous oxide emissions from arable soils	882
B. Leick and C. Engels	
Field emissions of NH₃ and NO_x following urea application to wheat	884
A. Weber, R. Gutser and U. Schmidhalter	
Application of the life cycle assessment methodology to investigate the environmental impact of different nitrogen fertiliser application rates in a crop rotation	886
F. Brentrup, J. Küsters and H. Kuhlmann	
Growth regulators for cereal and oil crops on the basis of 2,3-dichloroisobutyric acid and chlormequat chloride and residue analyses in the grain of oat	888
W. Gans and W. Merbach	

11. Nutrient dynamics in natural and agricultural ecosystems – Processes and modelling

Nitrogen saturation in forest ecosystems: Progress and remaining mysteries	892
J. D. Aber	
Carbon and nitrogen balances in Danish forest and agro ecosystems	894
L. Rasmussen	
Modelling nutrient cycles in grazed pasture systems of Southern Australia	896
R. J. Simpson, A. D. Moore, A. E. Richardson, J. R. Donnelly, G. J. Blair and I. R. Johnson	
Modelling soil acidification under pastures - The GRAZPLAN soil acidity model	898
J. Braschkat, A. D. Moore, R. J. Simpson and P. J. Randall	
Simulation study of nitrogen supply in boreal forests using model of soil organic matter dynamics ROMUL	900
O. G. Chertov, A. S. Komarov, M. Nadporozhskaya, S. S. Bykhovets, S. L. Zudin	
The effect of site specific fertilisation on N₂O emissions and N-leaching - measurements and simulations	902
J. C. Munch, A. Berkenkamp and U. Sehy	
Modelling controlled nutrient release from coated fertilisers: Deterministic and statistical model	904
A. Shaviv	
Inventory and budget of nutrients in managed German forest stands - a method for sustainable nutrient management	906
P. Rademacher, B. Mueller-Using, H. Meesenburg and K. J. Meiwes	

Long-term nutrient dynamics of a spruce stand fertilised periodically for more than 50 years M. Mindrup, K. J. Meiwes and P. K. Khanna	908
Changes in the nitrogen budget of forest ecosystems under sustained reduction of inputs - analysis of state and prognoses based on a case study in a Norway spruce forest at Solling, Germany N. P. Lamersdorf, M. Bredemeier and F. Beese	910
Inverse estimation of parameters in a soil nitrogen turnover model for a beech forest E. Priesack, S. Gayler, R. Brumme, N. Bartsch and T. Vor	912
Ecosystem effects after ameliorative liming of a catchment at the Harz mountains, Germany H. Meesenburg, K. J. Meiwes, M. Wagner and J. Prenzel	914
Contribution of root turnover to nutrient cycling in beech forests K.-H. Wu, G. Jentschke and D. L. Godbold	916
Nitrate reductase activity in fine roots of norway spruce - A biochemical marker for nitrogen conditions in the soil? M. Genenger, E. Frossard, S. Zimmermann and I. Brunner	918
Fine roots of trees: Indicators for the element availability in forest soils and for forest soil conditions I. Brunner, S. Zimmermann and M. Genenger	920
Parameterizing net N mineralisation from 'old humus' in sandy arable soils of a drinking water catchment (Fuhrberger Feld) S. Heumann, J. Könecke, J. Böttcher and G. Springob	922
A study of nutrition and toxic elements in the Carpathian Mountain forests using foliar analysis of white fir (<i>Abies alba</i> Mill.), Norway spruce (<i>Picea abies</i> Karst.), beech (<i>Fagus sylvatica</i> L.) and humus. B. Mankovská	924
Nutrient concentrations in leaves of peach trees subjected to acid rain Klimenko O. E. and Klimenko N. I.	926
Nutritional effects on leaf area index and growth of a young <i>Eucalyptus nitens</i> plantation P. Smethurst, C. Baillie and M. Cherry	928
Possible role of the soil in the Sissoo forest (<i>Dalbergia sissoo</i>, Roxb.) decline in the Nepal terai S. P. Sah, C. K. Sharma F. Sehested	930
Relations between the use of N-fertilisers and the resulting N-balances on sandy and marshy soils in Lower Saxony/Germany – A farm study K. Möller and E. Przemeck	932
Effects of subsurface drainage design on nitrate leaching and crop yield A. El-Sadek and J. Feyen	934
Measured and simulated nitrate leaching in vegetable culture K. R. Végh and I. Cserni	936
Nitrogen balances derived from long-term experiments with vegetable crops J. Rühlmann and B. Geyer	938
Mineralisation of newly accumulated nitrogen R. Nieder, H. P. Dauck and D. K. Benbi	940
Recycling of N between soil and plants during the growing season M. A. Jimenez, R. Gutser, H. Schmid and J. C. Munch	942

Sulphate and nitrogen net mineralisation in coarse-textured soils in western Australia G. C. Anderson and I. R. P. Fillery	944
Nitrogen mineralisation kinetics in soils: An assessment of some modelling approaches D. K. Benbi and J. Richter	946
Validation of the EPIC model for nitrogen and phosphorus uptake by intercropped maize and cowpea on Alumi Haplic Acrisol I. de Barros, T. Gaiser and V. Römheld	948
Influence of rain distribution on yield and management practices for a winter wheat cultivation J. Bobert and U. Schmidhalter	950
Long-term trial on soil formation at Halle/Saale H. Beschow and W. Merbach	952
Model type selection for the examination of SOM dynamics and soil assessment as CO₂ source/sink based on EuroSOMNET database O. D. Sirotenko, L. K. Shevtsova and V. A. Romanenkov	954
Removal of N and P from eutrophic pond water by using plant bed filter ditches planted with crops and flowers K. Abe and Y. Ozaki	956
Nitrous oxide and dinitrogen losses from flooded fen peat with and without reed canarygrass (<i>Phalaris arundinacea</i> L.) and common reed (<i>Phragmites australis</i> (Cav.) Trin. ex Steud.) plants J. Augustin, U. Münchmeyer and R. Russow	958
Production, consumption and emission of nitrous oxide in profiles of Stagnic Gleysols under changing soil moisture conditions M. Trimborn and W. Werner	960
Effect of pH on denitrification losses from different arable soils B. W. Hütsch, S. Zhang, K. Feng, F. Yan and S. Schubert	962
 12. Plant nutrition and sustainable development	
Challenges for sustaining productivity gains and environmental quality in intensive grain production systems of Asia and the United States A. Dobermann and K. G. Cassman	966
Does the farming system affect the nitrogen fertiliser value of animal manure? M. Langmeier, A. Oberson, M. Kreuzer, P. Mäder, D. Dubois and E. Frossard	968
The role of N nutrition on lowland rice yields along an agroecological gradient in West Africa M. Becker, M. C. S. Wopereis and D. E. Johnson	970
Causes of legume-rotation effects in increasing cereal yields across the Sudanian, Sahelian and Guinean zone of West Africa A. Bürkert, M. Bagayoko, S. Alvey and A. Bationo	972
Integrated approach for improved P nutrition of plants in tropical acid soils G. Keerthisinghe, F. Zapata, P. Chalk and P. Hocking	974
Root turnover and nutrient cycling in native and introduced pastures in tropical savannas I. M. Rao, C. Plazas and J. Ricaurte	976
Contribution of above- and below-ground interactions to intercropping F. S. Zhang, L. Li and J. H. Sun	978

Organic matter and its relation to maize crops on acid soils of Colombia	980
L. A. Rojas, J. E. Baquero, M. Ramírez, F. Rodríguez and G. Roveda	
Interaction effects of organic materials and lime on grain yield and nutrient acquisition of three maize varieties grown in an Oxisol of the Colombian eastern plains	982
J. E. Baquerol and L. A. Rojas	
Three years performance of a tolerant and a susceptible maize cultivar on non-amended and amended acid soil	984
C. The, H. Calba, W. J. Horst and C. Zonkeng	
The effect of bio-compost application on crop yield and nitrogen dynamic in the soil	986
R. Schulz, H. Al-Najar, J. Breuer and V. Römheld	
Agricultural application of municipal solid waste compost in the Gaza Strip: in situ measurement of nutrient and heavy metal leaching	988
A. Kaschl, E. Neumann, Y. Chen and V. Römheld	
Chemical properties of different composts consisting of sewage sludge, cement kiln dust and plant residues	990
A. Zayed, S. Mabrouk and M. Abdou	
Utilisation of boiler ash from biomass heating plants as fertiliser substitut	992
G. Uckert, R. Mette and B. Sattelmacher	
Heavy metal pollution in a rhodic ferralsol of Cuba	994
O. Muñiz, J. Molina, S. Quicute and J. Estevez	
Physicochemical processes effecting ¹³⁷Cs and ⁹⁰Sr migration in soils and uptake by plants	996
E. N. Rovdan and A. M. Abramets	
Control of Al/Fe activities in soils of the humid tropics by a balanced fertiliser management	998
K. Sommer	
Optimum rice yield under short-term cover crop fallow systems	1000
R. K. Akanvou M. Becker M. J. Kropff L. Bastiaans and G. Dea	
Dynamics, balance and recycling of nitrogen in lowland rice-based cropping system	1002
R. K. Shrestha and J. K. Ladha	
Effects of cover crops species on <i>Passiflora edulis</i> nutrition	1004
L. R. M. de Andrade, A. M. de Carvalho, I. de C. Mendes, L. Vivaldi, C. T. Karia and N. T. V. Junqueira	
Cultivation of legumes and grass/legume mixtures on arable land as a sustainable management	1006
W. Grzebisz, J. Kryszak, W. Szczepaniak and R. Gaj	
Productivity and yield quality of fodder galega (<i>Galega orientalis</i> Lam.) - Grass mixed swards	1008
A. M. Adamovich	
Root growth and nitrogen utilization of a leek crop and an undersown catch crop	1010
K. L. Nielsen and K. Thorup-Kristensen	
Competition for nutrients by key species of grassland systems on the tablelands of southeast Australia.	1012
J. Hill, R. J. Simpson, A. D. Moore and D. Chapman	
Water and nutrient balance under slash-and-burn agriculture in the Eastern Amazon, Brasil - The role of a deep rooting fallow vegetation	1014
R. Sommer, T. D. A. de Sá, K. Vielhauer, P. L. G. Vlek and H. Fölster	

Effects of short-duration fallows on P transformations in Oxisols of Western Kenya E. Bünnemann, A. Oberson, P. C. Smithson, B. Jama and E. Frossard	1016
Phosphorus fractionation in oxisols under agroforestry and conventional coffee systems in Brazil I. M. Cardoso, B. H. Janssen, O. Oenema and Th. Kuyper	1018
Fuzzy set analysis and canonical correspondence analysis of soil arthropods (Coleoptera, Isopoda) in organic and conventional agroecosystems E. Hadjicharalambous, K. L. Kalburtji and A. P. Mamolos	1020
Soil arthropod diversity in relation to weed diversity in organic and conventional agroecosystems E. Hadjicharalambous, K. L. Kalburtji and A. P. Mamolos	1022
Plastic film mulching cultivation: a new technology for resource saving water N fertiliser and reduced environmental pollution L. Wu, Z. Zhu, Y. Liang and F. Zhang	1024
A holistic approach towards sustainable land use management in the Hedgerow - Field crop interface R. Mette, G. Uckert and B. Sattelmacher	1026
Integration of plant nutrition and soil fertility in international and interdisciplinary teaching activities on sustainable land use and natural resource management T. Müller, Q. Gausset, P. Van der Keur, O. Mertz, P. Oksen and A. Aalbæk	1028
Author index	1031
Appendix of manuscripts	1039