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Role of mineral nutrients in confronting citrus canker caused by *Xanthomonas axonopodis* Pv. citri

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Abstract

Mineral nutrients play an important role in plant-disease interactions. Experiments were conducted under Randomized Complete Block Design (RCBD) with three replications to find out the influence of macro and micro-nutrients with relation to the citrus canker caused by *Xanthomonas axonopodis* pv. *citri* (*Xac*). Mixture of nutrients NPK (Compound) and B, Zn, Fe, Mg, Mn and Ca (Nutritop) were evaluated under greenhouse and field conditions. In greenhouse experiment, combination of both Nutritop and Compound expressed very low disease incidence (16.27) as compared to other Compound (25.72), Nutritop (31.55) alone as well as control consistently. Treatments and concentrations interaction exhibited 21.33 % disease incidence which was expressed through Compound @ 6000 mL/ha as compared to 5000 (26.50) as well as 4000 mL/ha (29.33) percent while 1000, 1200 and 1400 mL/ha Nutritop concentrations exhibited 35.50, 31.83 and 27.33 % disease incidence consistently. Under field conditions, very low disease incidence (19.50, 17.50 and 11.83) % was recorded when (Compound + Nutritop) was applied at the rate of 3000, 4000 and 5000 mL/ha consistently. Compound with the Nutritop showed less disease incidence (20.27) in comparison to Compound (29.72), Nutritop (35.55) as well as control consistently. Treatments and concentrations interaction expressed 25.33% disease incidence was exhibited by Compound at the rate of 6000 mL/ha as compared to 5000 (30.50) as well as 4000 mL/ha (33.33) % while 1000, 1200 and 1400 mL/ha Nutritop concentrations showed 39.50, 35.83 and 31.33% disease incidence consistently.

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Introduction

Citrus is one of the world's major fruit crops, belongs to the family *Rutaceae*. Citrus is grown in more than 130 countries. Its origin is probably temperate and subtropical areas of South East Asia. Due to its high production it stands first among all fruits in the whole world (Ladaniya *et al.*, 2010). In Pakistan, its production rate is 2.2 million tons and categorized 12th among all the countries of world (Memon, 2017). Citrus is damaged by a number of destructive diseases like canker, greening (citrus huanglongbing), scab, gummosis, decline and brown rot. Among all these diseases citrus canker caused by *Xanthomonas axonopodis* pv. *citri* is the most devastating disease. The Asiatic type of canker (canker A) is most severe and prevalent form of canker caused by the Asian strain *Xanthomonas citri* (Faegheh *et al.*, 2014).

Over the time, canker disease has been tried to be managed by use of various synthetic chemicals. These chemicals have been somewhat effective in disease control, but their side effects outweigh their benefits. They cause massive water, air, and soil contamination as a large portion of these chemicals either get mixed up with runoff or rainwater or disposed away by the air (Heinlaan *et al.*, 2008). Pesticides also causes various level of toxic effects on every population group with manufacturing workers, agricultural farmers and people living in close vicinity. Long term low concentration absorbance of such chemicals by human results into endocrine functional abnormalities; which includes role in production and destruction of hormones, dementia, reproductive abnormalities and certain forms of cancers (Mostafalou and Abdollahi, 2013). These chemicals also cause severe damage to beneficial soil microbiome resulting in reduction of soil biodiversity. In consideration to the above facts, its need of time to devise a strategy that does not involve the use of such chemicals and does not pollute the environment is essential. Mineral nutrients play an important role in the development and growth of plant but also in plant disease interaction. When pathogen attacks, it affects the physiology of plant in many ways like retarding the uptake of nutrient, translocation, assimilation and consumption which lead toward the deficiencies of different macro and micro- nutrients in plants (Ryan *et al.*, 2011). In precision agriculture, nutrients management in different stages of plant growth has received a little attention for diseases control. No doubt, physical and biochemical functions of these plant nutrients are well understood but still there is a lot of work need to be done for understanding the mechanism between nutrients and plant pathogens (Zekri and Obreza, 2015). When *Xac* attacks on citrus plant, it interferes with its defense mechanism, induces different changes in its metabolism by disturbing its ionic content which ultimately leads to the disease development (Hajiboland, 2012). Therefore, in present study, role of different macro and micro-nutrients was studied in canker affected citrus plants.

Material and methods

One-year old plants of susceptible varieties were grown in the pots (30×15cm) containing sterilized soil and arranged them under completely randomized design (CRD) on wooden table in greenhouse and inoculated them with bacterial suspension (1×10^8 CFU/mL of H_2O). Inoculation was done by using Hydroponic syringe method. A mixture of macronutrients consisting of NPK with trade name Compound and @ of (4000, 5000 and 6000 mL/ha) B, Zn, Fe, Mg, Cu with trade name Nutritop (1000, 1200 and 1400 mL/ha) and their combination (Compound and Nutritop) @ of (3000, 4000 and 5000 mL/ha) was applied by using simple hand sprayer in the morning when maximum stomata were opened (Ashfaq, 2007). In case of field experiment, Compound, Nutritop and their combination with three replications were assessed on susceptible citrus plants by fulfilling all horticultural pratices under Randomized Complete Block Design (RCBD) as explained by Steel *et al.*, 1997. Statistical analysis was carried out by using statistical software SAS/STAT (SAS Institute, 1990). Fisher's protected least significant difference (LSD) with the probability level 0.05% used for the separation of averages (Steel *et al.*, 1997). SAS/STAT software package was used for the preparation of ANOVA table, interaction between

different treatments and their combinations.

Results

Management of Citrus canker under greenhouse conditions through different nutrient mixtures

ANOVA analysis of variance expressed that all treatments (T), concentration (C) as well as their interaction (T×C) expressed important results. Nutritop compound expressed very low disease incidence (16.27) as compared to other Compound (25.72), Nutritop (31.55) as well as control consistently (Fig. 1). Treatments and concentrations interaction exhibited 21.33 % disease incidence which was expressed through Compound @ 6000 mL/ha as compared to 5000 (26.50) as well as 4000 mL/ha (29.33) percent while 1000, 1200 and 1400 mL/ha Nutritop concentrations exhibited 35.50, 31.83 and 27.33 % disease incidence consistently. Very low disease incidence (19.50, 17.50 and 11.83) % was recorded when (Compound + Nutritop) was applied at the rate of 3000, 4000 and 5000 mL/ha consistently (Fig. 2).

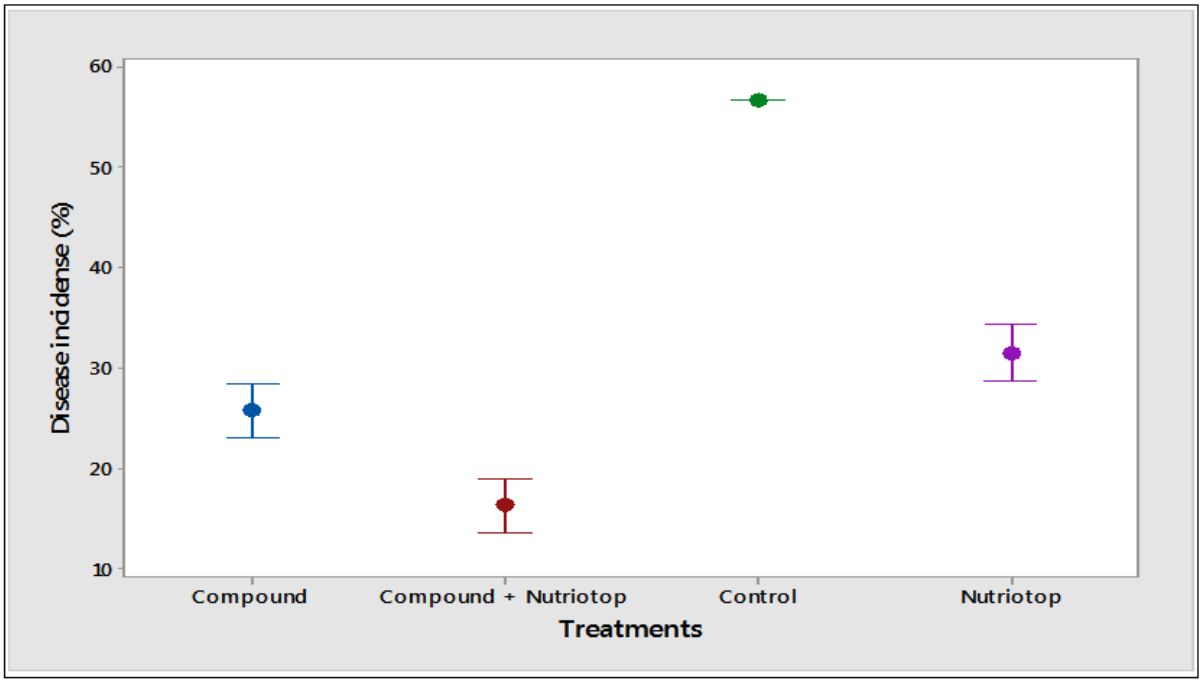

Fig. 1. Various nutrients impact on citrus canker development under greenhouse conditions.

Management of citrus canker under field conditions through different nutrient mixtures

ANOVA analysis expressed that all treatments (T), concentration (C) along with their interactions (T×C) exhibited significant result. Compound with the Nutritop showed less disease incidence (20.27) in comparison to Compound (29.72), Nutritop (35.55) as well as control consistently (Fig. 3). Treatments and concentrations interaction expressed 25.33% disease incidence was exhibited by Compound at the rate of 6000 mL/ha as compared to 5000 (30.50) as well as 4000 mL/ha (33.33) % while 1000, 1200 and 1400 mL/ha Nutritop concentrations showed 39.50, 35.83 and 31.33% disease incidence consistently. Less disease incidence (23.50, 21.50 and 15.83) % was seen when (Compound + Nutritop) was applied at the rate of 3000, 4000 and 5000 mL/ha consistently (Fig. 4).

Discussion

Citrus canker cause by *Xanthomonas axonopodis* pv. *citri* (*Xac*) is a major threat among all the constraints faced by citrus crop throughout world (Wali *et al.*, 2013). Multiple biotic and abiotic factors are responsible for the development of symptoms caused by pytopathogenic bacteria, this include infection time, plant age, strain of pathogen, genetic makeup of host, infection type and environmental conditions.

Citrus canker is a major threat to the successful production of quality citrus in Pakistan.

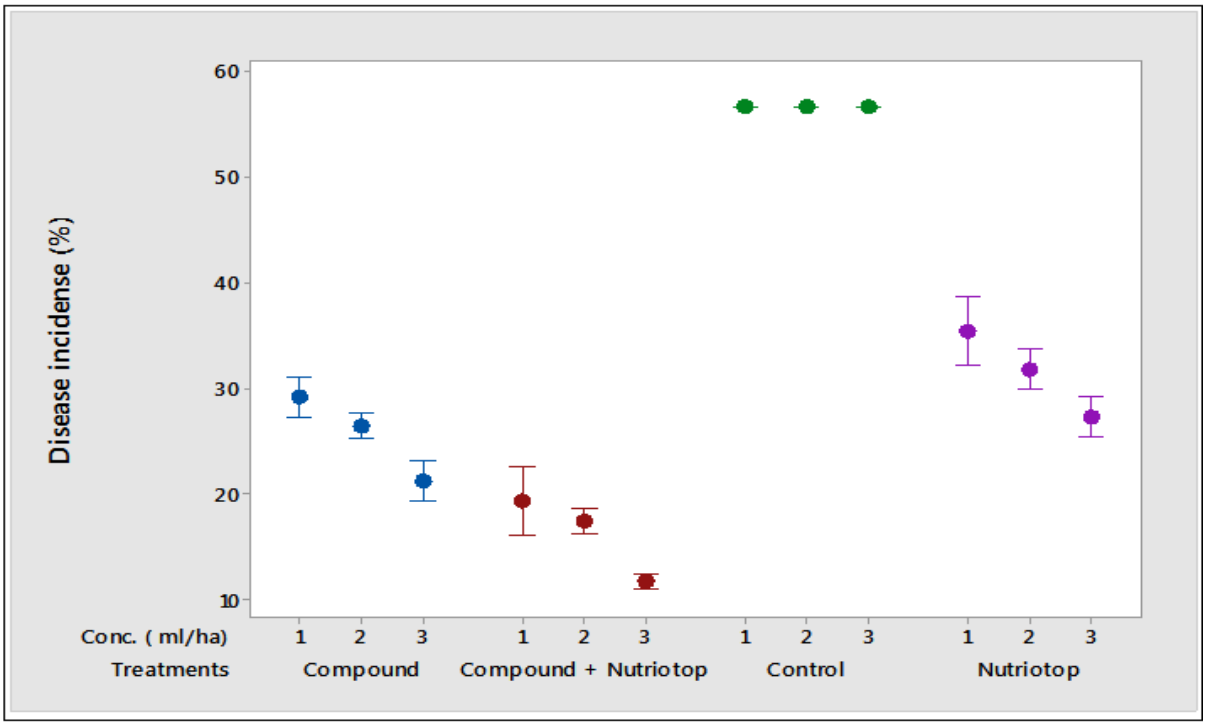

Fig. 2. Influence of interactions between different nutrient treatments and concentrations (TxC) on citrus canker under greenhouse conditions.

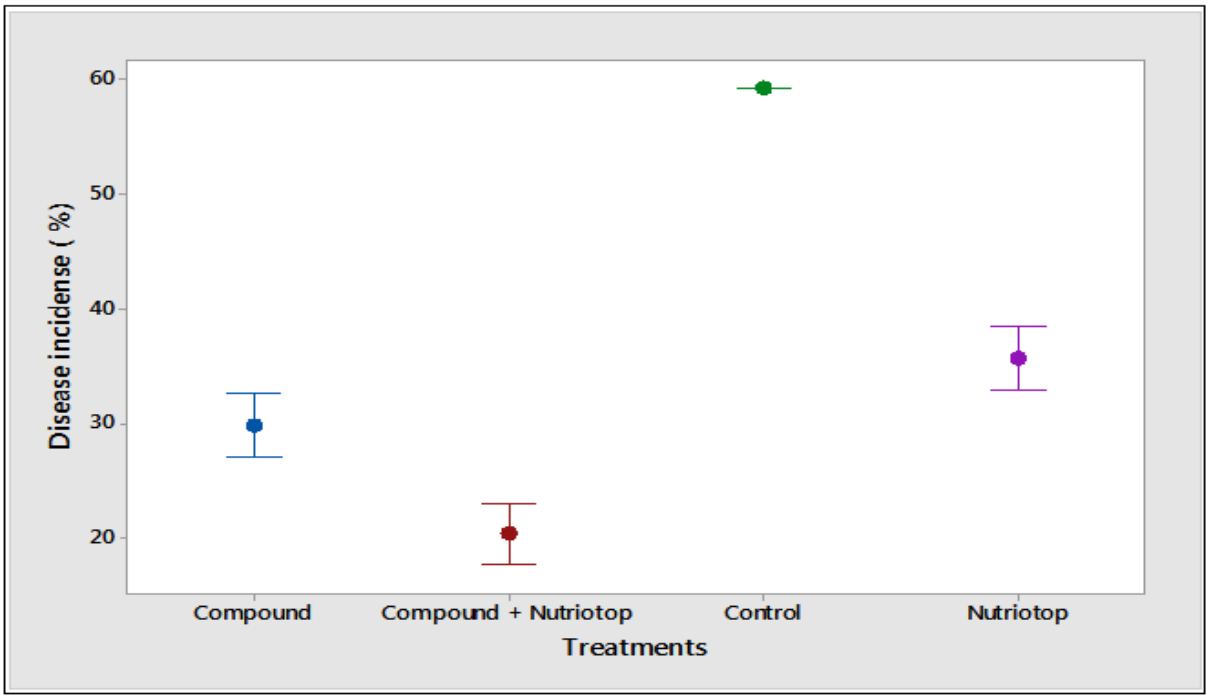

Fig. 3. Impact of different nutrients on the development of citrus canker under field conditions.

It affects cosmetic and market value. Due to this disease, 144 consignments were rejected by European Union (Pervaiz, 2015). A number of management strategies are available against canker disease, but the use of resistant cultivars is the only effective and durable solution to save the crop from the infection of *Xac*. Physiological functions of plants like translocation of water from root system to shoot system, assimilation, and nutrients uptake are destroyed due to the attack of pathogen (Ryan *et al.*, 2011). Nutrients are essential for plant growth and also helpful in metabolism activation and for

regulating several cellular functions that are necessary for plants to resist the attack of various plant pathogens which causes different diseases (Bhaduri *et al.,* 2014). Sufficient number of micronutrients (Zn, B and Fe) and macro (NPK) reduces the disease severity as well as incidence (Dordas, 2008) because mostly they act as co-factor in enzymes and catalyze the reactions. Protein molecules are structurally stabilized through nutrients (Day, 2013). Availability of these nutrients is reduced by the attack of pathogen which destroyed plant defense system, development of plant as well as their growth (Walters, 2011). Nitrogen is an integral part of proteins, amides, amino acids, nucleotides, nucleic acids, coenzymes, chlorophyll, auxin and cytosine (Guertal, 2000). Phosphorus is a crucial component of ATP (Adenosine triphosphate), nucleoprotein, RNA, DNA, phosphoprotein, and cell membrane (Suntoro, 2002). Similarly, Zinc is an important element that plays crucial role in the synthesis of protein and starch. Its low concentration inhibits amino acid production and reduces the sugar level in plant tissues. It involves in the cell membrane protection against oxidative damage by detoxifying the superoxide radicals (Cakmak, 2000). Boron is an essential micronutrient for healthy and vigorous plant. Its deficiency in plants is the major problem in the world (Brown *et al*., 2002).

It plays an important role in diminishing disease severity by enhancing stability and rigidity of cell wall (Dordas and Brown, 2005). Iron (Fe) promotes the synthesis of antimycosis. It activates the enzymes that are involved in the defense system of host plant.

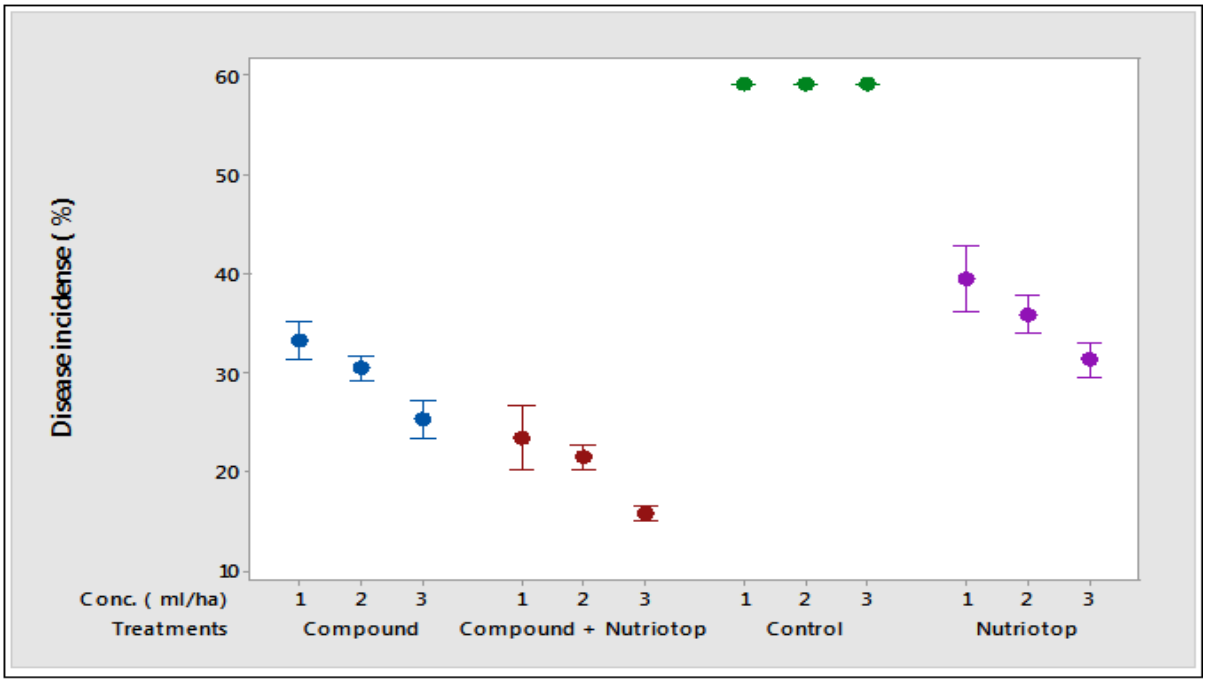

Fig. 4. Impact of interaction between different nutrient treatments and concentrations (TxC) on citrus canker development under field conditions.

In present research, combination of NPK (Compound) and B, Zn, Ca, Mg, Cu and Fe (Nutritop) alone and in combination (Compound + Nutritop) were checked against *Xac*. Compound with the combination of Nutritop and alone expressed better results for the management of citrus canker. Compound alone and in combination with Nutritop expressed significant results against citrus canker disease. Results of this study were also agreed by Obreza and Rouse (2006) who checked the efficacy of these nutrients in minimizing the disease prevalence.

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References

Bhaduri D, Rakshit R, Chakraborty K. 2014. Primary and secondary nutrients-a boon to defense system against plant diseases. International Journal of Bio-resource and Stress Management **5(3),** 461-466.

Day L. 2013. Proteins from land plants–potential resources for human nutrition and food security. Trends in Food Science and Technology **32(1),** 25-42.

Dordas C. 2008. Role of nutrients in controlling plant diseases in sustainable agriculture. A review. Agronomy for sustainable development **28(1),** p 33-46.

Faegheh S, Khodayga P, Azadvar M, Sedaghati E, Riseh RS, Ravari SB. 2014. Association of *Pantoea agglomerans* with the citrus bacterial canker disease in Iran. Journal of Crop Protection **3,** 345-355.

Hajiboland R. 2012. Effect of micronutrient deficiencies on plants stress responses, Abiotic stress responses in plants. Springer p 283-329.

Heinlaan M, Ivask A, Blinova I, Dubourguier HC, Kahru A. 2008. Toxicity of nanosized and bulk ZnO, CuO and TiO_2 to bacteria *Vibrio fischeri* and crustaceans *Daphnia magna* and *Thamnocephalus platyurus*. Chemosphere **71,** 1308-1316.

Ladanyia M, Ladaniya M. 2010. Citrus Fruit: Biology, Technology and Evaluation. – Academic Press, Amsterdam.

Memon NA. 2017. Citrus fruit (kino): Punjab produced 98% of production. Pakistan Bureau of statistics 2016-2017.

Mostafalou S, Abdollahi M. 2013. Pesticides and human chronic diseases: evidences, mechanisms, and perspectives. Toxic App. Pharmacology **268,** 157-177.

Obreza TA, Rouse RE. 2006. Long-term Response ofHamlin'Orange Trees to Controlled-release Nitrogen Fertilizers. HortScience, **41(2),** p 423-426.

Pervaiz S. 2015. Fruit, vegetable fail to enter Eurpeon Union. A Report. htt://thedailystar.net/business.

Ryan RP, Vorhölter FJ, Potnis N, Jones JB, Van MA, Sluys Bogdanove AJ, Dow JM. 2011. Pathogenomics of *Xanthomonas*: understanding bacterium–plant interactions. Nature Reviews Microbiology **9,** 344-355.

Steel RGD, Torrie JH. 1997. Principles and procedures of statistics. Principles and procedures of statistics.

Wali S, Munir F. Mahmood T. 2013. Phylogenetic studies of selected Citrus species based on chloroplast gene, rps14. International Journal of Agriculture and Biology **15,** 357-361.

Walters D. 2011. Plant defense: warding off attack by pathogens, herbivores and parasitic plants. John Wiley & Sons.

Zekri M, Obreza T. 2015. Macronutrient Deficiencies in Citrus: Nitrogen. Phosphorus, and Potassium, University of Florida: IFAS extension, retrieved from http://edis.ifas.ufl.edu/ss420.

Guertal EA. 2000. Preplant slow release nitrogen fertilizers produce similar bell pepper yields as split applications of soluble fertilizers. Agronomy Journal, **92,** 388-393.

Suntoro, 2002. Effect of organic matter addition, dolomite and KCl on chlorophyll content and its impact on peanut (Arachis hypogeae L.) yield. Biosmart **4(2),** 36-40. Indonesia.

Cakmak IM. 2000. Possible roles of zinc in protecting plant cells from damage by reactive oxygen species. New Phytologist **146,** 185–205.

Brown PH, Bellaloui N, Wimmer MA, Bassil ES, Ruiz J, Hu H, Pfeffer H, Dannel F, Romheld V. 2002. Boron in plant biology. Current Plant Biology **4,** 205–223.

Dordas C, Brown PH. 2005. Boron deficiency affects cell viability, phenolic leakage and oxidative burst in rose cell cultures. South African Journal of Plant Soil **268,** 293–301.