Phosphate transport in Mycorrhizal Plants: Cloning and Characterisation of Genes Encoding Phosphate Transporters

by

DONNA GLASSOP

B.App.Sci., Grad.Dip.Biotech., M.App.Sc.(Life Sc.),

Queensland University of Technology

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School of Earth and Environmental Sciences

The University of Adelaide

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Abbreviations and Symbols

Abbreviation	Full title
~	Approximately
%	Percentage
>	Greater than
#	Catalogue number
°C	Degrees Celsius
bp	Base pair of nucleic acids
cDNA	Complementary DNA
cm	Centimetres
cv	Cultivar
DNA	Deoxy ribonucleic acid
eg.	Example
et al.	And others
g	Gram
gDNA	Genomic DNA
h	Hours
kDa	Kilodalton, molecular mass
kg	Kilogram
K_m	Affinity of a substance for an enzyme – Michaelis-Menton constant
L	Litres
lb sq.in.$^{-1}$	Pounds per square inch, a measure of pressure
m	Minutes
M	Molar
mg	Milligram
mg kg^{-1}	Milligram per Kilogram
mL	Millilitres
mm	Millimetres
mM	milli Molar
m^2s^{-1}	Metres squared per second
ng	Nanograms
nm	Nanometres
N	Normal = 1 Molar
P	Phosphorus, phosphate

Pi	Inorganic phosphate
rpm	Revolutions per minute
RNA	Ribonucleic acid
s	Seconds
µg	Microgram
µL	Microlitres
µm	Micrometres
µM	micro Molar
UV	Ultra violet light
V	Volts
Vmax	Maximum velocity of a reaction

Abstract

Many Australian soils are phosphate deficient. This has encouraged the use of fertilisers for profitable agricultural production. However, the inefficiencies, expense and environmental issues associated with high fertiliser use have led to a search for technologies that improve phosphate (P) uptake and utilisation.

Most crop plants are adapted to low soil P through symbiotic relationships with mycorrhizal fungi that enhance P acquisition. Mycorrhizal plants have two possible routes for P uptake from soil a) the direct uptake pathway via the root epidermis and root hairs, and b) a mycorrhizal pathway. In the latter mycorrhizal fungi deliver P from the soil to the interfacial zone between the symbionts, where plant P transporters in the cortical cell membranes acquire the P provided.

This project has successfully identified four plant P transporters that are expressed in mycorrhizal roots of the major cereal crop species barley (*HORvu;Pht1;8*), wheat (*TRIae;Pht1;myc*), maize (*ZEAma;Pht1;6*) and rice (*ORYsa;Pht1;11*) and are implicated in the mycorrhizal uptake pathway. The information on barley, maize and wheat is new; *ORYsa;Pht1;11* from rice was reported in 2002 with further information presented here. In barley the expression of *HORvu;Pht1;8* and two other barley P transporters, that appear to be involved in the direct uptake pathway, has been compared in plants grown in high and low P soil and in the presence and absence of mycorrhizal colonization. The expression pattern of these genes is indicative of the mycorrhizal P uptake pathway being utilised by the plant.

It is known that cereals are not highly responsive to mycorrhizal colonization in terms of either growth or P uptake and it might be expected that the mycorrhizal P uptake pathway is relatively unimportant. However, it has been recently shown that other non-responsive plants can receive 100% of their P via the mycorrhizal pathway, implying that P transporters in the direct pathway (epidermis and root hairs) are switched off. This hypothesis can now be tested with cereals. The finding that field grown (and hence mycorrhizal) barley and other cereals may acquire P via mycorrhizal fungi and not directly via the epidermis and root hairs would have significant implications for improvement of P efficiency.

DECLARATION OF ORIGINALITY

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

D.Glassop

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