

**Uptake and Partitioning of Cadmium in Two  
Cultivars of Potato (*Solanum tuberosum* L.)**

A thesis submitted in fulfilment of the requirements for the Degree  
of Doctor of Philosophy at the University of Adelaide

By

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## Abstract

This thesis presents the results of an investigation into the uptake and distribution of cadmium (Cd) in two cultivars of potato (*Solanum tuberosum* L.) shown to contain different concentrations of Cd in the tuber at maturity.

An initial glasshouse trial sought to determine whether differences in tuber Cd between these two cultivars resulted from differences in uptake from the soil, or were due to differences in the allocation of Cd to the various tissues within the plant. Total uptake of Cd from the soil did not differ between cultivars, nor did the yield of tubers. However, there were marked differences in Cd distribution within the plant. Most of the differences in tuber Cd concentration could be accounted for by a large (3-fold) retention of Cd in the roots of cultivar Wilwash. The concentration of Cd in the shoots of Wilwash was also higher than of Kennebec, although to a lesser extent than the roots.

Further studies were conducted to trace the pathways of Cd uptake and movement within the plant. A split-pot trial, involving long-term growth of potatoes in  $^{109}\text{Cd}$ -labelled soil, was undertaken to determine the overall pattern of Cd distribution and the importance of the root system in supplying Cd to the tubers. The root system of the potato plant is different to many plants, in that the main root system (basal roots) is augmented after tuber initiation by roots extending from the stolon and from the tuber itself. The basal roots were found to be the dominant source of Cd to all tissues and accounted for approximately 85% of tuber Cd. The remaining tuber Cd was sourced directly from the stolon and tuber roots. However, there was no evidence of a direct link between the main (basal) root system and the stolons. Although Cd was found to accumulate in the periderm of the tubers, there was no uptake into the tuber tissue itself.

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Isotopic studies were undertaken to investigate the short-term movement of newly absorbed Cd in the xylem and the phloem. Cadmium was found to be highly mobile in both the xylem and phloem, with added Cd being rapidly assimilated into all tissues following both root and foliar application. Newly absorbed Cd was rapidly sequestered by the stems when applied to either the soil or to a source leaf, suggesting that the stems may act as a transitional storage pool when rapid turnover of nutrients and other mineral elements is required during tuber bulking.

Inhibition of Cd uptake by zinc (Zn), has been proposed as a method for reducing the concentration of Cd in various agricultural crops, including potatoes. The ability of Zn to reduce Cd uptake was found to be highly dependent upon cultivar and on the concentration of Cd in the external medium. Although competition between Zn and Cd was found for cultivar Wilwash when the external concentration of Cd was low, when the concentration of Cd in the external media was high, increasing Zn served to increase Cd uptake. Both synergistic and competitive responses were also noted for cultivar Kennebec. However, the patterns of response were opposite to those evident in Wilwash. The complexity of these interactions highlighted the possible shortcomings in using soil applied Zn to limit Cd uptake by potatoes.

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## **Declaration**

This thesis 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, this thesis contains no material previously published or written by another person, except where due reference is made in the text.

I give consent to the librarian of the Barr-Smith Library, University of Adelaide, or his/her appointed agent to make this thesis freely available for photocopy or loan.

Kelly R. Dunbar

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