

Absorption and Redistribution of ^{65}Zn in Citrus Plants

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INTRODUCTION

The micronutrients Zn and B are applied routinely in Brazilian citrus orchards. Increases in foliar micronutrient contents have been demonstrated in leaves that received foliar sprays, but there are no reports on Zn distribution in orange trees. The objectives were to evaluate the redistribution of Zn within orange trees and to compare the contributions of Zn applied as foliar spray or onto the soil surface in supplying Zn to the organs grown after Zn fertilization.

METHODS

The orange trees 'Valencia' variety (*Citrus sinensis* (L.) Osbeck) budded on 'Swingle' citrumelo (*Citrus paradisi* Macfad. Cv. Duncan x *Poncirus trifoliata* (L.) Raf.) were used in three experiments carried out in a greenhouse.

In the first experiment, young orange trees were grown in plastic pots with complete nutrient solutions (10 L, 0.118 mg Zn L⁻¹). Before starting flower flux emission, $^{65}\text{ZnCl}_2$ (506 dpm μg^{-1} of Zn) was added to the nutrient solution. The fluxes emitted after the addition of ^{65}Zn in the nutrient solution were identified and harvested when the trees were completely developed and split in branches (B-sn), leaves (L-sn) and fruits (Fr-sn). The remaining organs of the orange tree (O-sn) were also harvested. In the second experiment, 5 years old orange trees, grown in substrate, were sprayed with 80 mL/tree of a solution containing $^{65}\text{ZnCl}_2$ (60 dpm μg^{-1} of Zn) when they were emitting flower fluxes. Soil was protected during the foliar fertilization to avoid soil ^{65}Zn contamination. When fruits had developed, parts of the orange tree were harvested and split in: branches ($^{65}\text{B-f}$) and leaves ($^{65}\text{L-f}$) that were already developed when the radioactive solution was sprayed; branches ($^{65}\text{Bf-f}$) and leaves ($^{65}\text{Lf-f}$) of the flower fluxes that were growing when the radioactive solution was sprayed; fruits (Fr-f), branches (Bvg-f) and leaves (Lvg-f) of the vegetative fluxes grown after spraying radioactive solution. In the third experiment, 5 years old orange trees were grown in pots with 64 dm⁻³ of arenosol soil (clay:122 g kg⁻¹, silt: 8 g kg⁻¹, sand: 870 g kg⁻¹) and 680 mg of Zn ($^{65}\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$, 3.7 dpm μg^{-1} of Zn) were applied to the soil surface. After Zn application, the orange trees emitted flower fluxes and when the fruits were developed, they were collected and separated in: branches (B-s), leaves (F-s) and fruits (Fr-s). The harvested vegetal material was dried and digested, and ^{65}Zn was counted in a solid scintillation (NaI) counting system. Total Zn was determined by Atomic Absorption Spectrophotometry (AAS).

RESULTS AND DISCUSSION

Orange trees, before the ^{65}Zn application to the nutrient solution, contained 5118 $\mu\text{g}/\text{tree}$ of Zn ($\text{Zn}_{\text{initial}}$). Branches, leaves and fruits emitted afterwards contained 1152 μg redistributed from the plant and 72 μg from the nutrient solution ($^{65}\text{Zn}_{\text{psn}}$). Zn, redistributed from orange old parts to new fluxes, corresponded to 22% of $\text{Zn}_{\text{initial}}$. For B-sn, L-sn and Fr-sn, the contribution of redistributed Zn corresponded to 92 to 94% of Zn in these parts, and 6 to 8% were contributed by Zn from the nutrient solution absorbed by roots during the flux development (Table 1).

Table 1. ⁶⁵Zinc absorption from nutrient solution (average of 3 replicates ± SE)

organ	----- Total Zn -----		----Derived from plant ---		----- ⁶⁵ Zn _{dsn} -----	
	µg/tree ± s(m)	mg kg ⁻¹	µg/tree ± s(m)	mg kg ⁻¹	µg/tree ± s(m)	mg kg ⁻¹
B-sn	88 ± 19	16	81 ± 17	15	7 ± 2	1
L-sn	428 ± 112	16	400 ± 104	15	28 ± 8	1
Fr-sn	636 ± 194	9	529 ± 186	8	37 ± 9	1
O-sn	4630	-	-	-	591	-

Foliar fertilization increased total Zn (Zn_{total}) and Zn derived from the foliar spraying (⁶⁵Zn_{dff}) in the organs that were already developed at the time of application (⁶⁵B-f and ⁶⁵L-f). However, this contribution was irrelevant (Table 2) for organs in development (⁶⁵Bf-f and ⁶⁵Lf-f) and for vegetative fluxes developed after the foliar application (Fr-f, Rvg-f and Fvg-f).

Table 2. ⁶⁵Zinc absorbed from foliar fertilization (average of 3 replicates ± SE).

Organ	----- Zn _{total} -----	----- ⁶⁵ Zn _{dff} -----		----- Zn _{plant+soil} -----	
	mg kg ⁻¹ ± s(m)	mg kg ⁻¹ ± s(m)	%	mg kg ⁻¹ ± s(m)	%
⁶⁵ B-f	34 ± 4.5	6 ± 0.8	19	27 ± 3.8	81
⁶⁵ L-f	110 ± 12.8	39 ± 6.8	36	71 ± 11.2	64
⁶⁵ Bf-f	22 ± 0.7	1 ± 0.6	7	21 ± 1.4	93
⁶⁵ Lf-f	42 ± 7.9	4 ± 1.1	10	38 ± 7.6	90
Fr-f	13 ± 1.4	1 ± 0,1	10	11 ± 1.5	90
Bvg-f	24 ± 3.5	1 ± 0.2	3	23 ± 3.3	97
Lvg-f	24 ± 1.4	2 ± 0,1	7	22 ± 1.4	93

Zinc derived from fertilizer (⁶⁵Zn_{ds}) applied to the soil increased the Zn content of branches (B-s), leaves (L-s) and fruits (Fr-s) that developed after Zn fertilization (Table 3).

Table 3. ⁶⁵Zinc absorbed from soil fertilization (average of 3 replicates ± SE).

Organ	Zn _{total}	⁶⁵ Zn _{ds}	%	Zn _{plant+soil}	%
	mg kg ⁻¹ ± s(m)	mg kg ⁻¹ ± s(m)		mg kg ⁻¹ ± s(m)	
B-s	70 ± 11	17 ± 3,99	23	56 ± 14,29	77
L-s	40 ± 6,83	7 ± 0,75	20	28 ± 1,57	80
Fr-s	20 ± 3,71	4 ± 0,77	20	16 ± 1,12	78

CONCLUSIONS

Approximately 20% of Zn present in young orange trees was distributed from old to new parts (flower flux). The foliar application was efficient in increasing the Zn content of leaves and branches that received it. However, the contribution was negligible for the Zn content of organs developed after spraying. Zinc applied onto the soil surface was absorbed by roots and increased the Zn content of organs grown after the fertilization.

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