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Some Sensitivity Studies of Chemical Transport Simulated in Models of the Soil-Plant-Litter System

C. L. Begovich
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ENVIRONMENTAL SCIENCES DIVISION
Publication No. 1313

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SOME SENSITIVITY STUDIES OF CHEMICAL TRANSPORT SIMULATED IN MODELS OF THE SOIL-PLANT-LITTER SYSTEM[1]

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C. L. Begovich,[2] and R. J. Luxmoore

ENVIRONMENTAL SCIENCES DIVISION
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[2] Computer Sciences Division, Union Carbide Corporation, Nuclear Division.

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ABSTRACT

BEGOVICH, C. L., and R. J. LUXMOORE. 1979. Some sensitivity studies of chemical transport simulated in models of the soil-plant-litter system. ORNL/TM-6791. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 106 pp.

Fifteen parameters in a set of five coupled models describing carbon, water, and chemical dynamics in the soil-plant-litter system were varied in a sensitivity analysis of model response. Results are presented for chemical distribution in the components of soil, plants, and litter along with selected responses of biomass, internal chemical transport (xylem and phloem pathways), and chemical uptake. Response and sensitivity coefficients are presented for up to 102 model outputs in an appendix.

Two soil properties (chemical distribution coefficient and chemical solubility) and three plant properties (leaf chemical permeability, cuticle thickness, and root chemical conductivity) had the greatest influence on chemical transport in the soil-plant-litter system under the conditions examined. Pollutant gas uptake (SO_2) increased with change in plant properties that increased plant growth. Heavy metal dynamics in litter responded to plant properties (phloem resistance, respiration characteristics) which induced changes in the chemical cycling to the litter system. Some of the SO_2 and heavy metal responses were not expected but became apparent through the modeling analysis.

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INTRODUCTION

Understanding of the chemical, physical, and physiological processes involved in chemical transport in terrestrial ecosystems can be aided with simulation models based on these processes. The complexity of process interactions within plants and the litter system, however, may require that the phenomenological behavior of chemical transport be modeled with empirically derived functions. Nevertheless, the continuing aim of process modeling is to represent the principles of chemistry, physics, and physiology. One attempt at modeling the carbon, water, and chemical fluxes and pools in the soil-plant-litter system was made in the development of the Unified Transport Model (Baes et al. 1976). Five models were developed, coupled together, and executed with hourly resolution of photosynthesis, translocation, respiration, transpiration, solute and water uptake, litter decomposition, and chemical mineralization. These models have been applied to heavy metal movement and SO_2 uptake in the vicinity of a lead mining and smelting complex (Munro et al. 1976; Luxmoore and Begovich, submitted). The sensitivity of the model output to changes in input parameters is critical information in model applications since it defines the precision with which input data should be obtained for a given precision of output results. Sensitivity analysis also serves to identify important parameters and important functions (from the model's viewpoint) that may aid in evaluation of real world phenomena.

Evaluation of the environmental hazard from chemical releases into terrestrial ecosystems often needs to be made by regulatory agencies without full information about the nature of the chemical-environmental-biological interactions. Modeling can aid in the evaluation process at both qualitative and quantitative levels of resolution. This study was conducted as an aid in evaluation of chemical transport in the soil-plant-litter system by providing sensitivity information about model parameters, seeking the identification of critical steps in chemical transport, and determining the outcomes of chemical transport in which water, carbon, and chemicals are represented as coupled components. A description of the models and the coupling between them is given below.

OVERVIEW OF MODELS

The component models involved in this evaluation are the Terrestrial Ecosystem Hydrology Model (TEHM) (Huff et al. 1977), the soil chemical exchange model (SCEHM) (Begovich and Jackson 1975), a model of forest stand biomass (CERES) (Dixon et al. 1976, 1978a,b), and models for investigating solute uptake and incorporation into the vegetation and litter (DRYADS and DIFMAS) (Luxmoore et al. 1976a, 1978). Each of the above reports gives the details of these models, so only a brief description with an emphasis on their interrelationships is given below. The combined set of models seeks to represent the major flow processes in the soil-plant-litter system (Fig. 1).

Infiltration, exchange, and movement of heavy metal contaminants are considered in the soil chemistry model. The contaminants are dissolved into infiltrating water according to a solubility constant. Contaminant movement through the soil profile is governed by soil water

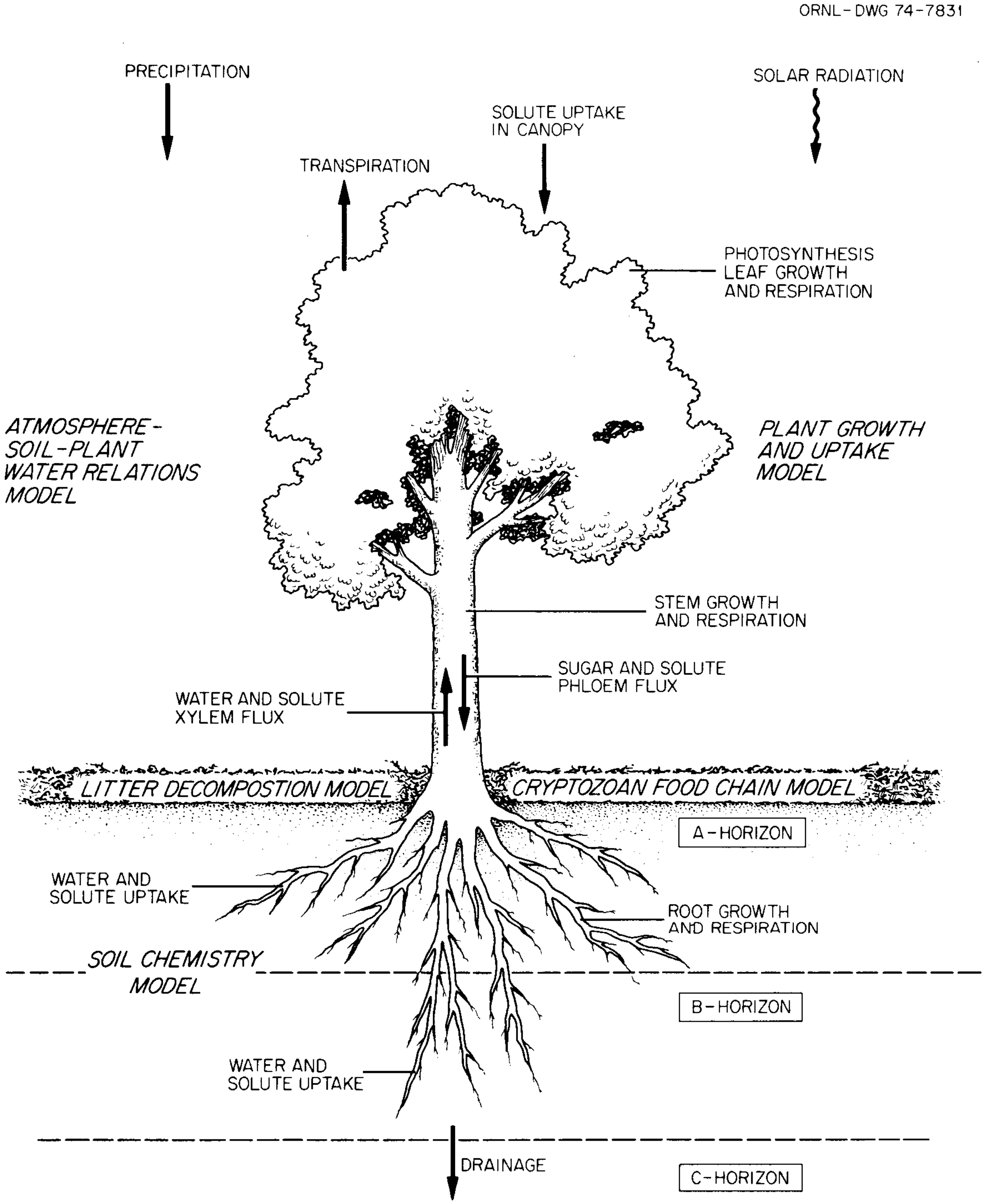

Fig. 1. Solute transport processes in the soil-plant-litter system and the associated models used to represent carbon, water, and chemical dynamics.

flow (Fig. 2), and the equilibrium between the amount on the soil exchange and the soil solution concentration is determined by a K_d relationship.

Carbon dynamics of plants and litter are modeled by CERES. Net photosynthesis is modeled by a CO_2 gradient/resistance equation; similarly, carbon translocation is governed by the gradient of sugar substrate between plant parts divided by a phloem resistance. Plant respiration and mortality rates reduce biomass. The growth of plant tissues (leaf, stem, root, fruit) is determined by tissue water potentials and the amounts of sugar substrate available to the tissues bounded by maximum attainable biomass input values (Fig. 3). A litter compartment model with temperature dependent decomposition is also included in CERES.

Incorporation of heavy metal contaminants into the plant and litter is modeled in DRYADS and DIFMAS. Leaf uptake of solutes is governed by solute gradients across the leaf surface together with a cuticle permeability input value. Uptake by the root system is by mass flow and diffusion according to the equations given by Baldwin et al. (1973). The solutes in the plant move along a concentration gradient in phloem or as mass flow in the xylem transpiration stream. Chemical losses from the plant system are determined by the rate of mortality of tissues (Fig. 4).

The interrelationships of these models with PROSPER, the soil-plant-atmosphere-water model contained in TEHM (Fig. 5) show that each model interfaces with at least two of the other models. Moisture relations are simulated in PROSPER, which depend upon the leaf and root parameters of the plants calculated in CERES. The soil water flow

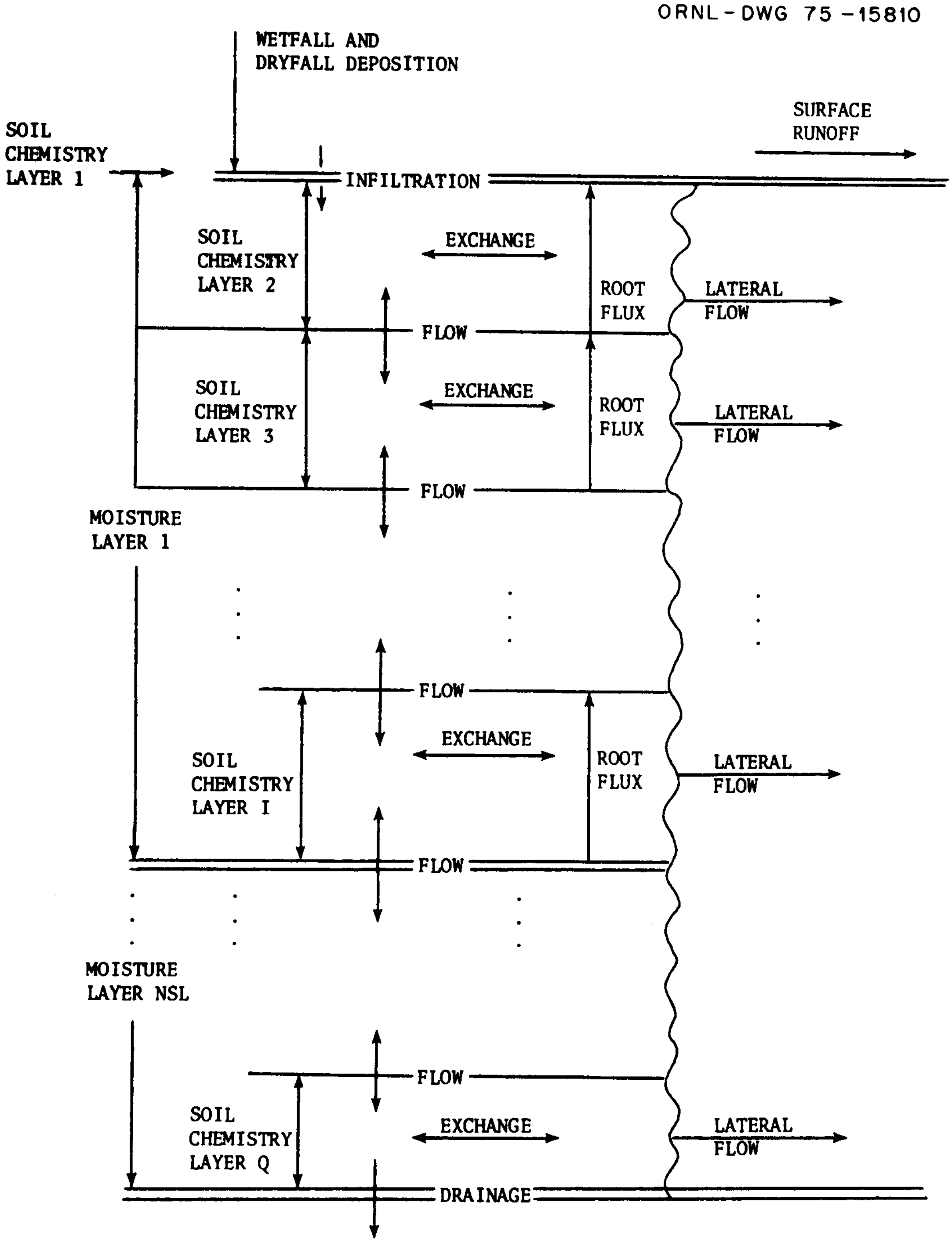

Fig. 2. Chemical transport and reaction processes in soil layers used in SCEHM.

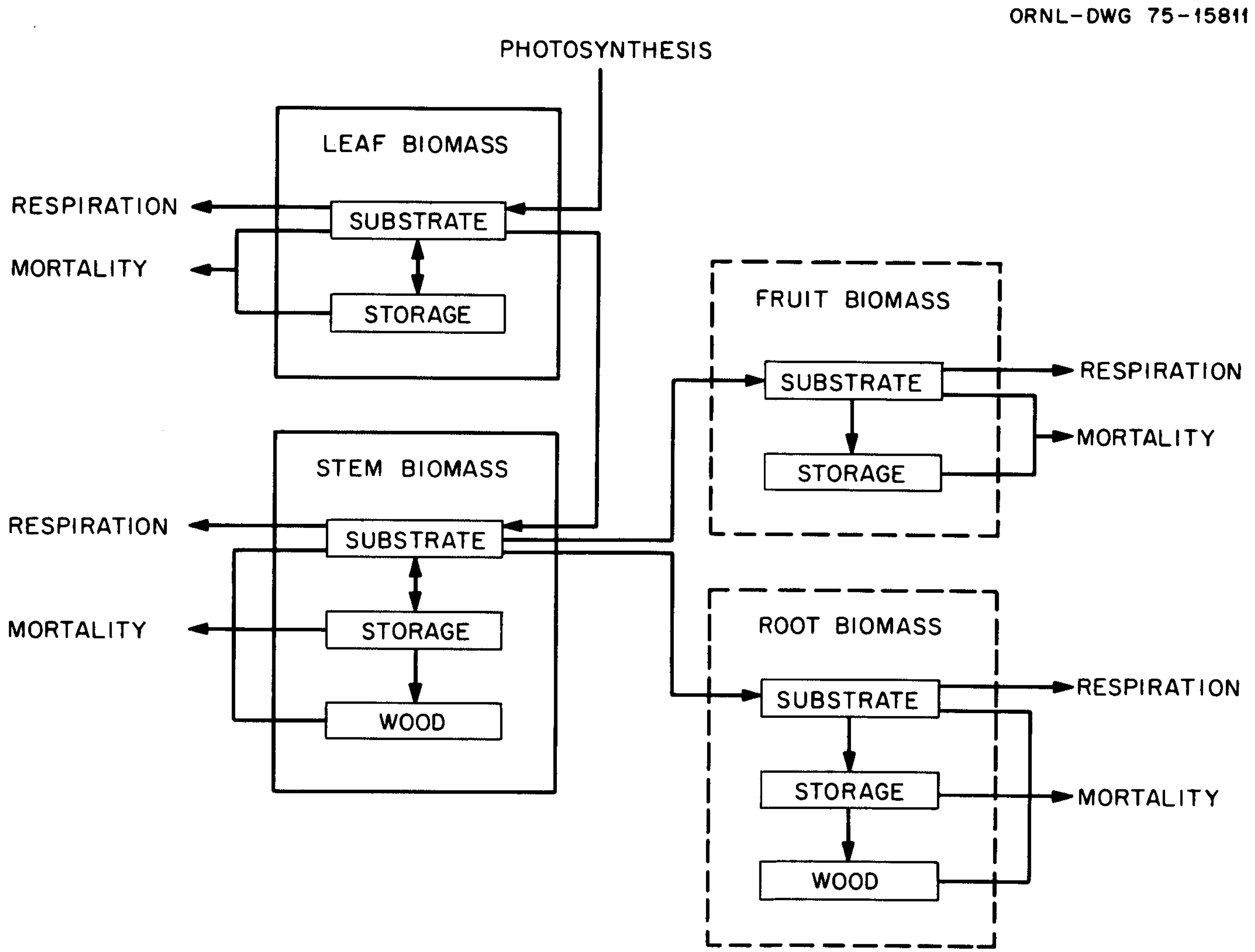

Fig. 3. The plant compartments and carbon processes represented in CERES.

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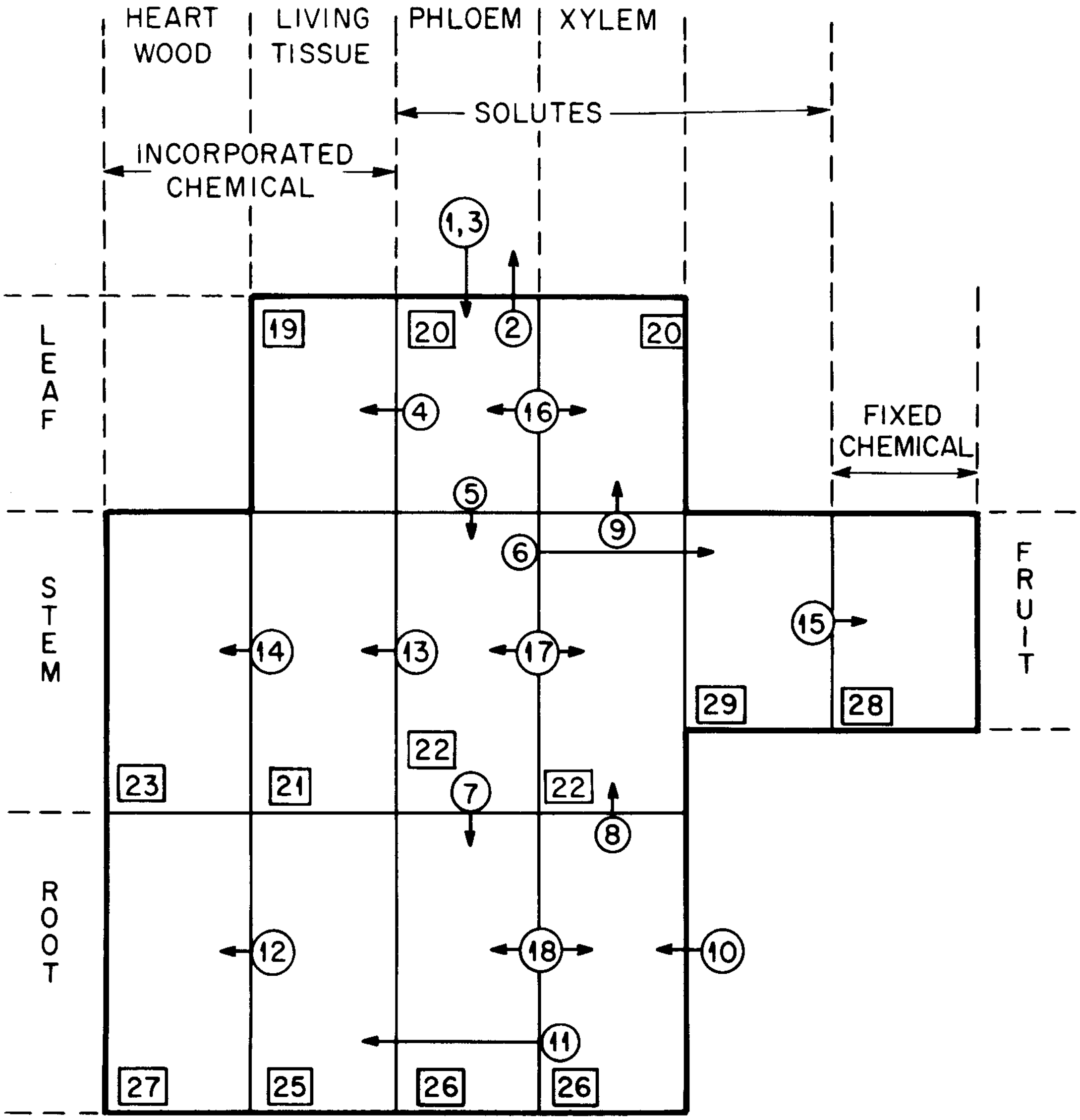

THE NUMBERS INDICATE THE SEQUENCE OF CALCULATIONS IN DRYADS

PROCESSES
- LEAF SOLUTE UPTAKE OR LEACHING 1–2
- LEAF GASEOUS UPTAKE 3
- PHLOEM TRANSLOCATION 5–7
- XYLEM TRANSPORT 8–9
- ROOT SOLUTE UPTAKE 10
- CHEMICAL INCORPORATION
  - IN LIVING TISSUE 4, 11, 13, 15
  - IN HEARTWOOD 12, 14
- SOLUTE EQUILIBRATION 16–18
- MORTALITY LOSSES 19–29

Fig. 4. The plant compartments and chemical processes represented in DRYADS.

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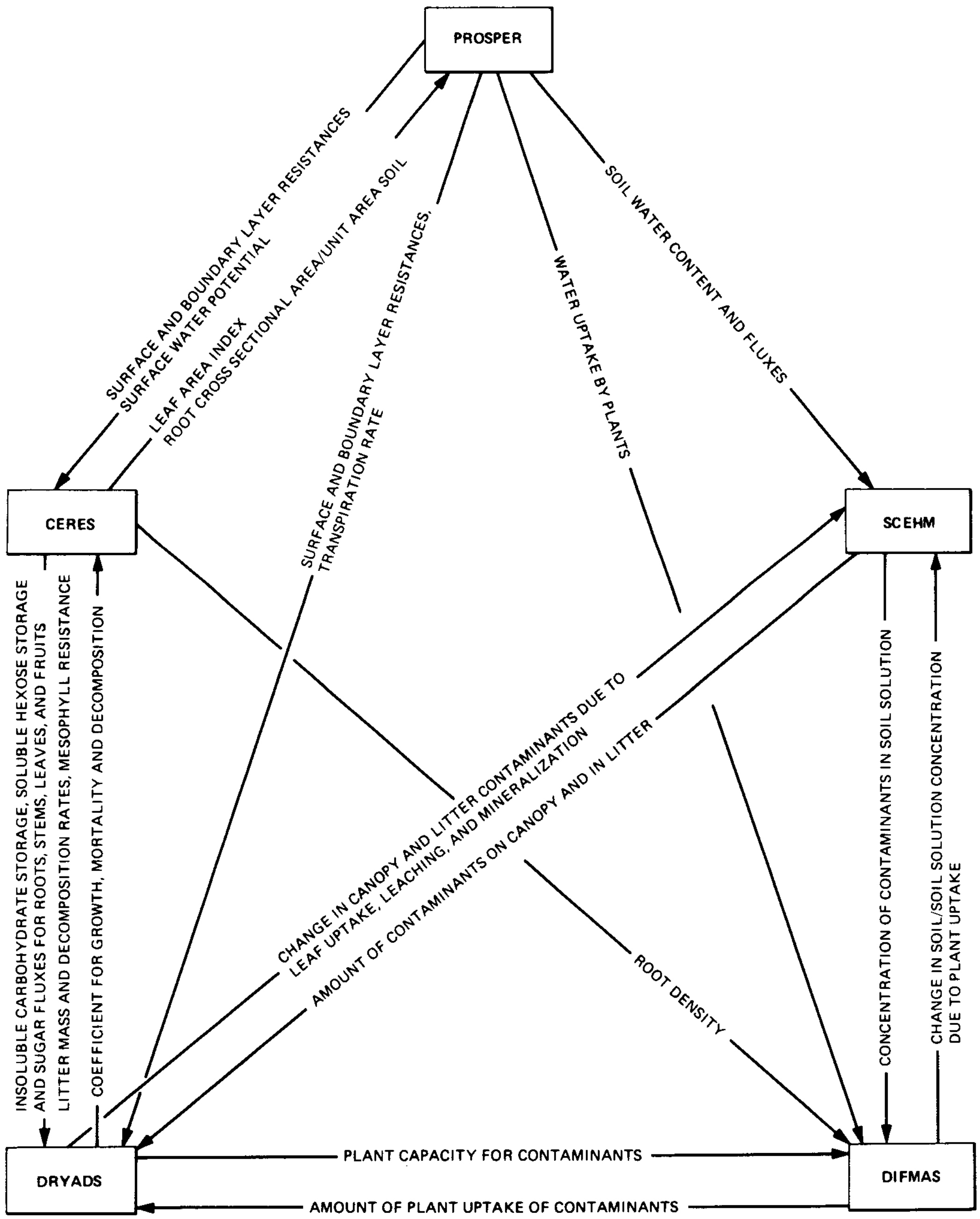

Fig 5. Coupling of five process models that describe hourly carbon, water, and chemical dynamics in the soil-plant-litter system.

and exchange of the contaminants are calculated in SCEHM, which depend on the water movement (PROSPER), root uptake (DIFMAS), and leaf uptake (DRYADS). The CERES model is used to predict plant growth, which in turn depends on resistances and water potentials (PROSPER) and any growth or mortality effects of nutrients or contaminants (DRYADS). Finally, the simulation of chemical dynamics in the DRYADS and DIFMAS models depend upon the plant size and growth (CERES) and the soil concentrations (SCEHM) of contaminants. Each of the models also depend directly or indirectly on climatic data which are established by the TEHM model. The basic timing and bookkeeping are conducted in TEHM.

SENSITIVITY ANALYSIS METHODS

Large computational models, useful for decision making, are difficult to evaluate because of their complex nature (Gass 1977). Sensitivity analysis is a valuable technique for evaluating the effects of model data parameters on the model results. The uncertainties in the data are used to estimate the uncertainty in the model prediction (Miller 1974). The purpose of the sensitivity analysis is to determine the parameters that produce the largest differences in the models' results. With this knowledge of the parameters, a user can determine which inputs require estimation to the highest degree of accuracy. In addition, given the models' assumptions, the results can be related back to the real world situation that the model represents to draw conclusions about the relative importance of the properties of the systems.

The difficulties in performing the sensitivity analysis lie in selecting the data parameters, estimating their uncertainties, and evaluating the differences in the model results. Several previous sensitivity analyses [the TEHM model (Luxmoore et al. 1976b), sensitivity analysis of different parameters affecting plant nutrient uptake (Baldwin 1976) and sensitivity analysis done as part of model validation (Miller et al. 1976)] provided guidelines for this analysis. The selection of the parameters and their ranges was based upon previous experience with the models and upon realistic evaluation of parameter values for a range of environmental conditions. The comparisons of model responses were complex because of the quantity of the output and their time dependence. The details of the analysis follow.

The parameters selected for investigation (Table 1) represent a range of soil and plant properties that may influence chemical transport. The table identifies the primary model, the standard value, and the range of values of the input parameters varied in the analysis. The soil, vegetation, litter, and climatic data used in the Crooked Creek Watershed simulation of lead and zinc transport (Munro et al. 1976) were chosen as the standard set of input values. Each parameter was varied around this standard, and the results were related back to this standard set of results. The output parameter list used in the analysis (Table 2) is extensive and provides many points at which the model sensitivity may be evaluated.

The method for testing the parameters consisted of running the model over a three-month period (May-July) with one particular value varied in the standard set of input. No data were recorded for the

Table 1. Standard parameter values and tested values for sensitive analyses

	Variable name	Standard values	Tested values[a]
SOIL AND CHEMICAL PARAMETERS (SCEHM)			
Distribution coefficient (ml/g) for upper and lower soil layers	KD	500, 600 lead	2500, 3000 100, 125
		10, 10 zinc	1000, 1000 100, 100 1, 1
Solubility (μg/ml)	SP	3 lead 2 zinc	300, 30 lead 200, 20 zinc
Diffusion coefficient (cm^2/sec)	DL	10^{-5}	10^{-7}, 10^{-3}, 10^{-1}
LITTER PARAMETER (CERES)			
Decomposition rate constant ($g \cdot g^{-1} \cdot hr^{-1}$)	DMAX	3.5×10^{-4} (fruit) 5.0×10^{-5} (leaf) 1.8×10^{-4} (stem) 1.2×10^{-4} (root)	$\times 10^{+1}$ $\times 10^{-1}$
PLANT PARAMETERS (CERES)			
Phloem resistances (hr)			
Leaf to stem	LSPHLO	20	100, 1
Stem to root	SRPHLO	30	100, 1
Stem to fruit	SFPHLO	500	1000, 100
Respiration rates ($g \cdot g^{-1} \cdot hr^{-1}$)			
Root	RRESTD	1.8×10^{4}	$\times 10^{1}$, $\times 10^{-1}$
Stem	SRESTD	1.9×10^{-4}	$\times 10^{1}$, $\times 10^{-1}$
Leaf	LRESTD	1.8×10^{-4}	$\times 10^{1}$, $\times 10^{-1}$
Fruit	FRESTD	1×10^{-4}	$\times 10^{1}$, $\times 10^{-1}$
Leaf area to weight ration (cm^2/g)	ARI	100	200, 50
Water potential effects (bars)	EI	4	2, 6
Root radius (cm)	R	0.05	5, 0.5, 0.005
Maximum leaf storage (g/m^2)	L MAX	420	210, 42
Ambient CO_2 concentration (ml/ml)	CO2X	3.2×10^{-4}	x2, x3, x4
PLANT UPTAKE PARAMETERS (DRYADS)			
Leaf cuticle permeability (cm/sec)	PERM	10^{-11}	10^{-1}, 10^{-9} 10^{-10}, 10^{-13}
Cuticle thickness (cm)	FILM	10^{-4}	10^{-2}, 10^{-5}, 10^{-6}
Root solute conductivity (cm/sec)	CONDUC	10^{-8}	10^{-6}, 10^{-10}, 10^{-12}
External SO_2 concentration (ml/ml)	GASEX	2×10^{-8}	2×10^{-7}, 2×10^{-9}

[a] The standard value was multiplied by the given number as indicated by x.

Table 2. Model output variables considered in this study

EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER	EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER	EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER	EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER
ROOT BIOMASS (G/M**2 LAND)	LEAF BIOMASS (G/M**2 LAND)
FRUIT BIOMASS (G/M**2 LAND)	STEM BIOMASS (G/M**2 LAND)
ROOT RESPIRATION (G/M**2 LAND/HR)	LEAF RESPIRATION (G/M**2 LAND/HR)
FRUIT RESPIRATION (G/M**2 LAND/HR)	STEM RESPIRATION (G/M**2 LAND/HR)
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)	LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)	CO2 CHLOROPLAST (ML/ML)
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)	LEAF LEAD CONCENTRATION (UG/G)
LEAF ZINC CONCENTRATION (UG/G)	LEAF SULFUR CONCENTRATION (UG/G)
FRUIT LEAD CONCENTRATION (UG/G)	FRUIT ZINC CONCENTRATION (UG/G)
FRUIT SULFUR CONCENTRATION (UG/G)	STEM LEAD CONCENTRATION (UG/G)
STEM ZINC CONCENTRATION (UG/G)	STEM SULFUR CONCENTRATION (UG/G)
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)	STEM HEARTWOOD ZINC CONCENTRATION (UG/G)
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)	ROOT LEAD CONCENTRATION (UG/G)
ROOT ZINC CONCENTRATION (UG/G)	ROOT SULFUR CONCENTRATION (UG/G)
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)	ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)	LEAD IN STEM LITTER (UG/M**2 LAND)
ZINC IN STEM LITTER (UG/M**2 LAND)	SULFUR IN STEM LITTER (UG/M**2 LAND)
LEAD IN FRUIT LITTER (UG/M**2 LAND)	ZINC IN FRUIT LITTER (UG/M**2 LAND)
SULFUR IN FRUIT LITTER (UG/M**2 LAND)	LEAD IN ROOT LITTER (UG/M**2 LAND)
ZINC IN ROOT LITTER (UG/M**2 LAND)	SULFUR IN ROOT LITTER (UG/M**2 LAND)
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)	ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)	LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)	SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)
LEAD CONTENT IN ROOT XYLEM (UG/M**2)	ZINC CONTENT IN ROOT XYLEM (UG/M**2)
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)	LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)	SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)	ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)	LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)	SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)	ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)	LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)	SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)	ZINC INPUT TO STEM LITTER (UG/M**2/DAY)
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)	LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)	SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)	ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)	SO2 UPTAKE (UG/CM**2 LEAF/DAY)
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)	ZINC LEACHED FROM LEAVES (UG/M**2/DAY)
LEAD UPTAKE BY LEAVES (UG/M**2/DAY)	ZINC UPTAKE BY LEAVES (UG/M**2/DAY)
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD (UG/M**2 LAND/HR)	LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC (UG/M**2 LAND/HR)
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR (UG/M**2 LAND/HR)	STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD (UG/M**2 LAND/HR)
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC (UG/M**2 LAND/HR)	STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR (UG/M**2 LAND/HR)
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD (UG/M**2 LAND/HR)	STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC (UG/M**2 LAND/HR)
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR (UG/M**2 LAND/HR	STEM TO LEAF XYLEM TRANSPORT OF LEAD (UG/M**2 LAND/HR)
STEM TO LEAF XYLEM TRANSPORT OF ZINC (UG/M**2 LAND/HR)	STEM TO LEAF XYLEM TRANSPORT OF SULFUR (UG/M**2 LAND/HR)
ROOT TO STEM XYLEM TRANSPORT OF LEAD (UG/M**2 LAND/HR)	ROOT TO STEM XYLEM TRANSPORT OF ZINC (UG/M**2 LAND/HR)
ROOT TO STEM XYLEM TRANSPORT OF SULFUR (UG/M**2 LAND/HR)	ROOT UPTAKE OF LEAD - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)
ROOT UPTAKE OF ZINC - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)	ROOT UPTAKE OF LEAD - DARK PERIOD (UG/M**2/DAY)

initial two-month period of the simulations to allow the model to stabilize. Daily values were output for the entire month of July, and hourly values were recorded for a period of eight days (16th-24th) during July for sensitivity and statistical analysis.

Two indices of variation were computed for each response over time for all sensitivity runs. The first, termed a relative output coefficient (r), measures the output response with respect to the standard response and has similarities with the χ^2 statistical test.

$$r_j^{(k)} = \sum_{i=1}^{T} \left[\frac{a_{ij}^{(k)} - e_{ij}}{e_{ij}} \right]^2 ,$$

where

e_{ij} = response of the j-th output parameter for i-th time step in the standard run,

$a_{ij}^{(k)}$ = response of the j-th output parameter for the i-th time step in sensitivity run k,

T = total number of time steps, and

$r_j^{(k)}$ = relative output coefficient for the j-th output parameter in the k-th sensitivity run.

The relative output coefficient is a measure of deviance of one output parameter between any sensitivity run and the standard run. A small variation in $r_j^{(k)}$ indicates little relationship between the parameters varied in sensitivity run k and output parameter j. The second index relates the change in output to the change in input and is called a sensitivity coefficient.

$$S_j(k) = \sum_{i=1}^{T} \frac{a_{ij}^{(k)} - e_{ij}}{v_k - v} ,$$

where

v_k = value of input parameter that was varied for the k-th sensitivity run,

v = value of parameter used in the standard run, and

$S_j(k)$ = sensitivity coefficient for k-th sensitivity run and the j-th parameter.

The sensitivity coefficient relates the variation in output parameter j to the variation of the input parameter from the standard. Since the output parameters are a function of the input parameters, $S_j(k)$ can be viewed as a measure of the slope of that function. However, because the variation in input parameters was sometimes large, the estimation as a slope is not reliable. The variation of input parameters was chosen to represent realistic values. Tables of these coefficients for each variation of input parameters are in the Appendix.

The effect of changing each of the parameters on the system being modeled is investigated by plotting the heavy metal contaminant concentration for each of the components: plants, litter, and soil. Let T = total heavy metal content in the entire system and T_p, T_e, and T_s represent the total heavy metal content in plants, litter, and soil. The fraction of chemical in a component is

$$F_i = \frac{T_i}{T} ,$$

where i can be p, l, or s for the plant, litter, or soil component. The value of F_i can be calculated for each change in a parameter to investigate the effects on chemical distribution for each variation. The distribution within each component is also examined by considering subcomponents of plant, litter, and soil. The subcomponents of the plant are root, stem, leaf, and fruit; for the litter they include the storage and mineral subcompartments; and for soil there are the three soil layers (0-3, 3-15, and 15-90 cm in depth). The fraction of the chemical content in each subcomponent is

$$f_j = \frac{tj}{T_i} \quad ,$$

where f_j is the fraction in subcomponent j, t_j is the content of heavy metal in subcomponent j, and T_i is the content in corresponding component i. For example, the fraction of chemical in the subcomponent roots is the content in the root system divided by the content in the whole plant. All fractions, F_i and f_j, are represented in one plot for the variation in an input parameter. In Fig. 6 the subgraph (on left, entitled "overall fraction") displays the values of F_i for the four values (increasing from left to right) of K_d investigated. The length of the bars represents the fraction. The combined lengths for the three components is 1.0 for each K_d value.

In the example, the largest fraction of lead, is in the litter. The fraction of lead in the plant decreases for increasing K_d; the soil has increased its proportion. The other subgraphs (on right) represent the fraction of lead in each subcomponent. The labels to the

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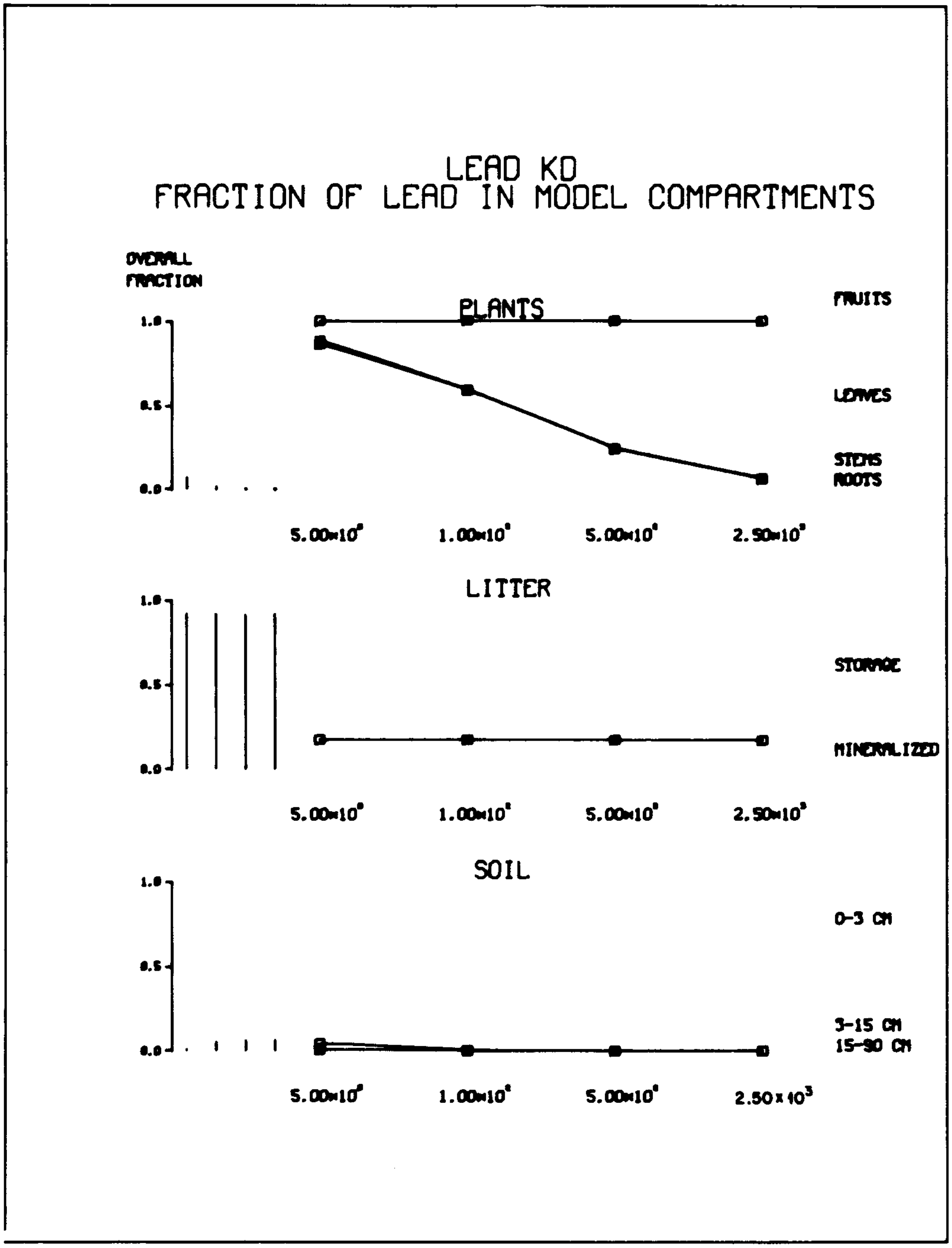

Fig. 6. Relative lead distribution in plant, litter, and soil components with change in lead distribution coefficient (KD).

right describe the subcomponent division; the distance between successive markers at each K_d value is the subcomponent fraction. Note that the uppermost and lowermost subcomponents (e.g., fruits and roots for the plant component) have chemical fractions represented by the distance from the 1 and 0 boundary lines (not shown) to the nearest graph line respectively. Table 3 gives the values represented in the plot as a guide to interpretation of the figure. Tabulated data will not be presented for later figures. Figure 7 shows results for zinc distribution in components and subcomponents as influenced by change in Kd. The interpretation of this figure is the same as described for Fig. 6.

Referring again to the example plot (Fig. 6), the roots contain the greatest fraction of lead within the plant for the lowest K_d value, but the leaves contain the greatest proportion at the highest K_d level. The stems and fruits contain a very small fraction of the lead. The proportion between stored and mineralized lead in the litter remains unchanged for varying K_d. The proportion in the soil layer shows only a small change in the proportion of exchanged lead in the second layer (3-15 cm) for the smallest K_d value.

The data are also plotted by the variation of one response over time for different input parameters. Daily (Fig. 8) and hourly (Fig. 9) responses are plotted versus time for variations in the parameter investigated. Although the amount of data is too extensive for all of the output to be examined in this manner, some individual plots can give insight into the overall responses indicated by the relative output and sensitivity coefficients.

Table 3. Chemical fractions for components (F) and subcomponents (f) of the soil-plant-litter system as influenced by change in chemical distribution coefficient

	Chemical distribution coefficient (ml/g)			
	5	10	500	2500
Component (F)				
Plant	0.07	0.02	0.01	0.01
Litter	0.92	0.92	0.91	0.92
Soil	0.01	0.06	0.08	0.07
Subcomponent (f)				
Leaf	0.10	0.41	0.76	0.94
Stem	0.85	0.00	0.00	0.00
Fruit	0.00	0.00	0.00	0.00
Root	0.05	0.59	0.24	0.06
Litter storage	0.85	0.85	0.85	0.85
Litter minerals	0.15	0.15	0.15	0.15
Soil 0-3 cm	0.96	0.99	0.99	1.00
Soil 3-15 cm	0.04	0.01	0.01	0.00
Soil 15-90 cm	0.00	0.00	0.00	0.00

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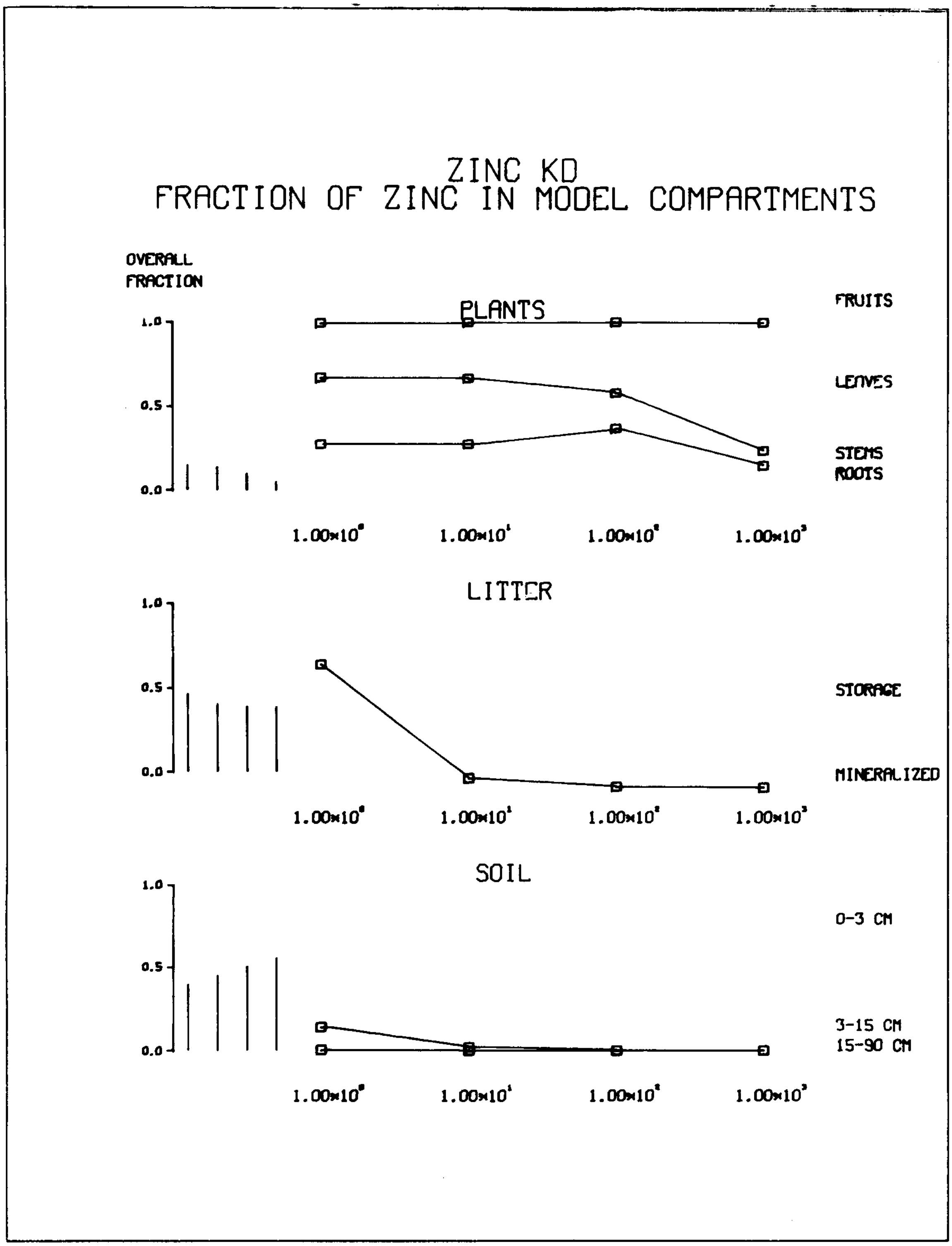


Fig. 7. Relative zinc distribution in plant, litter, and soil compartments with change in zinc distribution coefficients (KD).

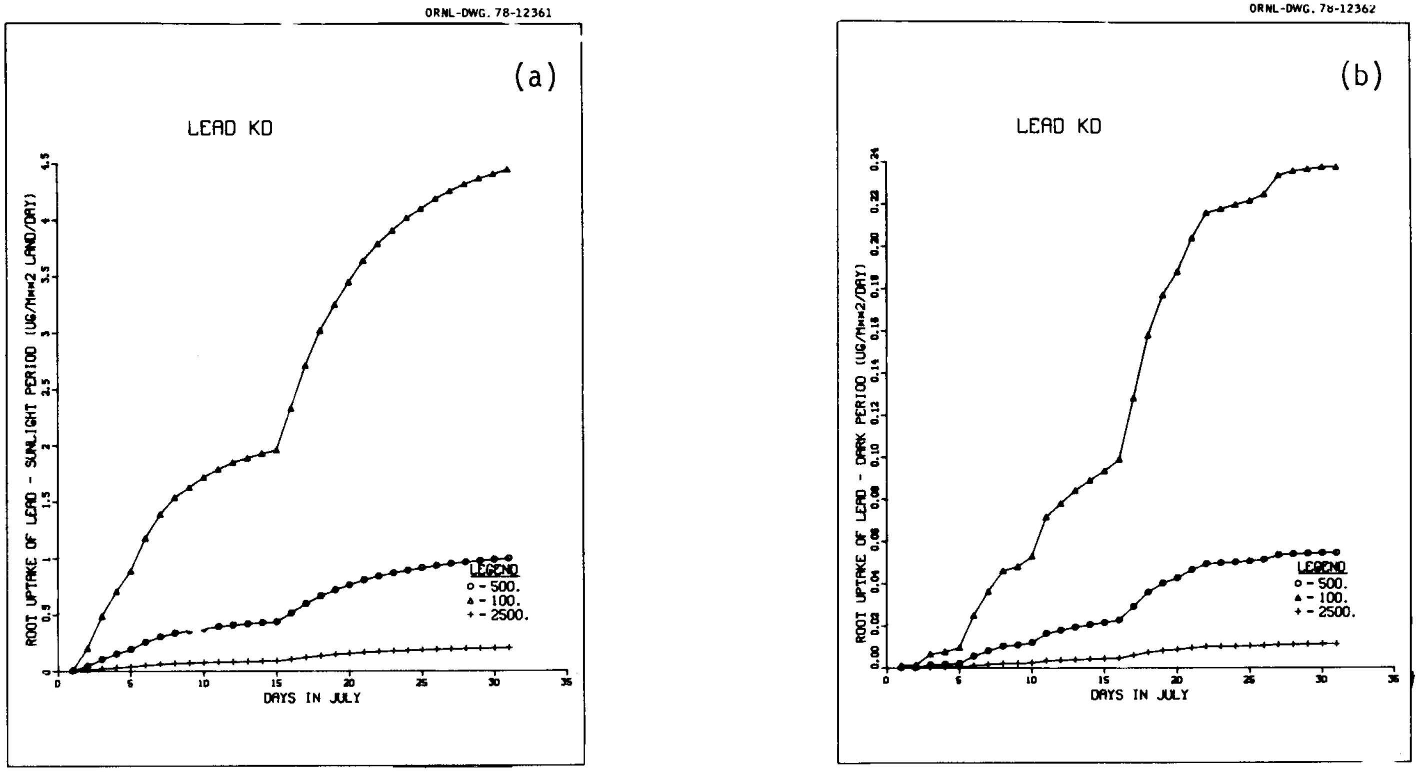


Fig. 8. Influence of lead KD on uptake through roots during: (a) sunlight period, (b) dark period.

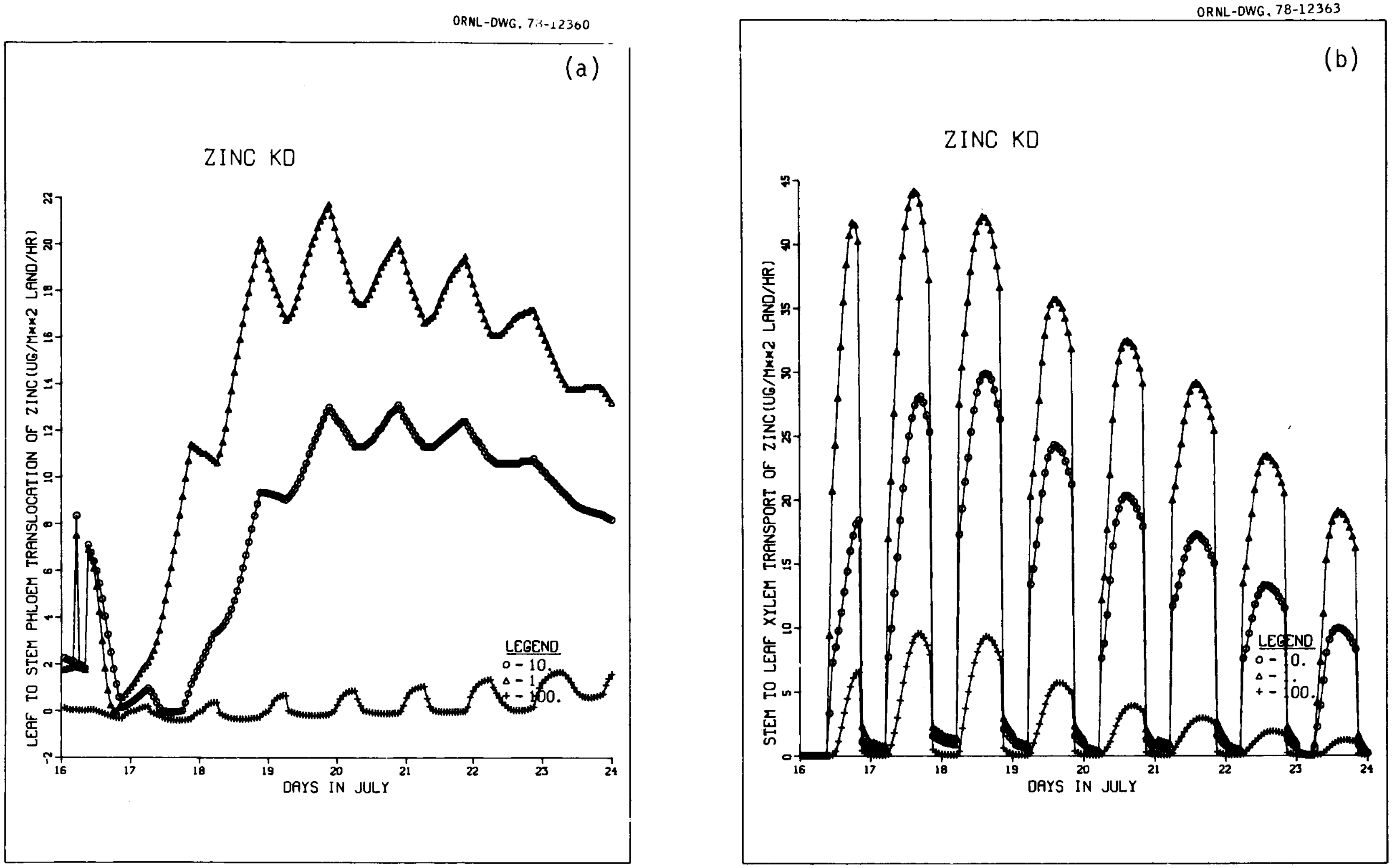


Fig. 9. Influence of zinc KD on zinc transport in the vegetation: (a) leaf to stem phloem, (b) stem to leaf xylem.

RESULTS

Soil and Chemical Parameters

Distribution Coefficient, K_d

The distribution coefficient is the ratio of the amount of contaminant exchanged onto the soil surface per unit soil mass to the amount of contaminant in the soil water per unit soil solution. Increasing this ratio increased the amount on the soil exchange, reduced the soil solution concentration, and thus reduced the total plant uptake (Figs. 6 and 7). A large variation of the fraction of contaminant in the plant parts was also found. The relative contaminant fraction in the leaves increased along with a decrease in both the root and stem contaminant fraction as the K_d increased (Figs. 6 and 7). The mineralized contaminant decreased with increase in zinc K_d, whereas there was little change with increase in lead K_d.

Root uptake of lead increased for both the sunlight (Fig. 8a) and dark (Fig. 8b) periods with decrease in K_d, especially after heavy rain which occurred on July 16. The day time uptake was about 20 times greater than the nocturnal uptake. Zinc root uptake followed a similar pattern.

Hourly plots of phloem (Fig. 9a) and xylem (Fig. 9b) translocation of zinc show greater transport with lower K_d and that phloem translocation can remain at high rates at night. Both transports vary indirectly with K_d. The most sensitive outputs include the chemical content in litter and roots and in the plant xylem transport pathway (Appendix).

Solubility (SP)

The amount of heavy metal contaminant which dissolves in the infiltrating soil water depends on the chemical solubility (SP) and this usually changes for different chemical compounds. The fraction of both lead and zinc in the soil increased with increasing solubility, causing the fraction in the litter to decrease (Figs. 10 and 11). The fraction in each of the separate soil layers and in the biomass was basically unchanged. The overall fraction of lead in the plant increased slightly because of increased root uptake. The fraction of zinc in the plant did not vary, due to the plant having attained near maximum concentrations in each of its tissues. The increase in the litter mineralized fraction resulted from the decrease in total litter content and a mineralization rate proportional to litter decomposition that is independent of solubility. As for the distribution coefficient, the most sensitive outputs to change in SP include the chemical content in litter compartments and in the plant tissue xylem (Appendix).

Diffusion Coefficient (DL)

The diffusion coefficient of the heavy metals is used in determining root uptake. Diffusive uptake increases for increasing values of $\partial a/(DL)b$ where α is the root absorbing power, a is the root radius, DL is the diffusion coefficient, and b is the buffer power (Baldwin et al. 1973). Thus, as DL increases, diffusive uptake decreases. Mass flow uptake is dependent on the transpiration rate, and

ORNL-DWG. 78-12296

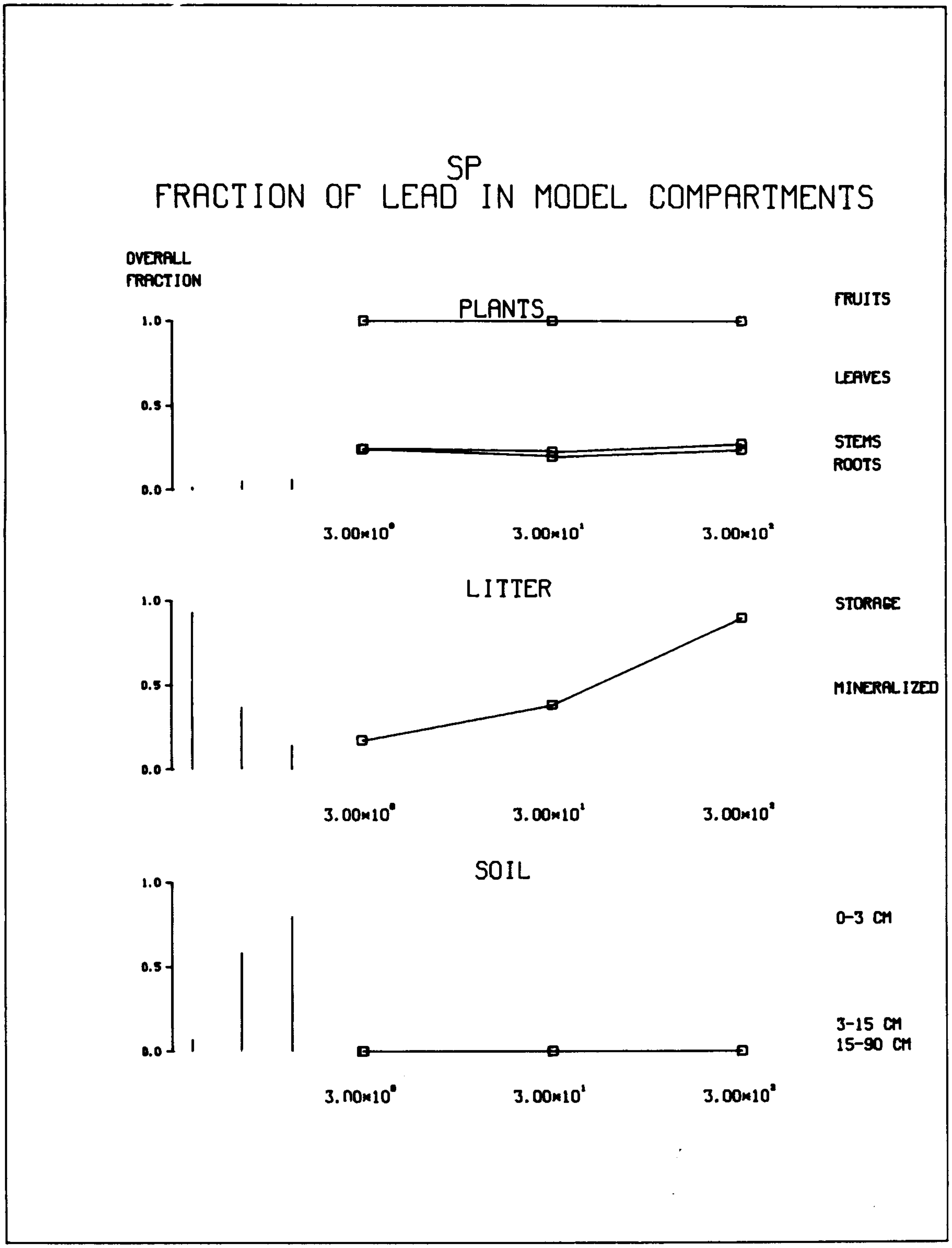


Fig. 10. Relative lead distribution in plant, litter, and soil components with change in lead solubility (SP).

ORNL-DWG. 78-12297R

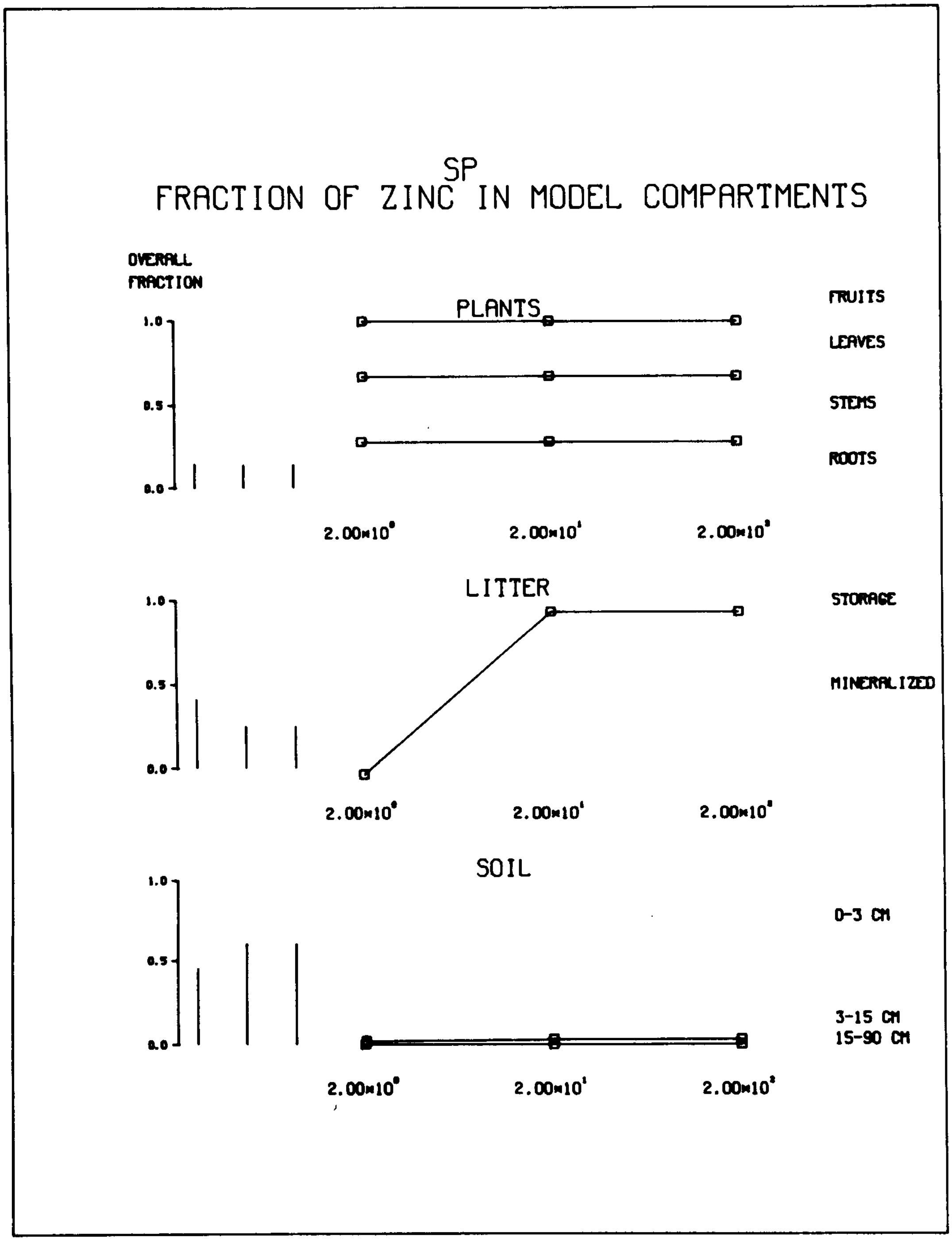


Fig. 11. Relative zinc distribution in plant, litter, and soil components with change in zinc solubility (SP).

the combined mass flow and diffusive uptake will be reduced with increase in diffusion coefficient. These results were shown by Baldwin et al. in their sensitivity analysis of model parameters. In this study, the overall fraction of contaminant in the plant decreased for increasing diffusion coefficient for lead (Fig. 12), but was unchanged for zinc (Fig. 13) because the vegetation was at maximum internal zinc concentration. This explained the differing rates of chemical uptake for zinc and lead. Hourly plots of root uptake during the day show greater rates for lead with decrease in DL (Fig. 14a) whereas zinc uptake was a reverse response (Fig. 14b). However, maximum root uptake for zinc occured at the lowest value of DL (Fig. 13). Zinc content in litter and plant xylem tissues showed the greatest sensitivity to change in DL (Appendix). The most sensitive response for lead was in the lead concentration of roots.

Litter Parameter

Decomposition Rate Constant (DMAX)

The rate of material decomposed in each of the litter compartments is a function of temperature and input values for the decomposition rate constant. Chemical mineralization from litter is proportional to the decomposition rate. Thus, an increase of the rate constant increased the amount of lead and zinc mineralization (Fig. 15 and 16). There was no change in overall chemical content in litter. The litter mineralization of chemical was the most sensitive output response (Appendix).

ORNL-DWG. 78-12298

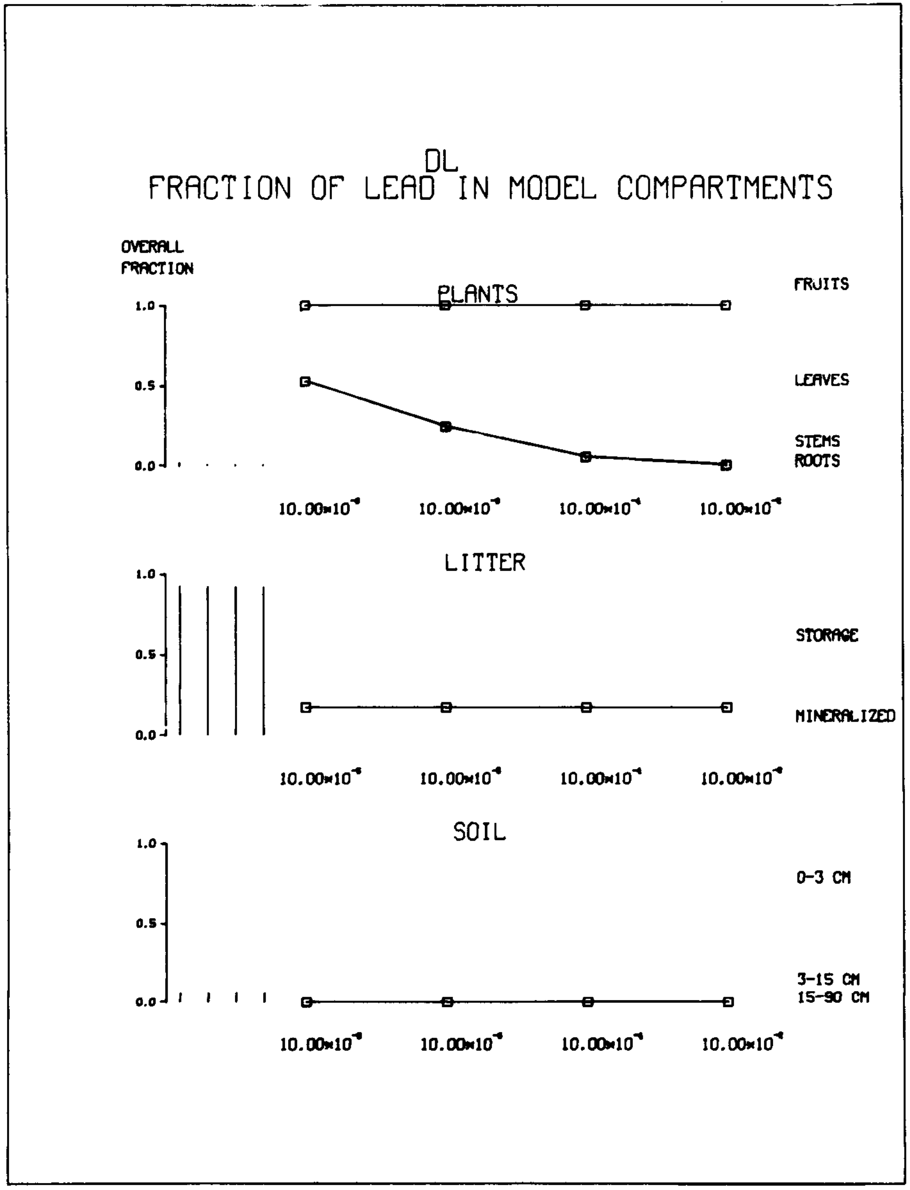


Fig. 12. Relative lead distribution in plant, litter, and soil components with change in diffusion coefficient of lead (DL).

ORNL-DWG. 78-12299

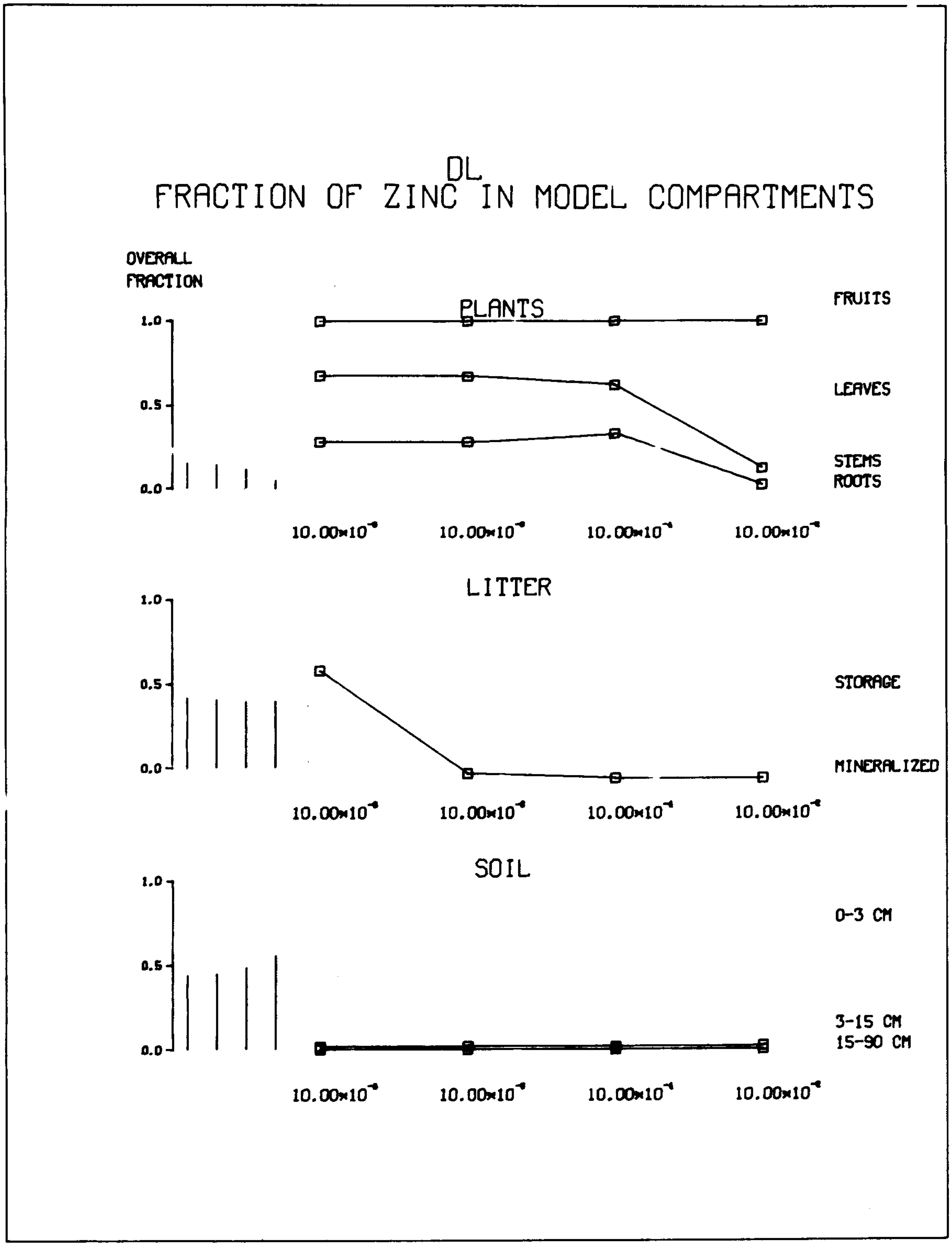


Fig. 13. Relative zinc distribution in plant, litter, and soil components with change in diffusion coefficient of zinc (DL).

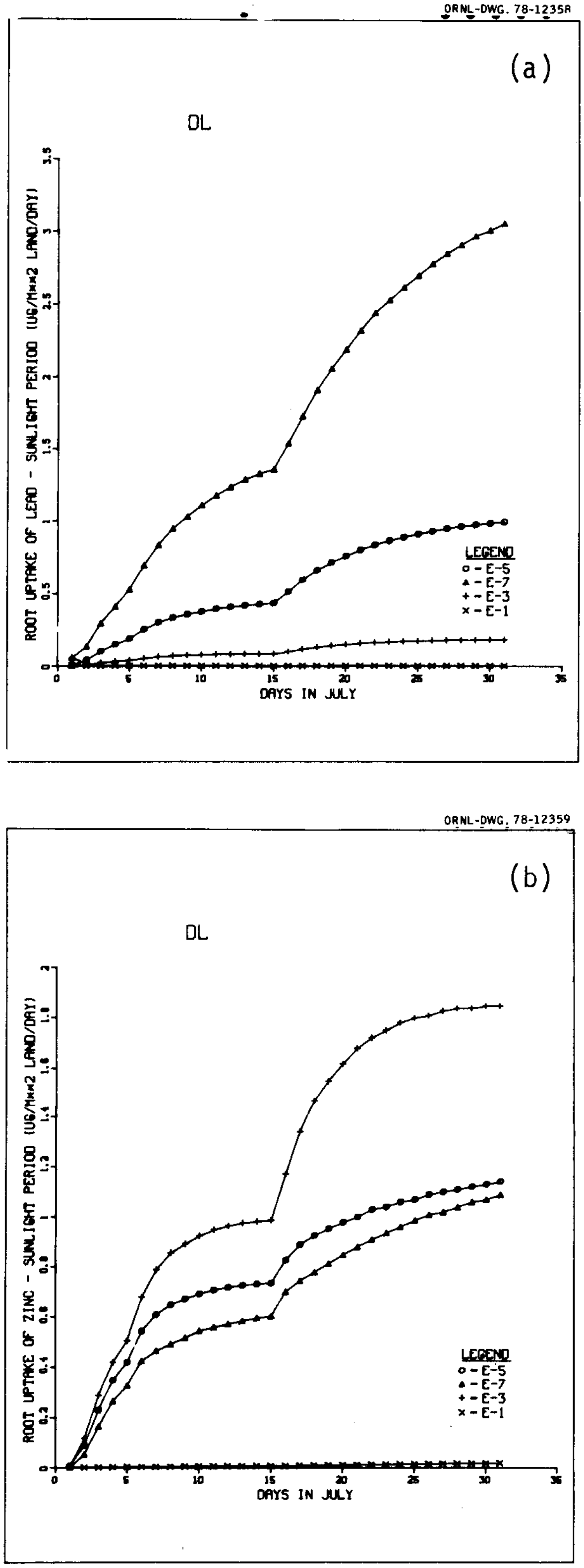


Fig. 14. Influence of chemical diffusion coefficient (DL) on root uptake of chemical during the sunlight period: (a) lead, (b) zinc.

ORNL-DWG. 78-12300

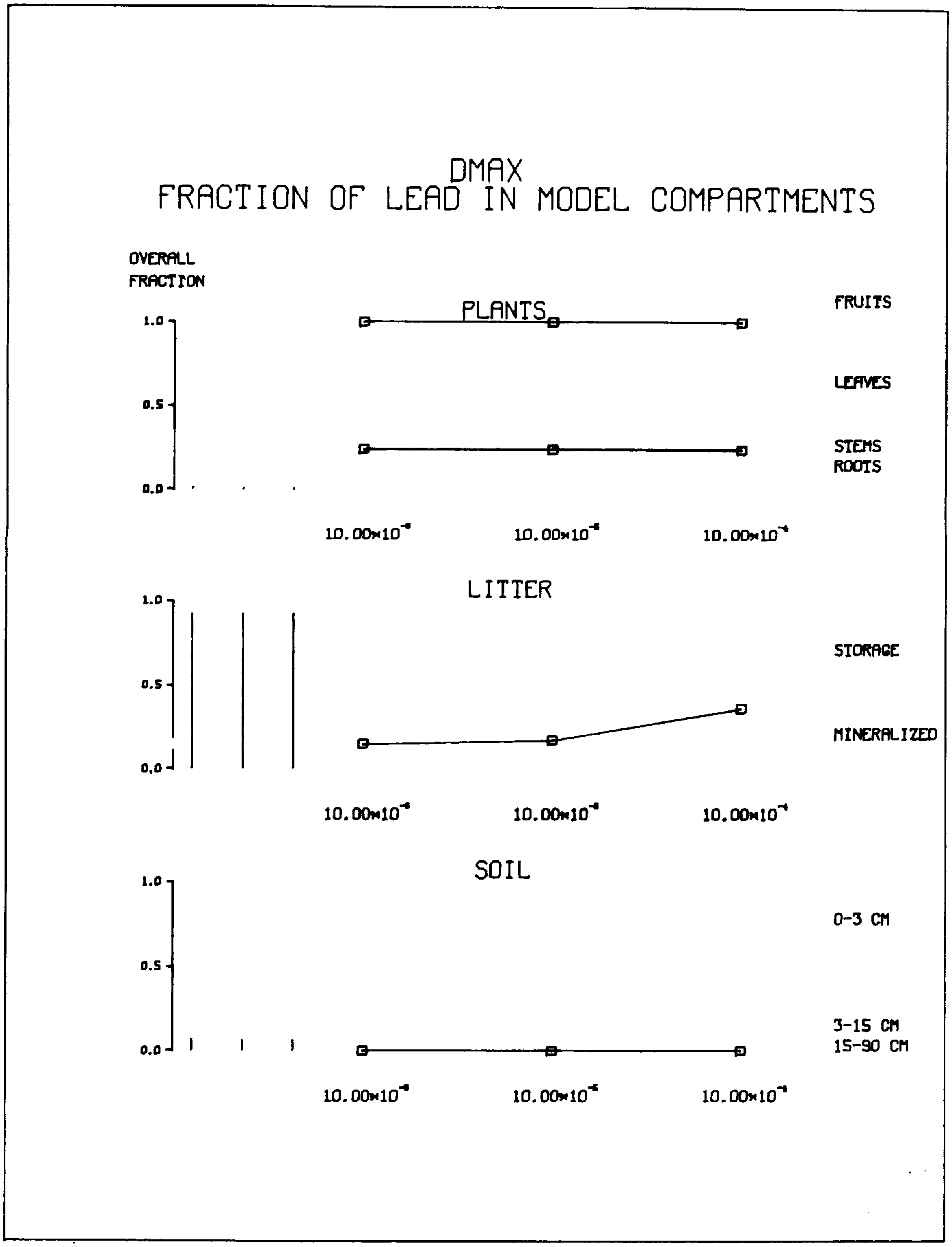


Fig. 15. Relative lead distribution in plant, litter, and soil components with change in litter decomposition rate constant (DMAX).

ORNL-DWG. 78-12301

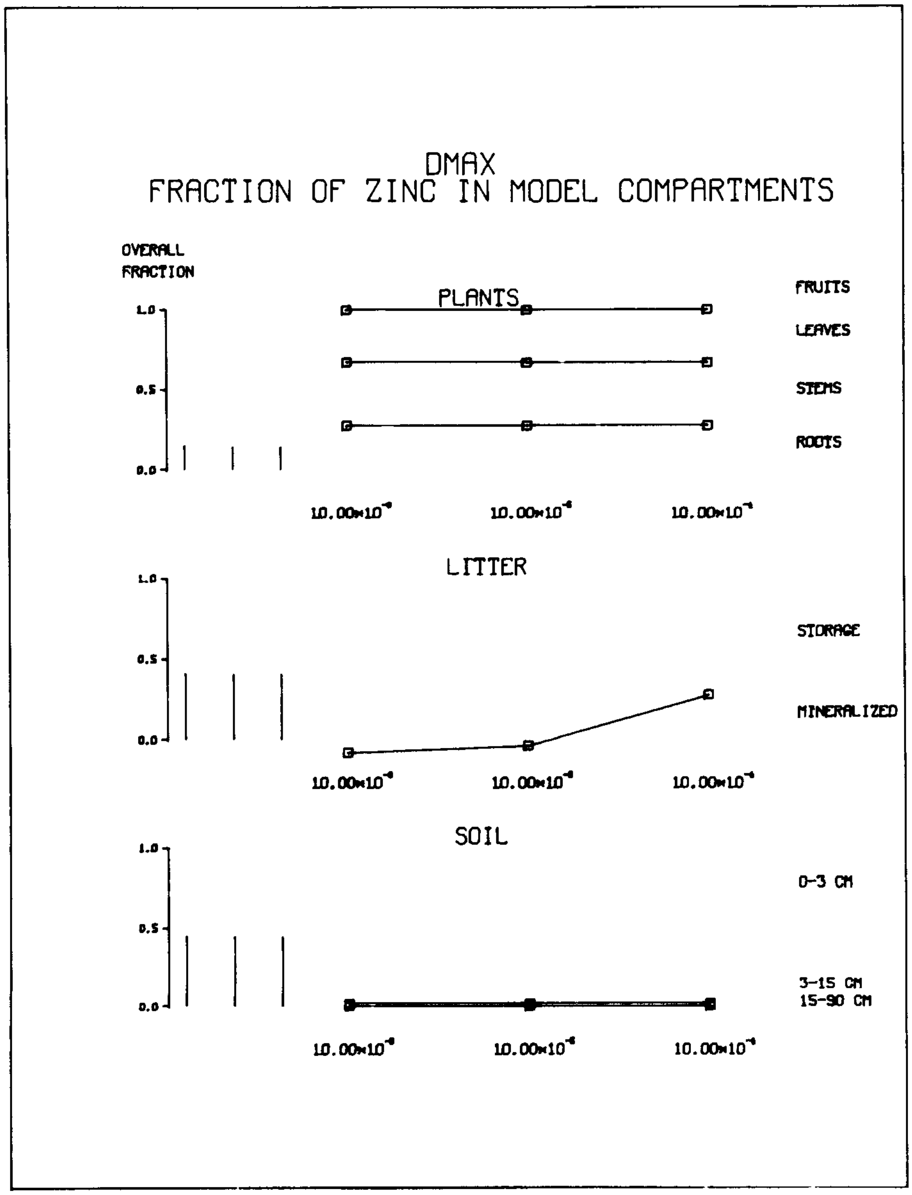


Fig. 16. Relative zinc distribution in plant, litter, and soil components with change in litter decomposition rate constant (DMAX).

Internal Plant Parameters

Phloem resistances (LSPHLO, SRPHLO, SFPHLO)

The rate of transport of sugar substrate between plant compartments is proportional to the substrate gradient and a phloem resistance factor (Dixon et al. 1976). Leaf-to-stem (LSPHLO), stem-to-root (SRPHLO), and stem-to-fruit (SFPHLO) resistances are all used in the CERES model. Increase in the leaf-to-stem phloem resistance reduced total growth and changed the relative biomass distribution of the plant. At higher resistances, there was greater leaf growth and lower stem growth (Fig. 17). The differences in biomass resulted in corresponding changes in contaminant uptake (Fig. 18). Lower resistance caused greater phloem chemical movement which is indicated by the higher sulfur content in roots supplied from leaf uptake (Fig. 19) and also in the hourly plot of zinc translocation rate (Fig. 20).

Increase in the stem-to-root phloem resistance slightly reduced total growth and changed the relative biomass distribution (Fig. 21). Although total contaminant uptake was highest at the lowest resistance there were changes in the relative uptake via leaves and roots. At high resistance, there was greater relative root uptake. Rather high leaf uptake (due to high standard value of PERM) and reduced transport to other plant components at high phloem resistance caused leaf concentration to be high. Mortality of these leaves increased the litter contaminant level and the rate of zinc mineralization (Fig. 22). Thus, a stem-root plant property influenced chemical dynamics in litter.

ORNL DWG. 78-12302

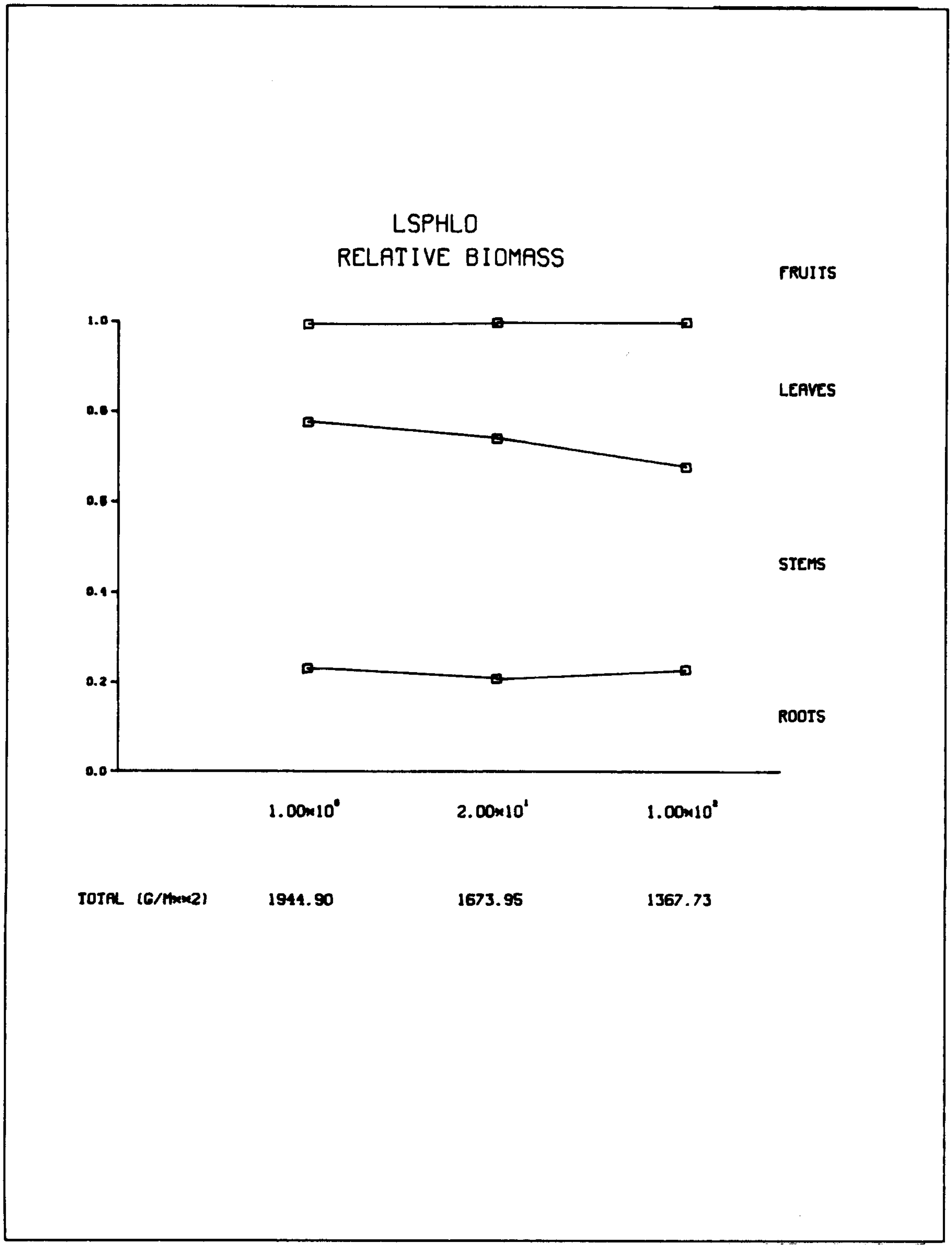
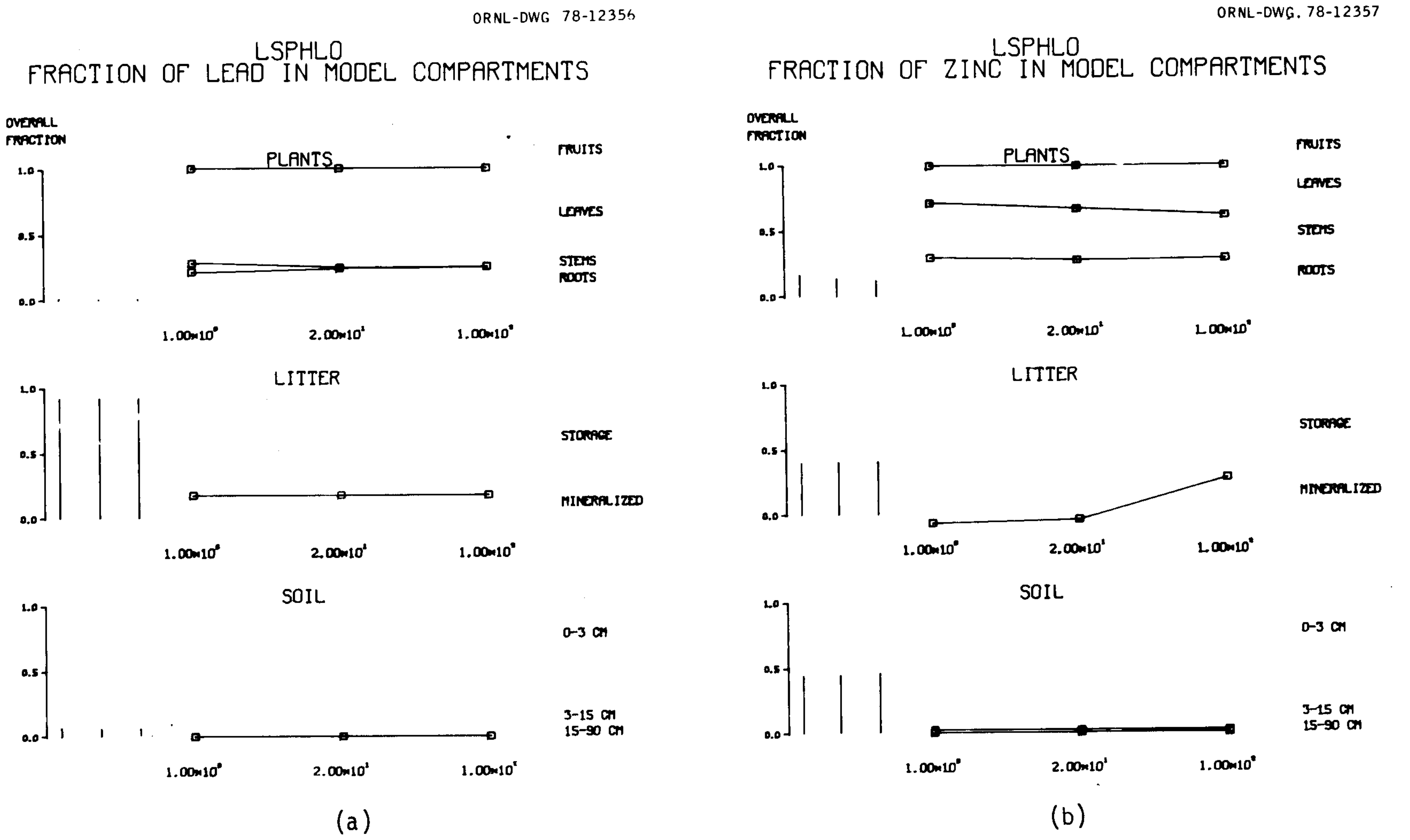


Fig. 17. Relative biomass distribution of plant components with change in leaf-to-stem phloem resistance (LSPHLO).



(a) (b)

Fig. 18. Relative chemical distribution in plant, litter, and soil components with change in leaf-to-stem phloem resistance (LSPHLO) for (a) lead, (b) zinc.

ORNL-DWG. 78-12303

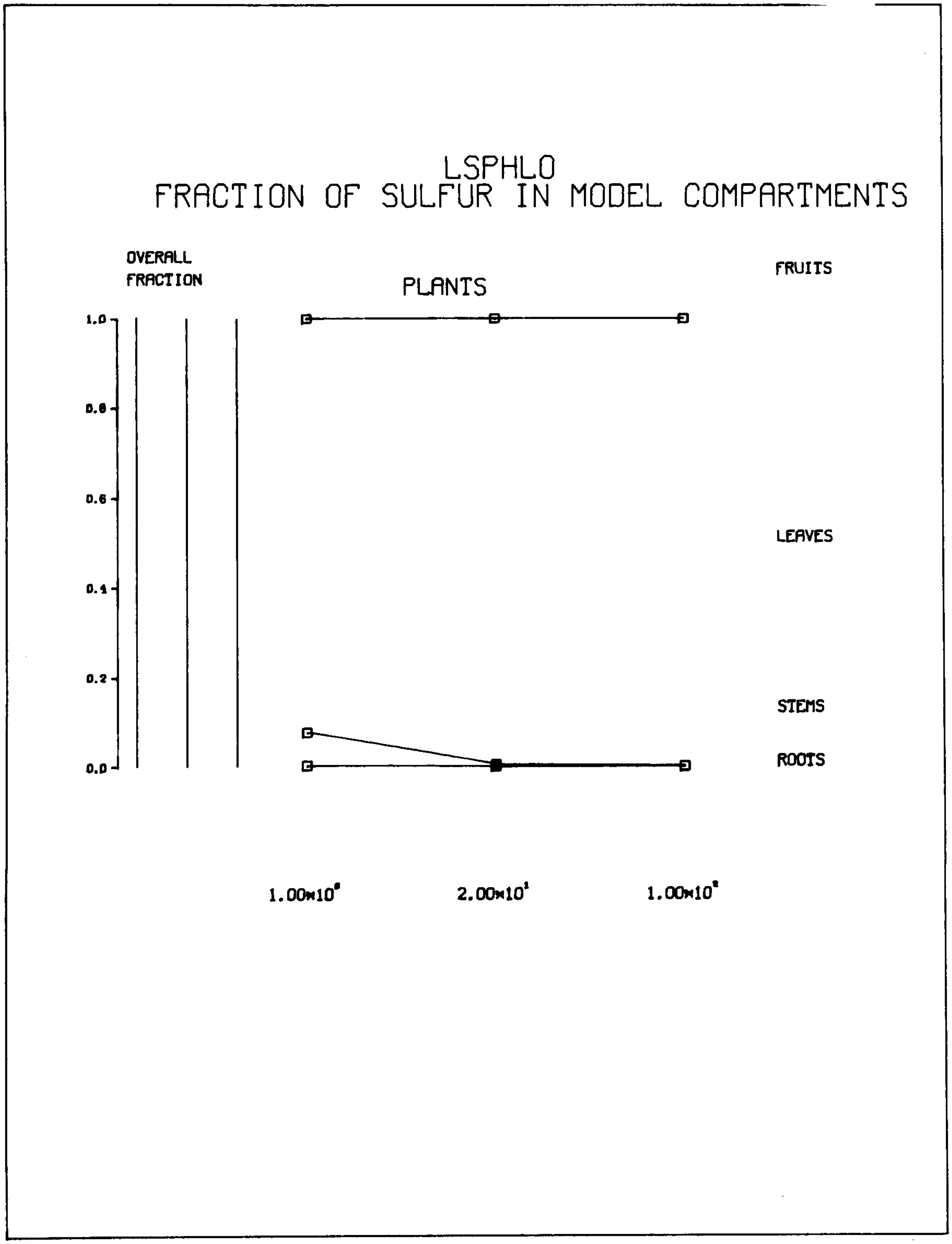


Fig. 19. Relative sulfur distribution in plant components with change in leaf-to-stem phloem resistance (LSPHLO).

ORNL-DWG. 78-12304

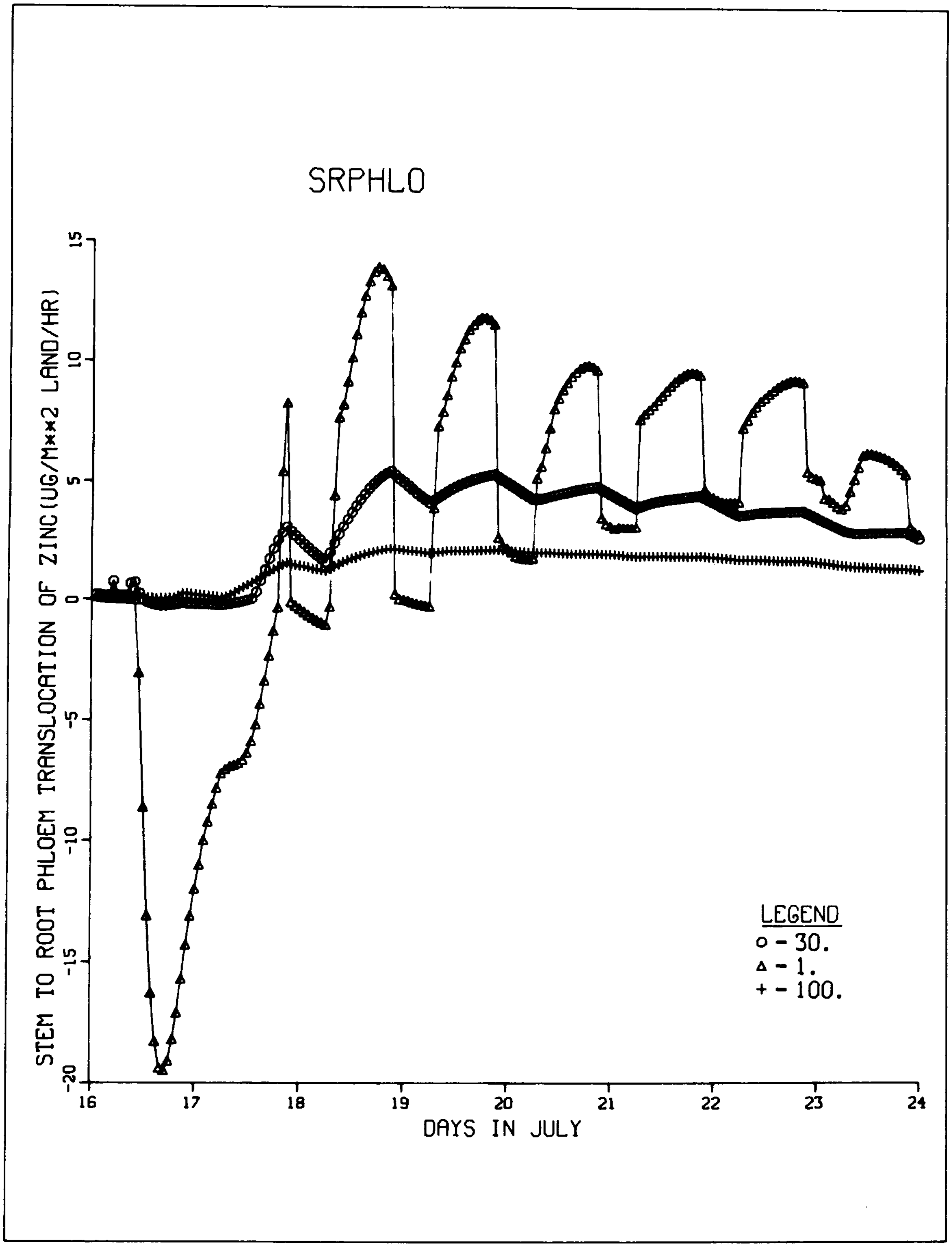


Fig. 20. Influence of stem-to-root phloem resistance (SRPHLO) on zinc translocation in stem-to-root phloem.

ORNL-DWG. 78-12305

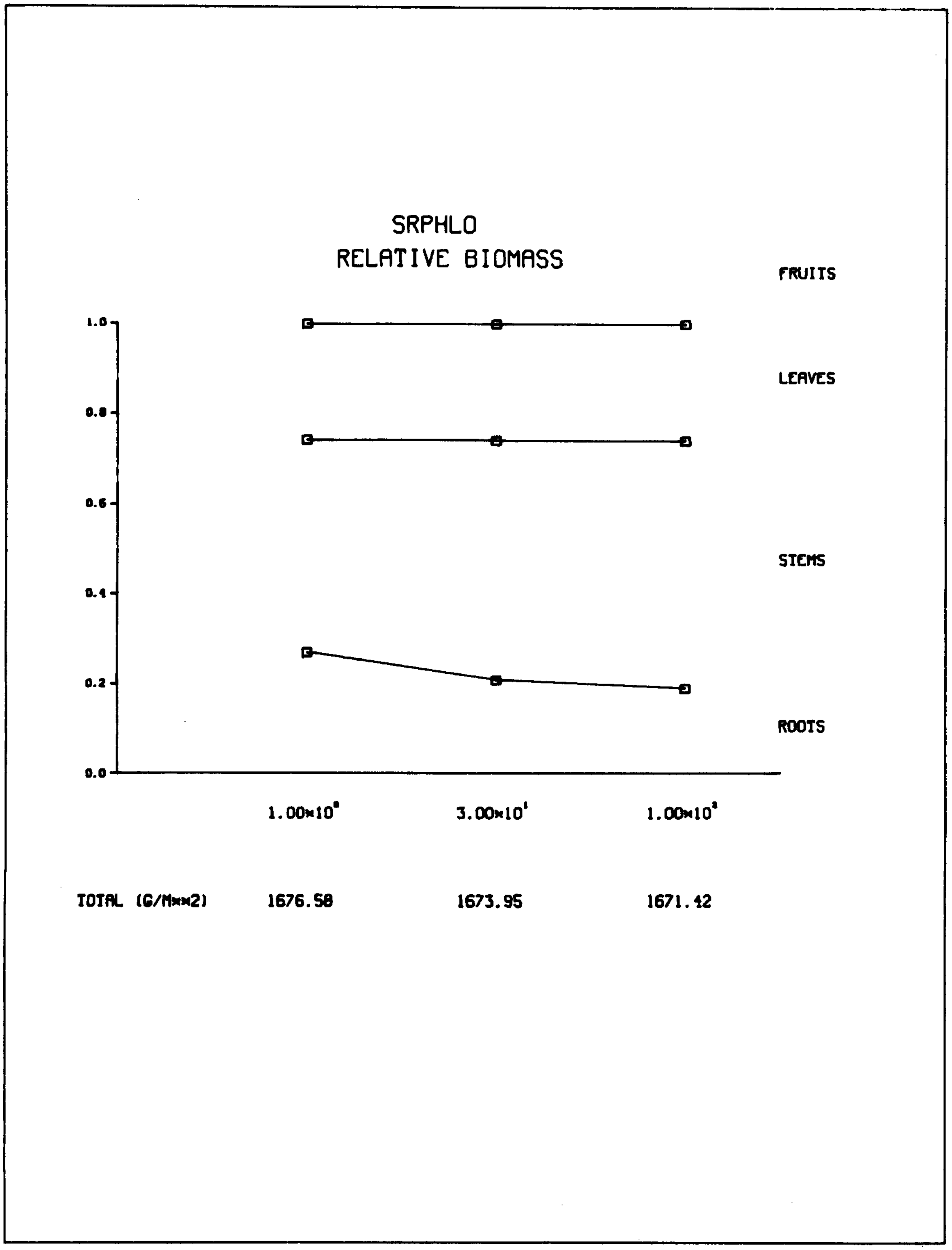


Fig. 21. Relative biomass distribution of plant components with change in stem-to-root phloem resistance (SRPHLO).

ORNL-DWG. 78-12306

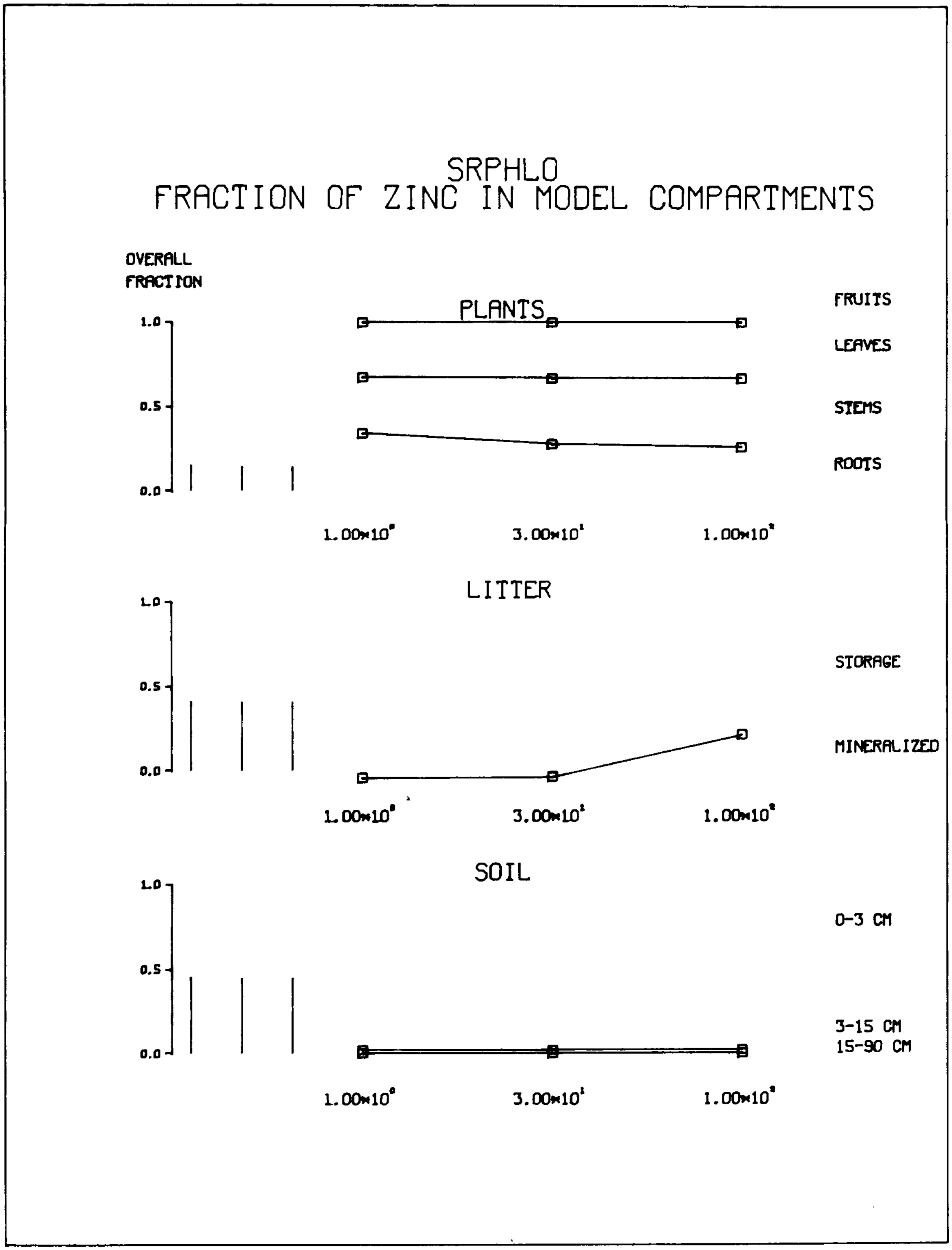


Fig. 22. Relative zinc distribution in plant, litter, and soil components with change in stem-to-root phloem resistance (SRPHLO).

The phloem translocation of chemicals was directly influenced by change in phloem resistance and this was shown in the output responses (Appendix). Sulfur dioxide gas uptake was influenced by LSPHLO. The zinc content in the root litter was very sensitive to both LSPHLO and SRPHLO.

The stem-to-fruit resistance had the smallest effect on plant growth and contaminant uptake and there were no noticeable differences.

Standard Respiration Rates (RRESTD, SRESTD, LRESTD, FRESTD)

The respiration rates determine the loss of sugar substrates from the plant parts. The total respiration of each plant compartment was doubled for each 10° C rise in temperature ($Q_{10} = 2.0$). Input values for standard tissue respiration rates at given temperatures were used for the Q_{10} functions. Total biomass decreased with increase in the standard root respiration rate and the relative proportion of roots decreased (Fig. 23).

The root contaminant uptake increased as the root biomass increased for decreased standard root respiration rate (Fig. 24a,b). At the two lower standard respiration rate values, zinc uptake became limited by the plant capacity for more chemical and the plant compartments approached maximum chemical content. Lead uptake did not approach maximum capacity and the roots showed a preferential retention of lead for the highest standard respiration rate case. The large proportion of lead in leaves was due to leaf uptake.

Zinc uptake definitely decreases with greater stem respiration rates (Fig. 25) whereas there is little change for lead. Because of the decrease in stem biomass, a greater fraction of the zinc stays in

ORNL-DWG. 78-12307

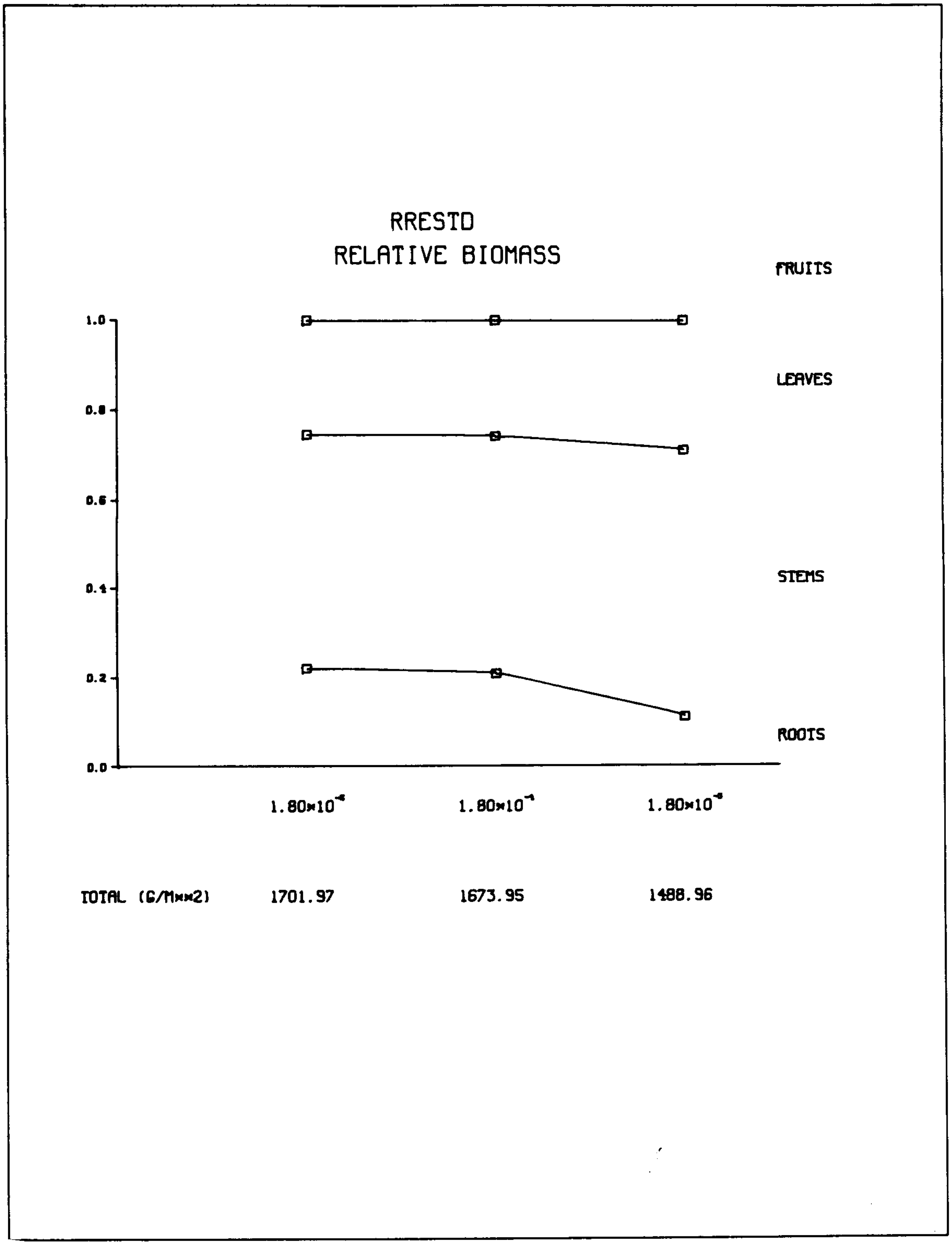


Fig. 23. Relative biomass distribution of plant components with change in standard root respiration rate (RRESTD).

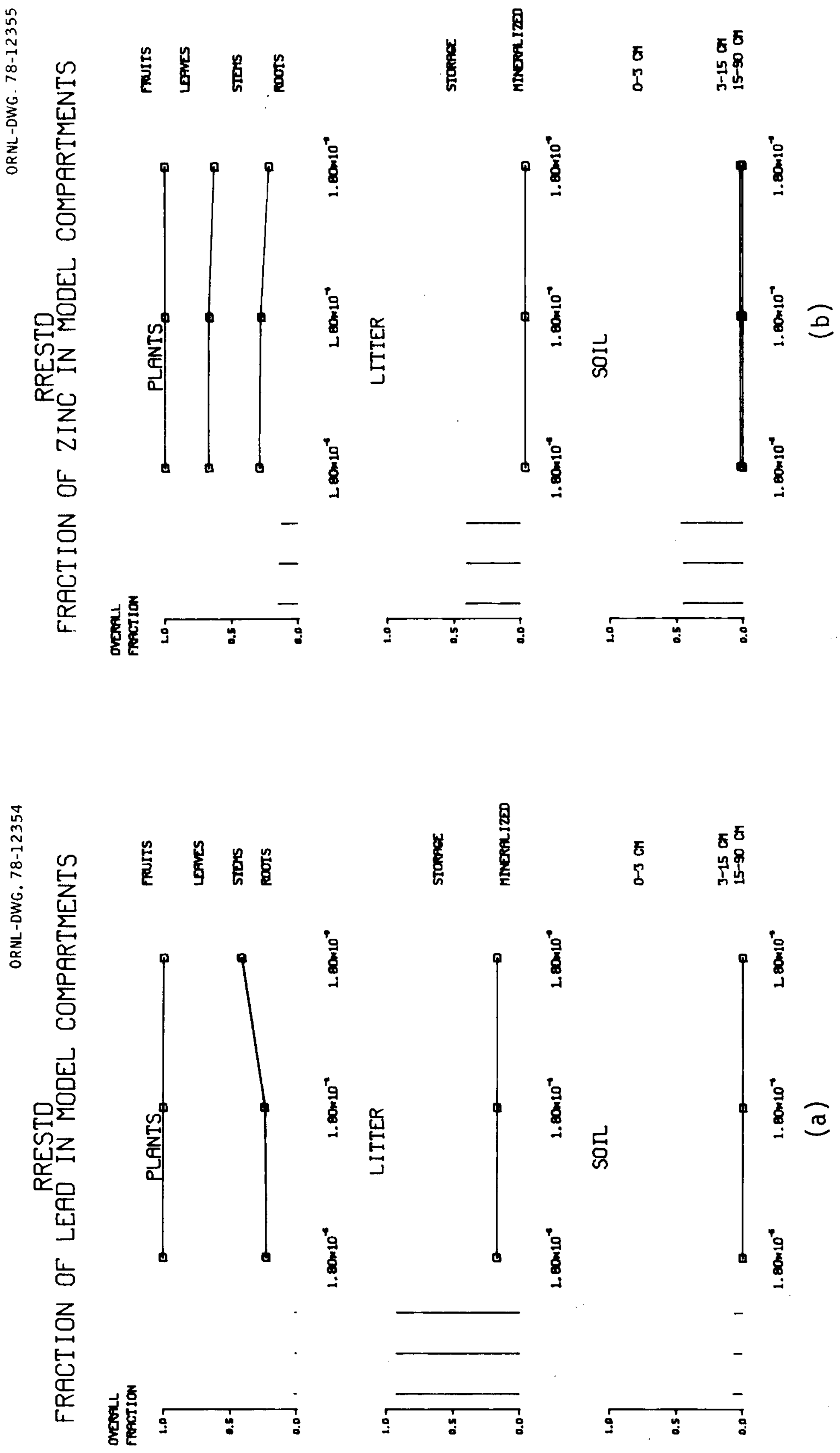


Fig. 24. Relative chemical distribution in plant, litter, and soil components with change in standard root respiration rate (RRESTD) for (a) lead, (b) zinc.

ORNL-DWG. 78-12308

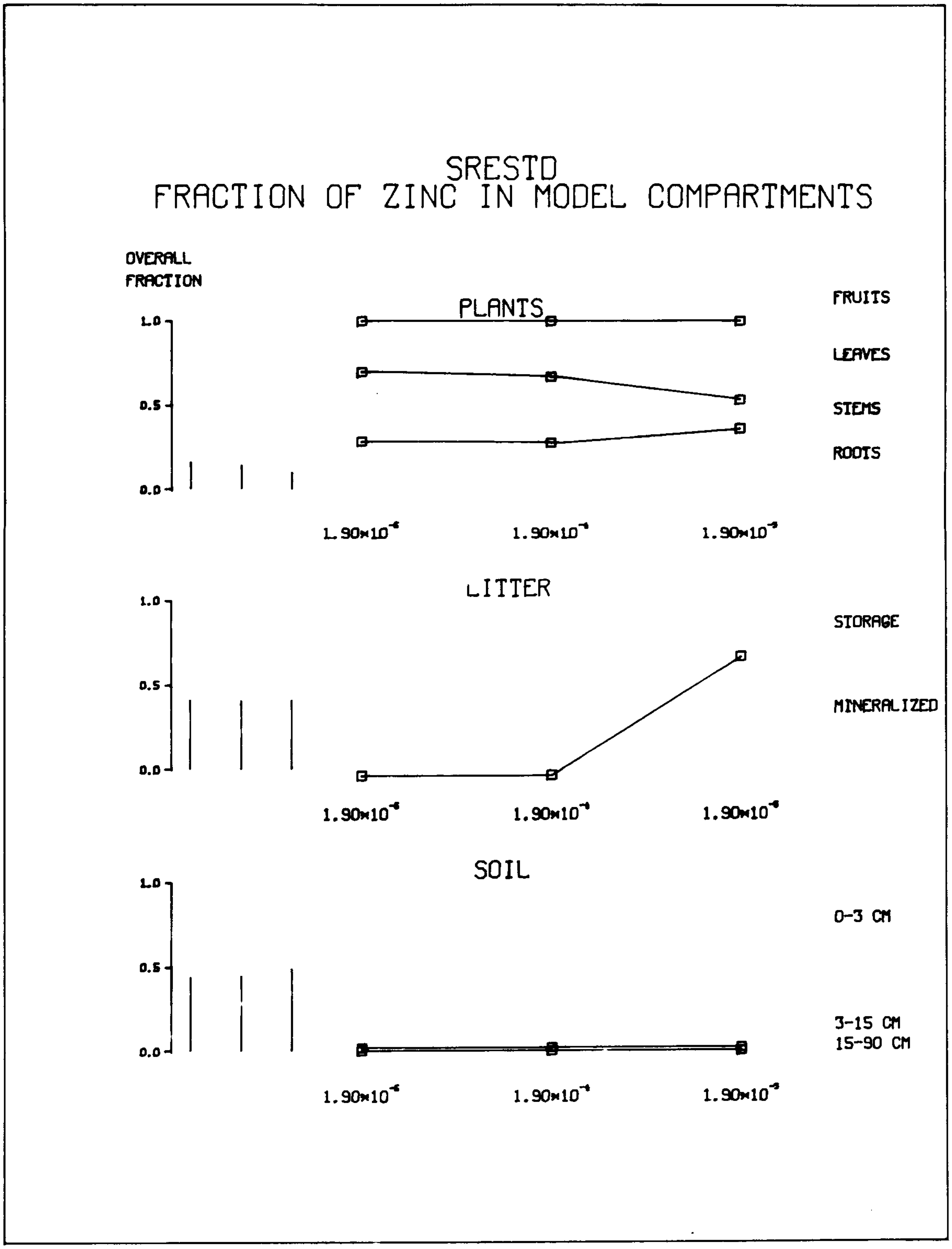


Fig. 25. Relative zinc distribution in plant, litter, and soil components with change in standard stem respiration rate (SRESTD).

the roots and leaves. The mortality of leaves with high contaminant levels increases the litter contaminant mineralization (Fig. 25).

Both leaf and fruit respiration rates caused little change in the overall fraction of contaminant in the plant. There was a small decrease in amount of zinc in the plant for higher leaf respiration rates. The difference in respiration rates influenced a large number of plant and chemical output responses. The most significant response to the RRESTD, SRESTD, LRESTD, and FRESTD factors were root lead concentration, zinc content in leaf xylem, SO_2 uptake, and fruit zinc concentration respectively (Appendix). Changes in stem-to-root translocation of zinc was induced by changes in biomass at the different respiration rate of roots (Fig. 26). Stem-to-root sugar translocation was highest for the largest standard stem respiration rate (Fig. 27). The chemical transport showed complex interaction effects during the July 16-18th period (Fig. 27) in response to rainfall.

Leaf Area to Weight Ratio (ARI)

The leaf area index is given by the product of leaf biomass and ARI. Therefore, the rates of net photosynthesis and transpiration are directly affected by varying ARI. Total plant growth increased with increase in ARI and there were changes in the proportion of plant parts (Fig. 28). This in turn affected the concentration of the contaminants in the plant tissues. Relative lead and zinc concentrations in the plant were affected differently (Fig. 29a,b). A ratio value of 50 is representative of thickened sun leaves, 100 is representative of mesic sun leaves, and a value of 200 is representative of mesic shade leaves.

ORNL-DWG. 78-12309R

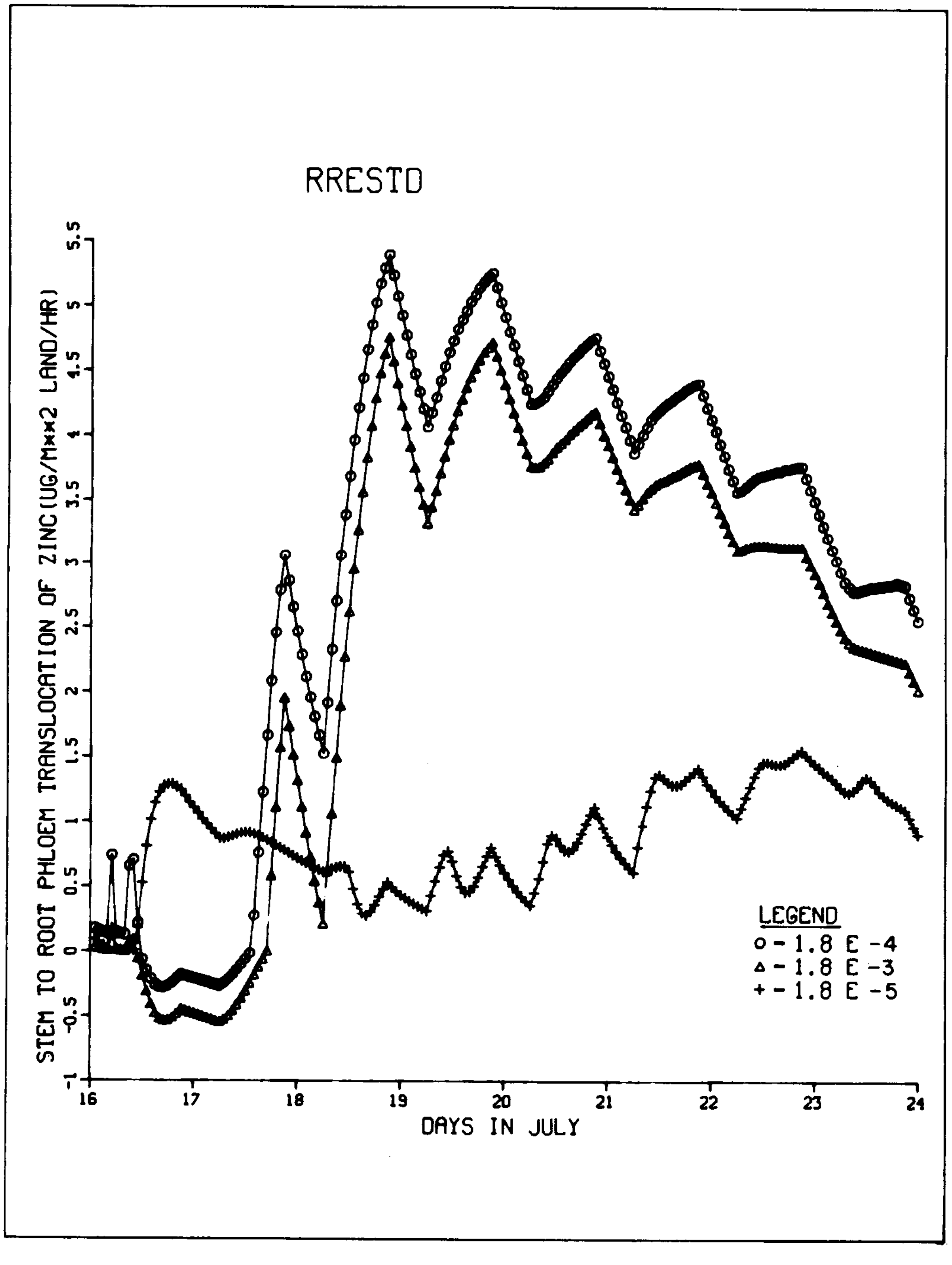


Fig. 26. Influence of standard root respiration rate (RRESTD) on zinc transport in stem-to-root phloem.

ORNL-DWG. 78-12310R

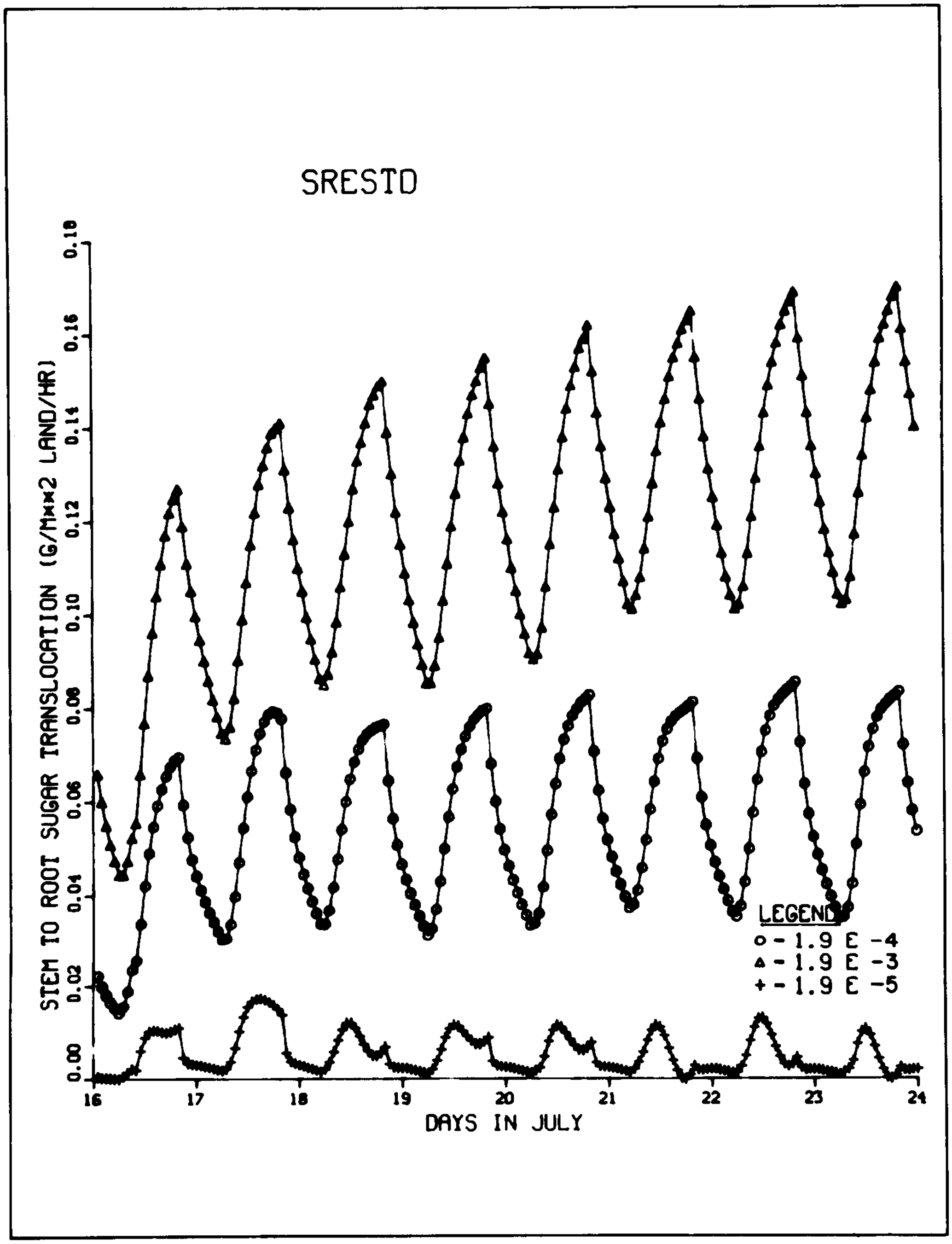


Fig. 27. Influence of standard stem respiration rate (SRESTD) on sugar translocation in stem-to-root phloem.

ORNL-DWG. 78-12311

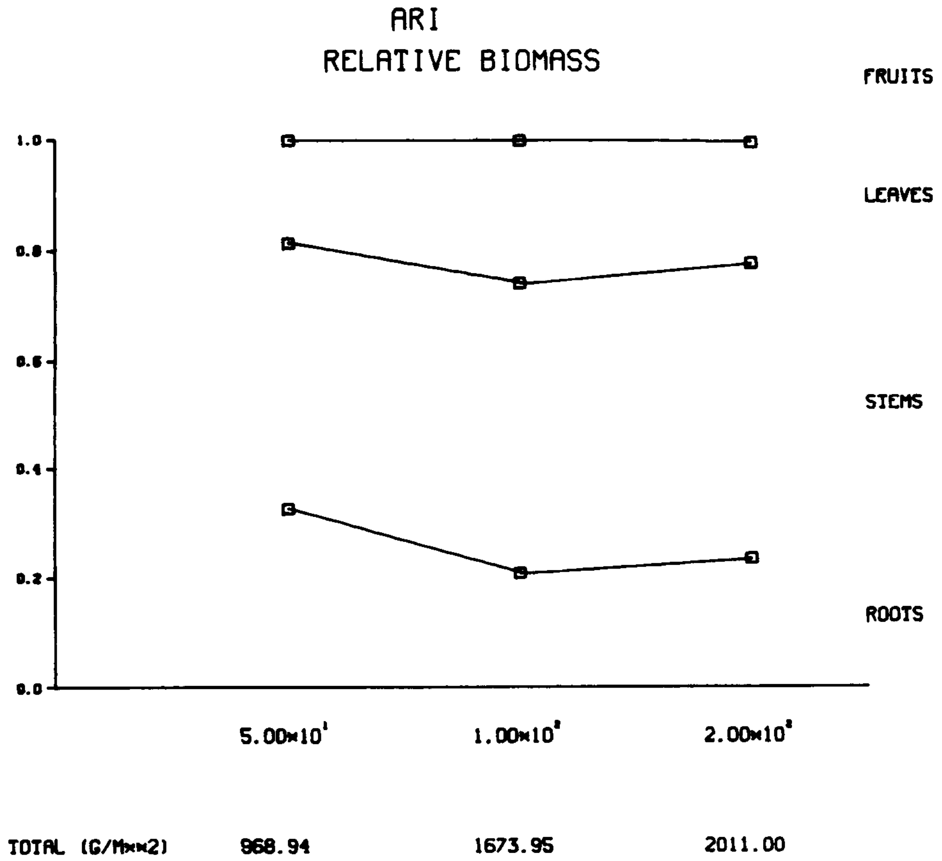
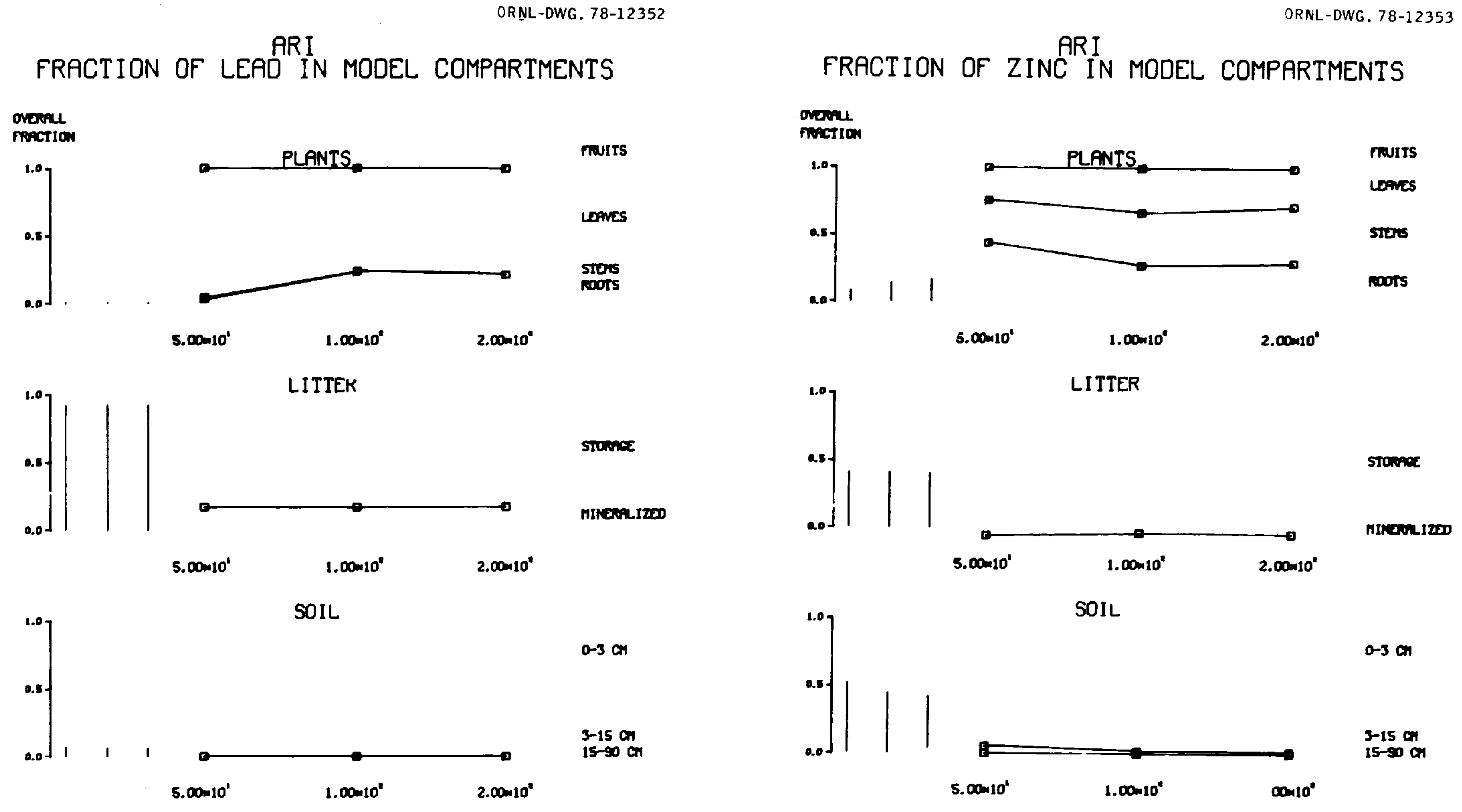


Fig. 28. Relative biomass distribution of plant components with change in leaf area weight ratio (ARI).



(a)

(b)

Fig. 29. Relative chemical distribution in plant, litter, and soil components with change in leaf area weight ratio (ARI) for (a) lead, (b) zinc.

Sulfur dioxide uptake, leaf sulfur concentration, zinc uptake by leaves, and leaf lead concentration were some of the most responsive outputs from the models (Appendix).

Water Potential Effects

A growth coefficient is used to simulate water stress effects on tissue (leaf, stem, root) growth. The coefficient is the value of an exponential function with a range from 0 to 1 which represents no growth or unaffected growth respectively. Input water potential values determining the sensitivity function include an initial potential at which tissue growth is reduced, the potential where tissue growth is reduced by one-half, and the potential where no further growth occurs (Dixon et al. 1976). Incremental values are added to each of these potentials in this test of water stress effects on overall plant growth such that the greater the input value the less growth is affected by the water potential stress. Thus, total productivity was higher (Fig. 30) with reduced sensitivity to water effects. Stem growth was proportionally increased for decreased sensitivity, whereas the fraction of roots was not changed. Water potential influenced leaf growth more readily than other tissues and SO_2 uptake was the most sensitive output response. Stem biomass and chemical content in xylem tissues were also greatly influenced (Appendix).

Root Radius (R)

The average root radius is used to determine root density and is a factor in the mass flow and diffusive uptake of soil contaminants. The direct effect of root radius on uptake is difficult to determine

ORNL-DWG. 78-12312R

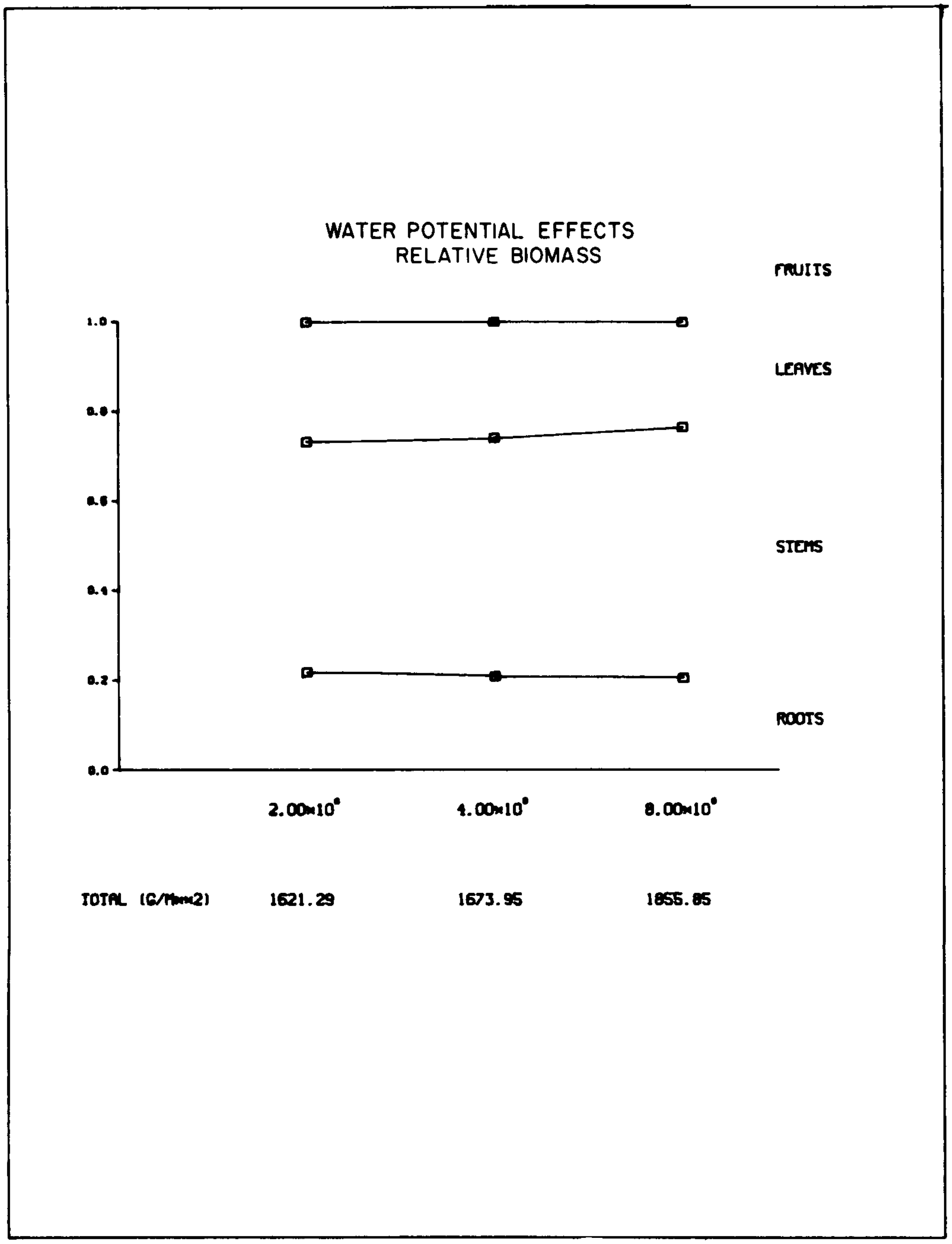


Fig. 30. Relative biomass distribution of plant components with change in water potential effects.

since many of the factors in the uptake equations are dependent on R. For zinc, uptake during the sunlight period is increased with increased root radius (Fig. 31). The root uptake for lead during sunlight periods, however, varies in exactly the opposite way (Fig. 32); there is more lead uptake for the decreased root radius. These responses depend on the interaction of the supply from the soil and plant demand which becomes low for zinc as the plant approaches maximum zinc content. The proportional contaminant distribution in the plant, litter, and soil components (Fig. 33a,b) shows relatively little change with change in root radius. The most sensitive output responses to change in root radius were the chemical content in litter and the mineralization rates of chemical in the litter (Appendix).

Maximum Leaf Storage (L MAX)

Each plant compartment has an upper limit to its storage value and the tissue growth rate is proportional to the difference between the current storage and maximum storage. The leaf maximum storage was reduced to test the sensitivity on overall plant response.

A reduction in total biomass as L MAX decreases (Fig. 34) is associated with a greater proportion of the biomass being located in the roots and stems. Lead uptake into the stem and root compartments changes reciprocally with change in L MAX (Fig. 35a). The main lead uptake is primarily through the leaves, whereas root uptake accounts for the smaller lead content in the roots. At the lower biomass levels with lower L MAX values, the leaf lead content approaches the maximum capacity and greater translocation to stems occurs (Fig. 35a). The

ORNL-DWG. 78-12313

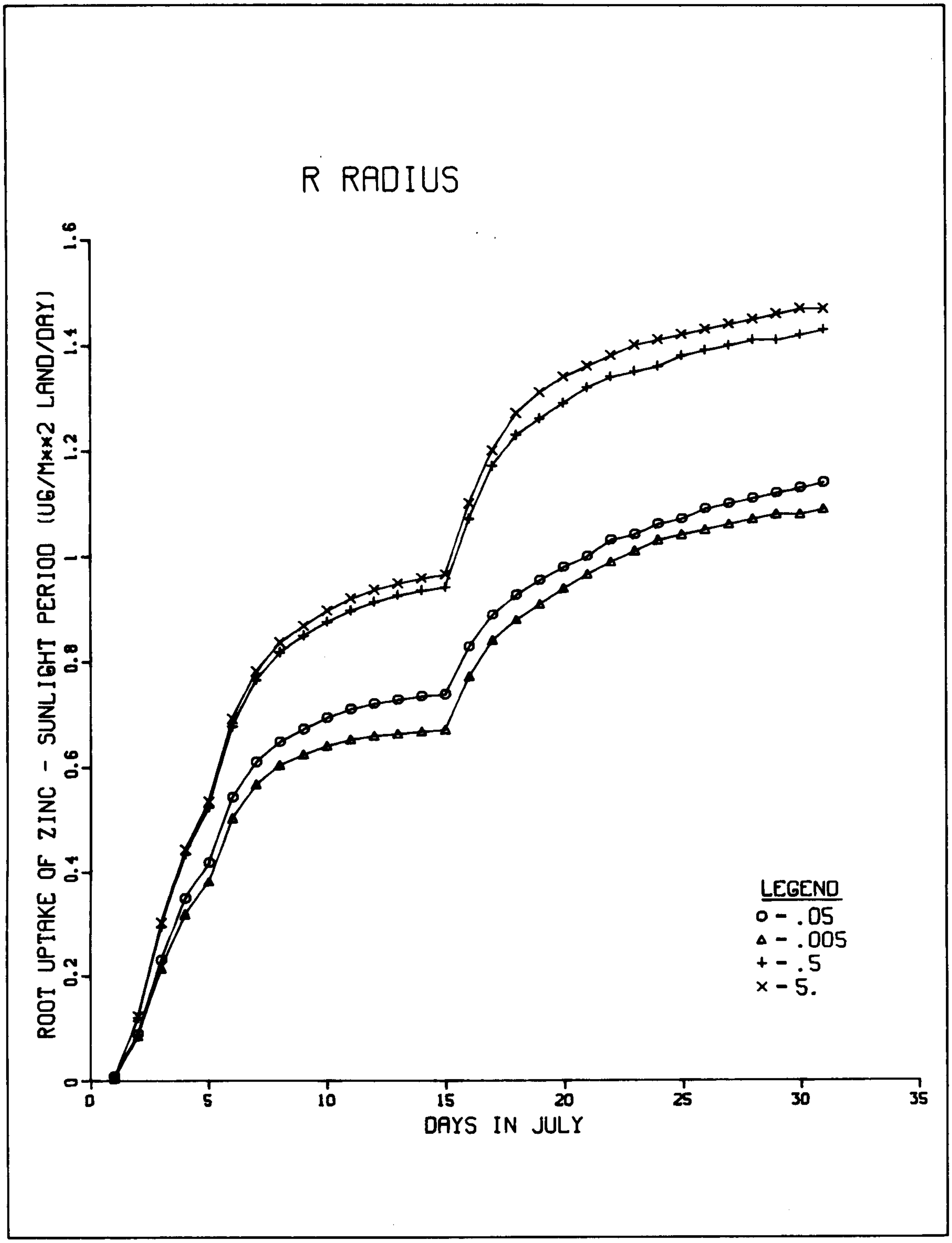


Fig. 31. Influence of root radius (R) on root uptake of zinc during the sunlight period.

ORNL-DWG. 78-12314

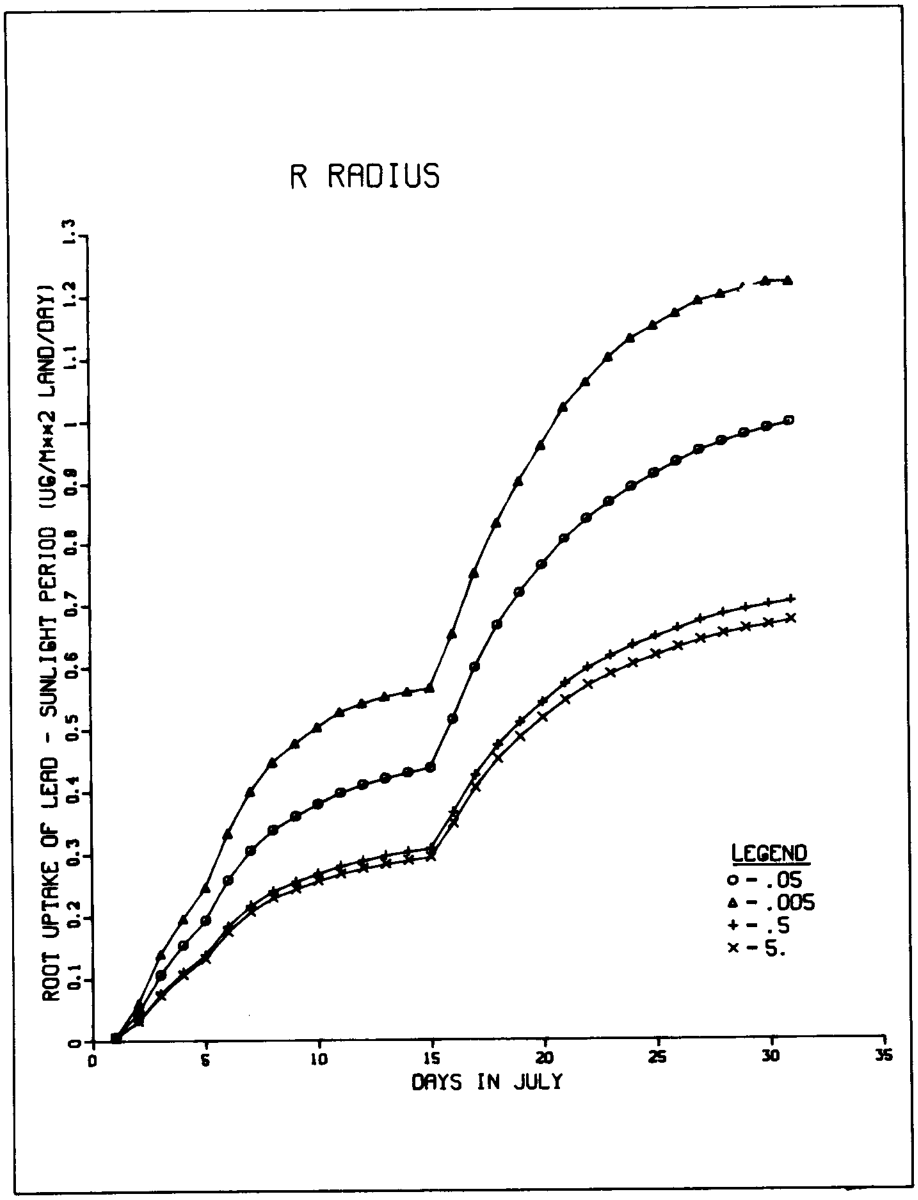


Fig. 32. Influence of root radius (R) on root uptake of lead during the sunlight period.

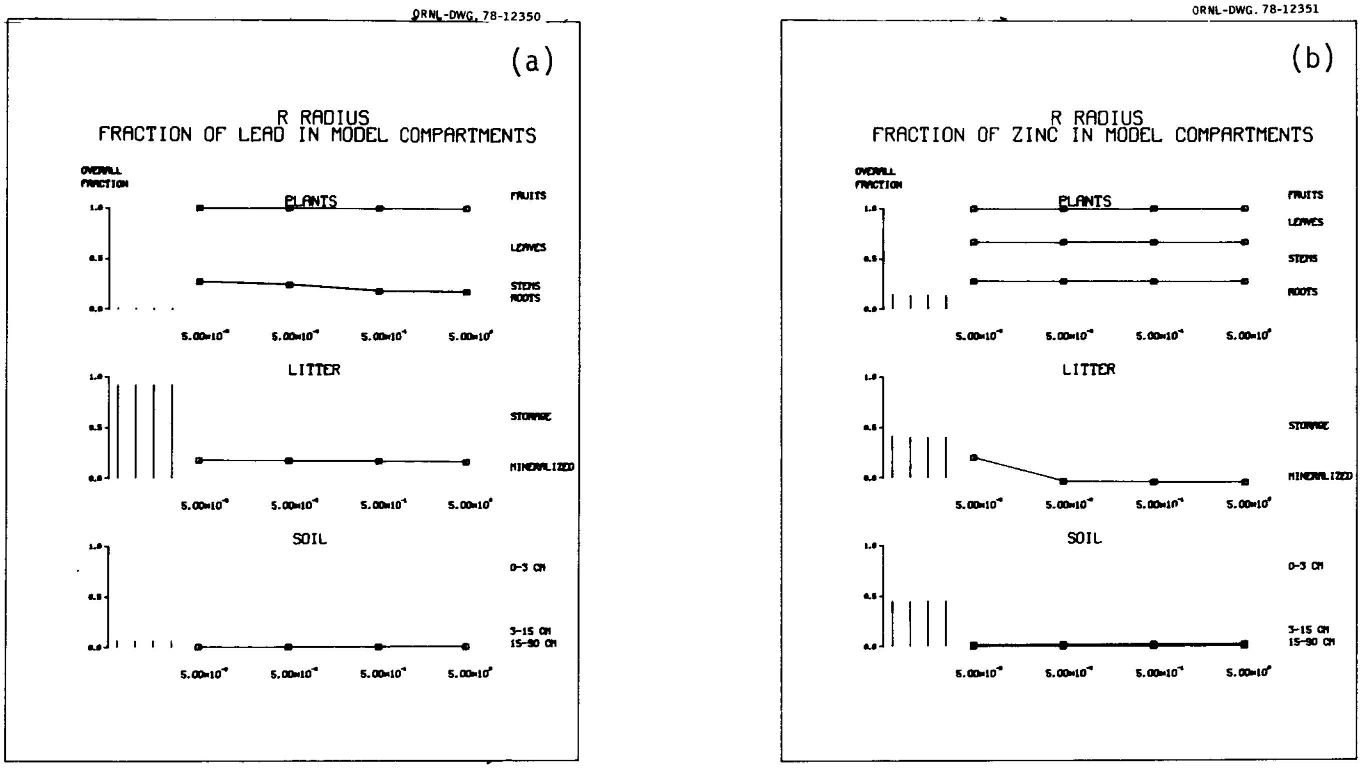


Fig. 33. Relative chemical distributions in plant, litter, and soil components with change in root radius (R) for (a) lead, (b) zinc.

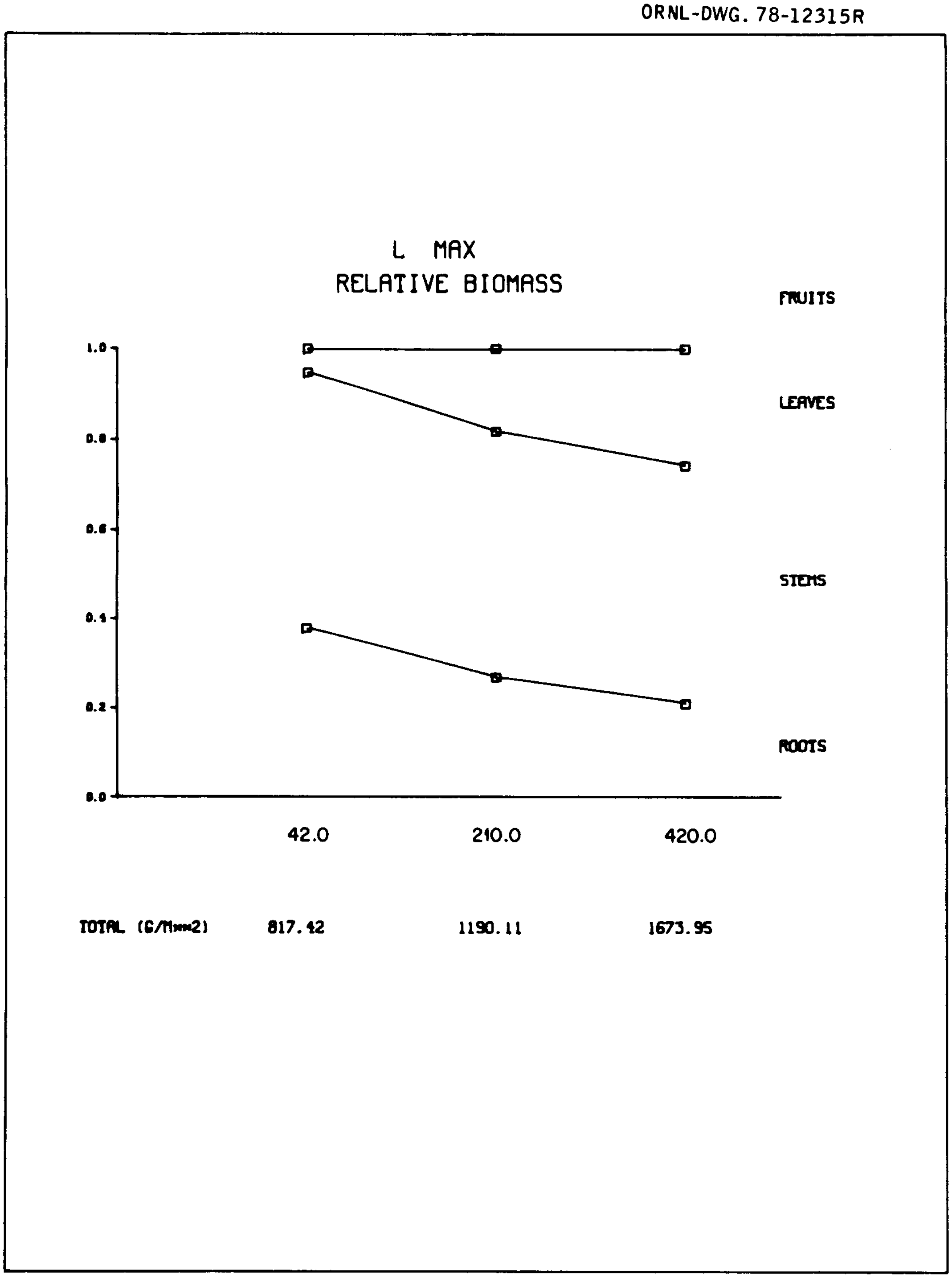
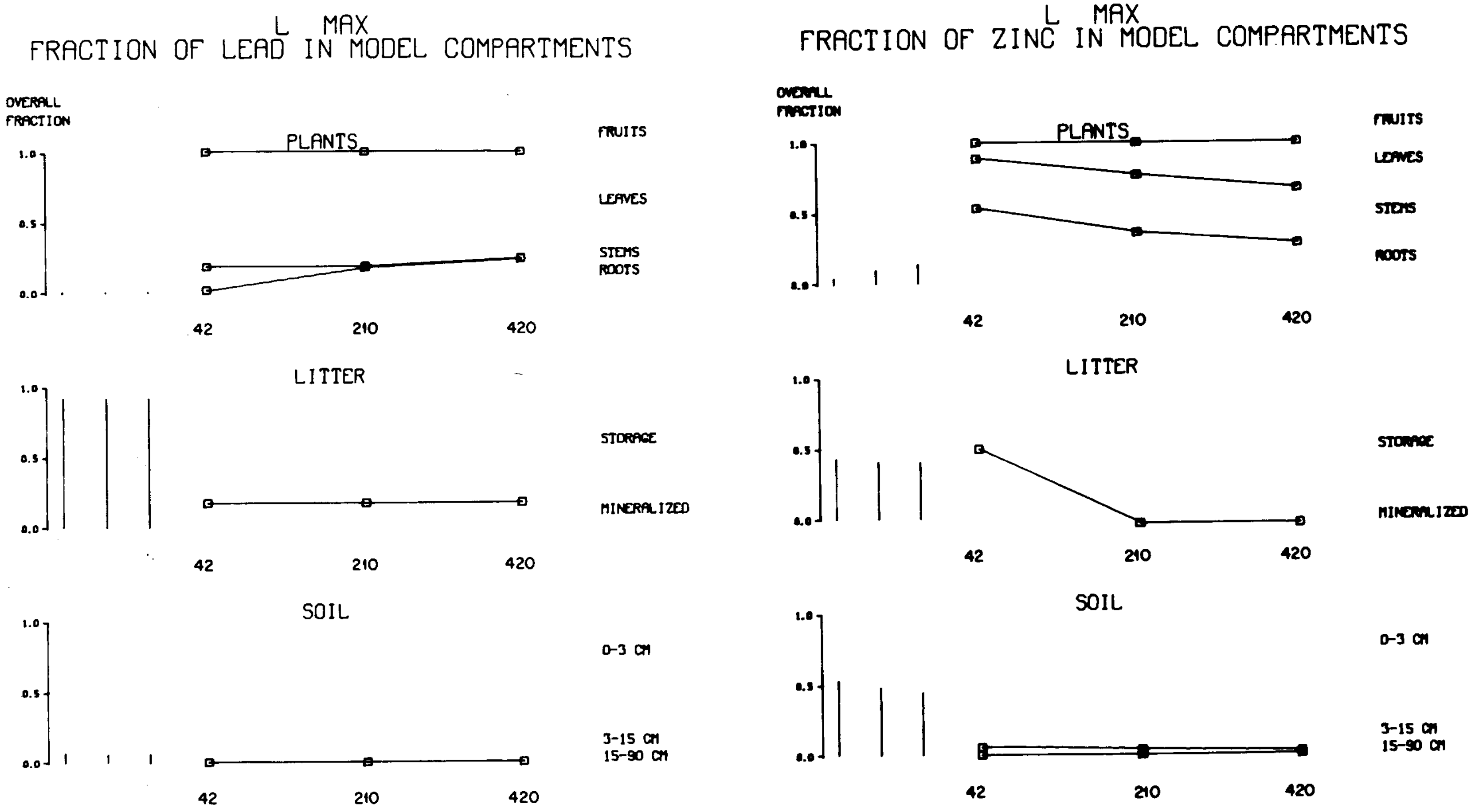


Fig. 34. Relative biomass distribution of plant components with change in maximum leaf storage (L MAX).

ORNL-DWG. 78-12348R ORNL-DWG. 78-12349R



(a) (b)

Fig. 35. Relative chemical distribution in plant, litter, and soil components with change in maximum leaf storage (L MAX) for (a) lead, (b) zinc.

effect on concentration of zinc (Fig. 35b) in the plant parallels the biomass change. An increase in the amount of zinc mineralized in the litter is partly due to a decrease of zinc uptake by foliar absorption. Again, SO_2 uptake was the most significant model response to change in maximum leaf storage, and the zinc content of root litter was also very responsive (Appendix).

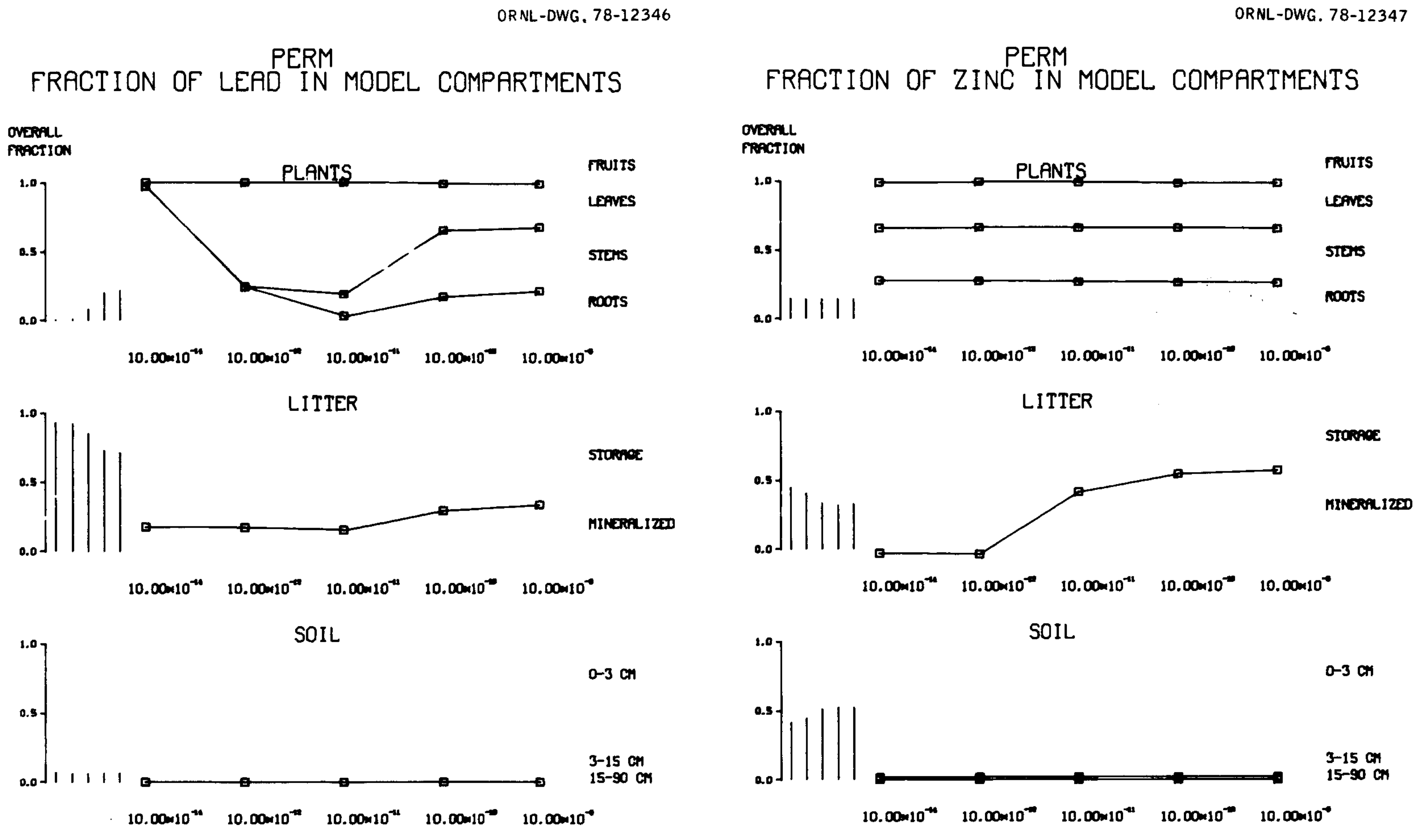
Plant Boundary and Atmosphere Parameters

Leaf Cuticle Permeability (PERM)

The rate of solute uptake across the leaf surface is dependent upon the solute concentration gradient, leaf cuticle thickness, and the leaf cuticle permeability. The permeability factor is one of the most sensitive parameters tested, especially in relation to contaminant movement.

The change in leaf uptake causes a change in the amount deposited on the litter surface. The increase in the overall fraction of contaminant in plants is accompanied by an overall decrease in the amount in the litter (Figs. 36a,b). Zinc has a higher solubility than lead and this is shown in the reduced litter zinc content and greater soil content.

Leaf uptake of zinc with increasing permeability (Fig. 37a) contrasts with a corresponding decrease in root uptake of zinc (Fig. 37b). Both the lead and zinc leached from leaves were greatly influenced by change in PERM. Chemical transport within the vegetation and chemical accumulation in litter responded to the changes in leaf permeability (Appendix).



(a) (b)

Fig. 36. Relative chemical distribution in plant, litter, and soil components with change in leaf permeability to chemicals (PERM) for (a) lead, (b) zinc.

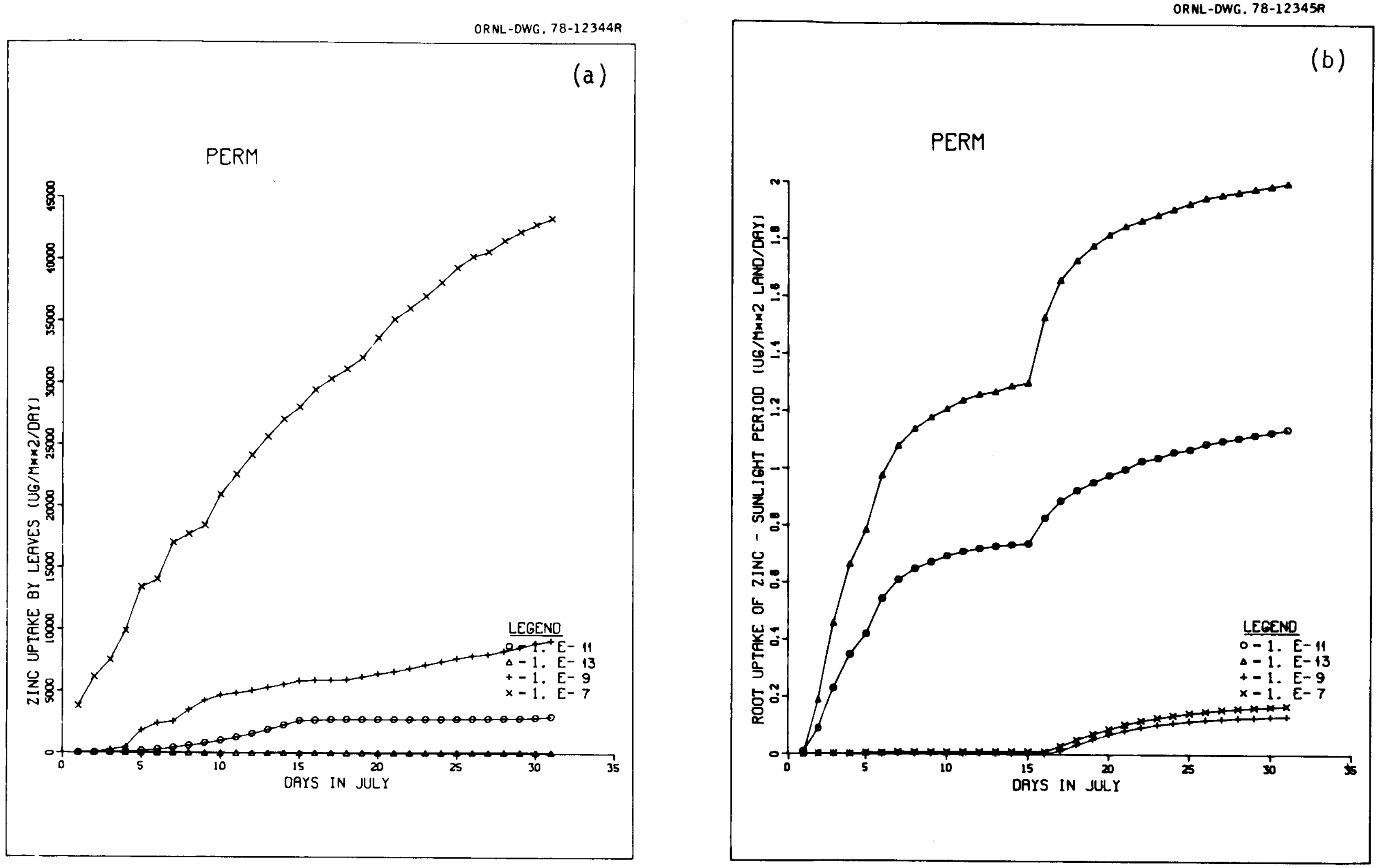


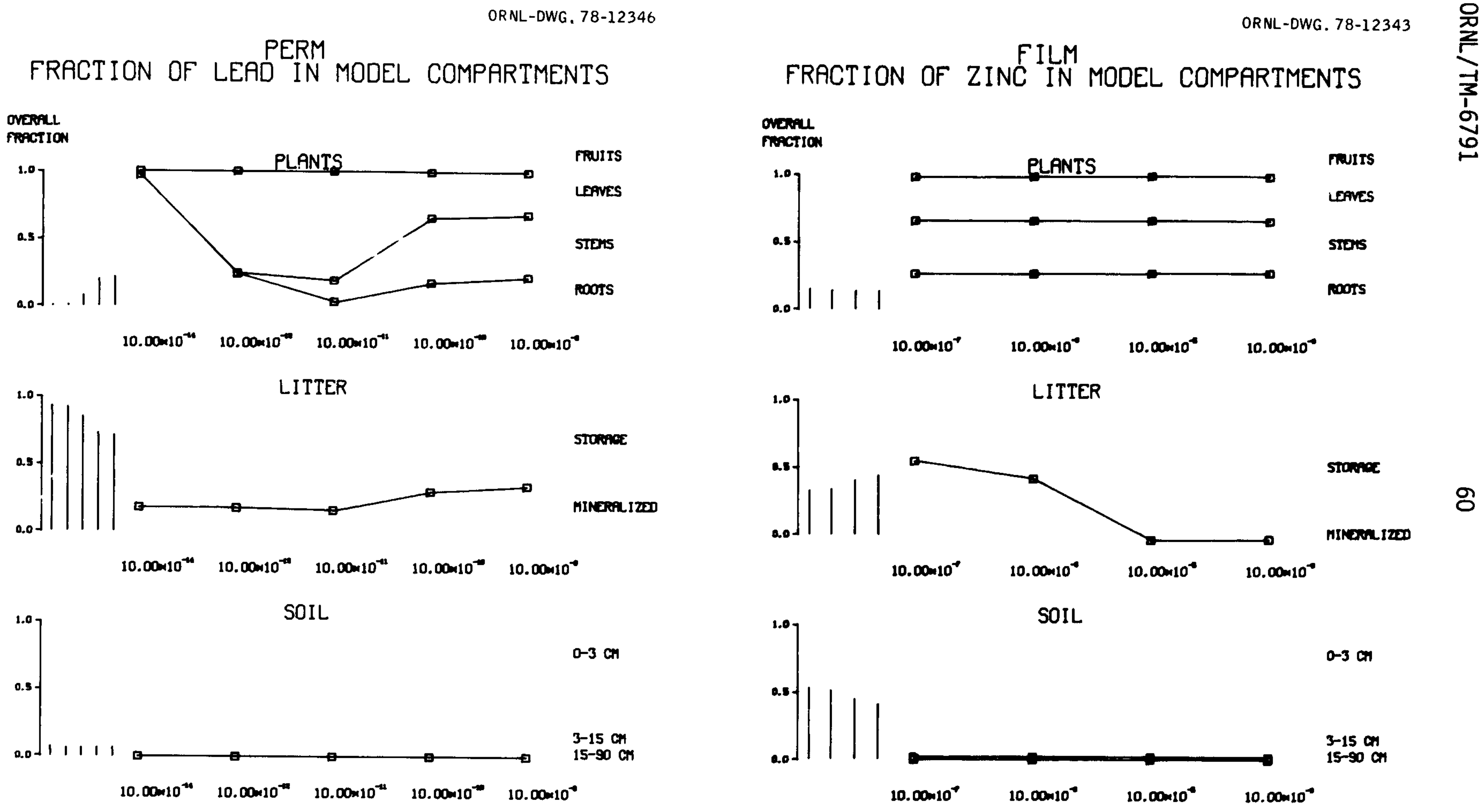
Fig. 37. Influence of leaf permeability (PERM) on zinc uptake by (a) leaf, (b) root.

Cuticle Thickness (FILM)

The solute uptake from the leaf surface is inversely proportional to leaf cuticle thickness. Therefore, the relationships depicting the fraction of contaminant in each of the compartments (Fig. 38) are almost completely opposite of Fig. 36. At high cuticle thicknesses, leaf uptake is diminished and all the lead is in the root system (Fig. 38a). Significant increases in zinc litter mineralization occur at the low cuticle thickness values (Fig. 38b). The lead content of stem xylem, lead leached from leaves, and lead xylem transport from stem to leaf were highly influenced by change in cuticle thickness (Appendix). The responses of zinc transport in the plant were suppressed since the plant had almost saturated its zinc uptake capacity (Fig. 38b).

Root Solute Conductivity (CONDUC)

The plant solute uptake depends on the plant tissue capacity for additional solutes and the root solute conductivity. With increase in root solute conductivity, the overall fraction of contaminant in the plant increased (Figs. 39 and 40). The amount of zinc uptake through leaves increased with reduced root conductivity, causing greater accumulation in the leaf compartment. Alternatively, when zinc uptake by roots was large, leaf uptake was reduced, allowing more contaminant to reach the litter surface which increased the amount mineralized. The model is very sensitive to the conductivity parameter. The zinc and lead content in the litter and the heavy metal mineralization rate were the most responsive outputs to change in root conductivity



(a)

(b)

Fig. 38. Relative chemical distribution in plant, litter, and soil components with change in leaf cuticle thickness (FILM) for (a) lead, (b) zinc.

ORNL-DWG. 78-12319

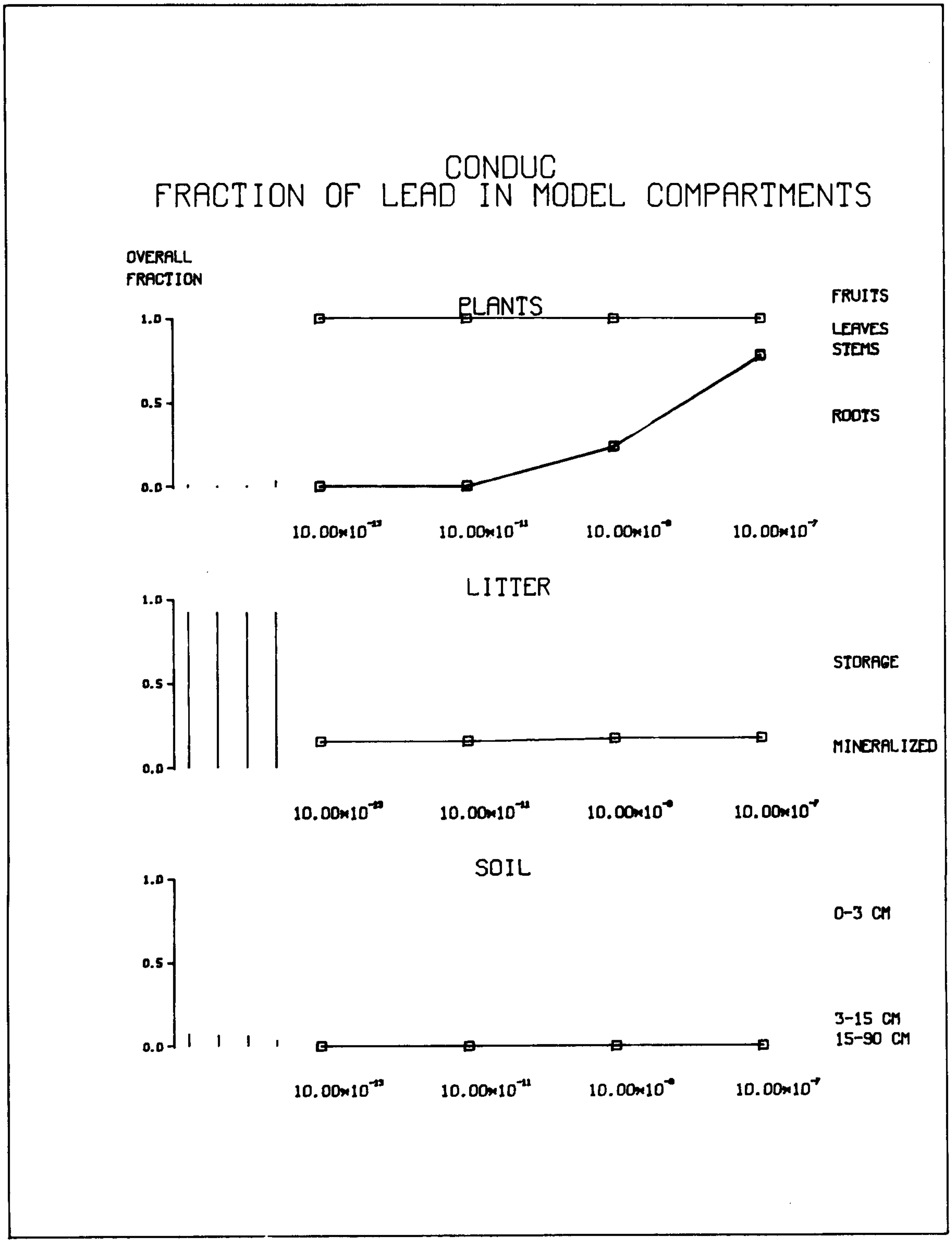


Fig. 39. Relative lead distribution in plant, litter, and soil components with change in root chemical conductivity (CONDUC).

ORNL-DWG. 78-12320

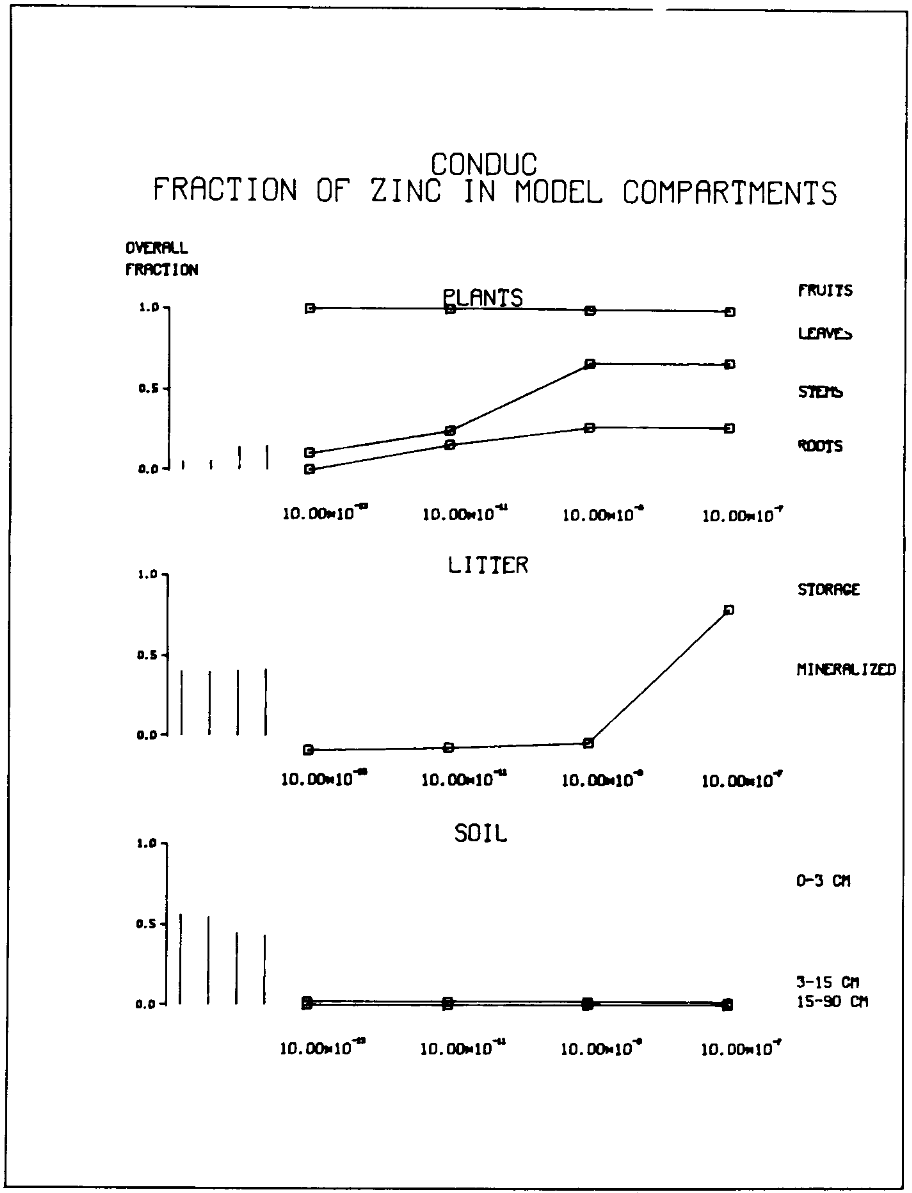


Fig. 40. Relative zinc distribution in plant, litter, and soil components with change in root chemical conductivity (CONDUC).

(Appendix). The root lead concentration was the most responsive plant property.

External Gas Concentration (GASEX)

The diffusive uptake of pollutant gases (SO_2 in this case) is calculated by determining the gas concentration differences between the leaf and the atmosphere. There was greater SO_2 uptake and greater sulfur translocation from leaves to stems with an increase in SO_2 concentration (Fig. 41). The leaf compartment was the dominant sulfur sink for the conditions examined. The SO_2 uptake and sulfur dynamics in the vegetation were very responsive to change in external SO_2 concentration (Appendix).

CO_2 Concentration in Ambient Air (CO2X)

In the plant growth model, net photosynthesis depends on the CO_2 gradient from the chloroplast to the ambient air (Dixon et al. 1976). Increasing the ambient CO_2 concentration affects the photosynthesis and causes an increase in plant growth (Fig. 42). The greatest proportion of the increase is divided between the roots and stems. As a result, a slight increase in the overall fraction of zinc in the plants was obtained (Fig. 43). Chemical uptake and transport was influenced by change in atmospheric CO_2 concentration. The uptake of SO_2 and zinc were the most responsive model outputs. Stem biomass was also significantly influenced (Appendix).

ORNL-DWG. 78-12321

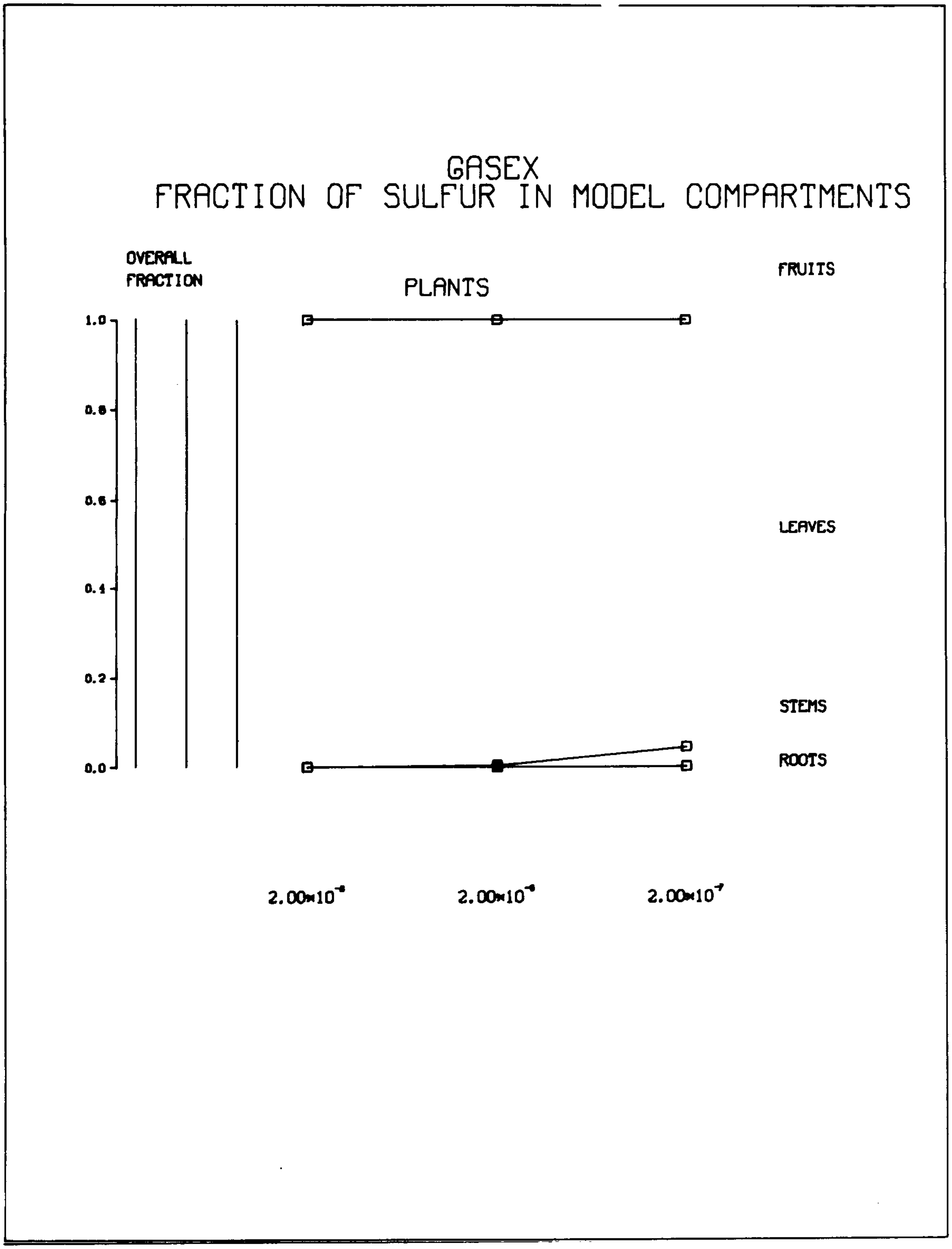


Fig. 41. Relative sulfur distribution in plant components with change in atmospheric SO_2 concentration (GASEX).

ORNL-DWG. 78-12316

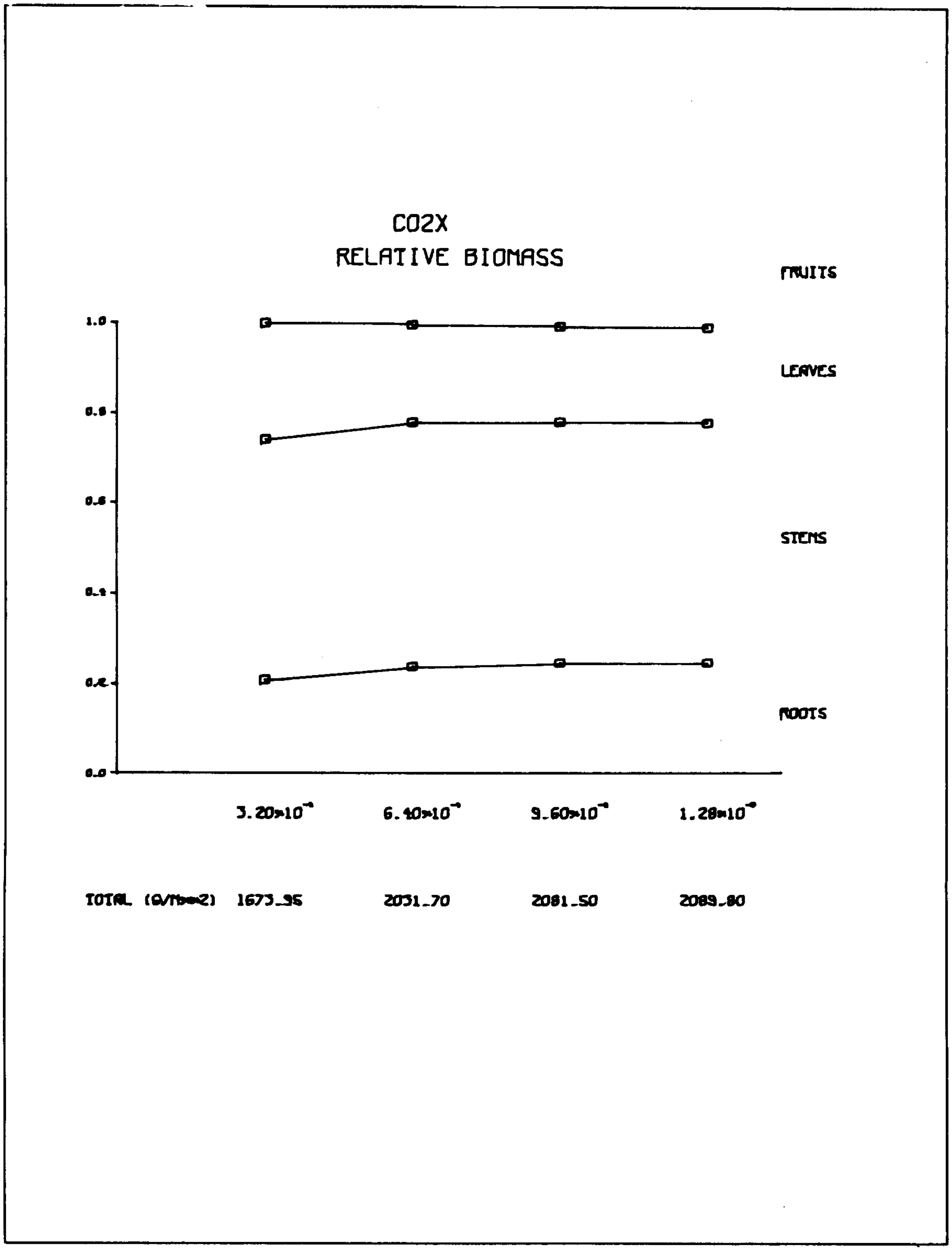


Fig. 42. Relative biomass distribution of plant components with change in atmospheric CO_2 concentration (CO2X).

ORNL-DWG. 78-12317

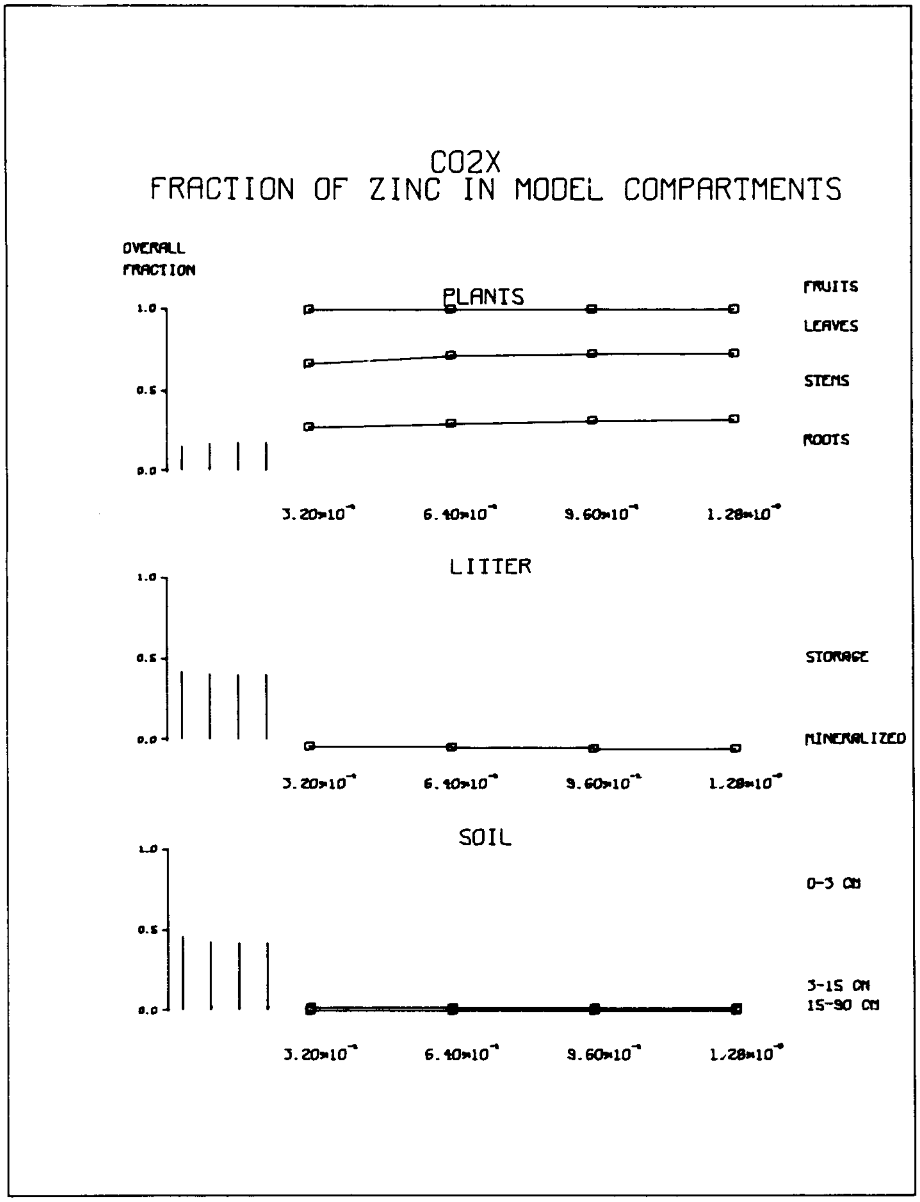


Fig. 43. Relative zinc distribution in plant, litter, and soil components with change in atmospheric CO_2 (CO2X).

DISCUSSION

A subjective summary of parameter effects on the model output (Table 4) identifies five of the fifteen parameters as highly sensitive factors in the model behavior. These are the chemical distribution coefficient in soil (KD) the chemical solubility (SP), the leaf permeability to chemical (PERM), leaf cuticle thickness (FILM), and the root conductivity to chemical (CONDUC). The KD, SP, and FILM terms can be fairly readily measured; however, this is not the case for the plant characteristics that determine the rate of chemical uptake at its leaf and root boundaries (PERM, CONDUC). Estimates of these characteristics can be obtained by tuning the models to results from experimental uptake studies (Luxmoore and Begovich, submitted).

Two parameters (DL, R) showed surprising results by generating opposite responses for zinc (soluble, mobile) and lead (less soluble, less mobile) movement within the plant. This was related to the standard parameter values that caused the plant to rapidly take up zinc and approach its maximum zinc content. In contrast, the plant demand for lead remains high for the three-month simulation period.

A consistent pattern obtained in the model output was an increase in litter mineralization in response to factors that increased the chemical content in the plant leaf tissue. These include the phloem resistance (LSPHLO, SRPHLO), standard tissue respiration rate (SRESTD), maximum leaf weight (L MAX), leaf permeability (PERM), leaf cuticle thickness (FILM), and root conductivity (CONDUC). Chemical dynamics in the litter system also showed responses to the chemical distribution

Table 4. Subjective evaluation of parameter effects on total chemical level and distribution in soil, litter, and plant components

Increase in parameter	Total chemical level						Chemical distribution					
	Soil		Litter		Plant		Soil		Litter		Plant	
	Pb	Zn	Pb	Zn	Pb	Zn	Pb	Zn	Pb	Zn	Pb	Zn
KD	+	++	0	-	-	-	+	++	0	+++	+++	++
SP	+++	++	---	--	+	0	0	0	+++	+++	+	0
DL	+	+	0	0	-	-	0	0	0	++	++	++
DMAX	0	0	0	0	0	0	0	0	+	+	0	0
PHLO	0	0	0	0	0	-	0	0	0	++	+	+
RESTD	0	0	0	0	0	0	0	0	0	0	++	+
ARI	0	-	0	0	0	+	0	+	0	0	+	+
EI	0	-	0	0	0	+	0	+	0	0	+	+
R	0	0	0	0	0	0	0	0	0	+	+	0
LMAX	0	-	0	-	0	++	0	+	0	++	+	++
PERM	0	++	--	--	+++	0	0	0	+	+++	+++	0
FILM	0	--	++	++	---	0	0	0	+	+++	+++	0
CONDUC	-	--	0	0	+	++	0	0	0	+++	+++	++
GASEX	0	0	0	0	0	0	0	0	0	0	0	0
CO2X	0	-	0	0	0	+	0	0	0	0	+	+

Qualitative ranking

+++	large increase
++	fair increase
+	small increase
0	no change
-	small decrease
--	fair decrease
---	large decrease

coefficient (KD), chemical solubility (SP), chemical diffusion coefficient (DL), litter decomposition characteristics (DMAX), and root radius (R) as shown by the response and sensitivity coefficients (Appendix). Some of the indirect relationships would not have been expected but become apparent through modeling methods. The study also suggests that monitoring of litter systems (chemical content, chemical mineralization) can provide one method for detection of plant response to chemical perturbation.

Sulfur dioxide uptake from a chronic atmospheric concentration (2×10^{-8} ml/ml) was found to be very responsive to change in several plant properties (Appendix). Reduced leaf-to-stem phloem resistance (LSPHLO), reduced stem-to-root phloem resistance (SRPHLO), reduced leaf respiration (LRESTD), increased leaf area weight ratio (ARI), reduced water stress sensitivity (E1), increased leaf storage (L MAX), and increased atmospheric CO_2 (CO2X) resulted in an increased SO_2 uptake by the vegetation. These effects were all the result of an increased sink for sulfur by increased growth associated with the change in the parameter value.

Much information is contained in the Appendix and has not been commented on; nevertheless, the output can be used as a reference to examine any model responses of interest.

REFERENCES

Baes, C. F., C. L. Begovich, W. M. Culkowski, K. R. Dixon, D. E. Fields, J. T. Holdeman, D. D. Huff, D. R. Jackson, N. M. Larson, R. J. Luxmoore, J. K. Munro, M. R. Patterson, R. J. Raridon, M. Reeves, O. C. Stein, J. L. Stolzy, and T. C. Tucker. 1976. The unified transport model. pp. 13-62. IN R. I. Van Hook and W. D. Shults (eds.), Ecology and Analysis of Trace Contaminants Progress Report October 1974-December 1975. ORNL/NSF/EATC-22. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 200 pp.

Baldwin, J. P. 1976. Competition for plant nutrients in soil, a theoretical approach. J. Agric. Sci. 87:341-356.

Baldwin, J. P., P. H. Nye, and P. B. Tinker. 1973. Uptake of solutes by multiple root systems from soil. III. A model for calculating the solute uptake by a randomly dispersed root system developing in a finite volume of soil. Plant Soil 38:621-635.

Begovich, C. L., and D. R. Jackson. 1975. Documentation and application of SCEHM. A model for soil chemical exchange of heavy metals. ORNL/NSF/EATC-16. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 67 pp.

Dixon, K. R., R. J. Luxmoore, and C. L. Begovich. 1976. CERES - A model of forest stand biomass dynamics for predicting trace contaminant, nutrient, and water effects. ORNL/NSF/EATC-25. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 102 pp.

Dixon, K. R., R. J. Luxmoore, and C. L. Begovich. 1978a. CERES - A model of forest stand biomass dynamics for predicting trace contaminant, nutrient and water effects. I. Model description. Ecol. Model. 5:17-38.

Dixon, K. R., R. J. Luxmoore, and C. L. Begovich. 1978b. CERES - A model of forest stand biomass dynamics for predicting trace contaminant, nutrient and water effects. II. Model application. Ecol. Model. 5:93-114.

Gass, S. I. 1977. Evaluation of complex models. Computers and Operations Research 4:27-35

Huff, D. D., R. J. Luxmoore, J. B. Mankin, and C. L. Begovich. 1977. TEHM: A Terrestrial Ecosystem Hydrology Model. ORNL/NSF/EATC-27. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 152 pp.

Luxmoore, R. J., and C. L. Begovich. Simulated heavy metal fluxes in tree microcosms and a deciduous forest. Ecol. Model. (submitted).

Luxmoore, R. J., C. L. Begovich, and K. R. Dixon. 1976a. DRYADS and DIFMAS: FORTRAN models for investigating solute uptake and incorporation into vegetation and litter. ORNL/NSF/EATC-26. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 133 pp.

Luxmoore, R. J., C. L. Begovich, and K. R. Dixon. 1978. Modelling solute uptake and incorporation into vegetation and litter. Ecol. Model. 5:137-171.

Luxmoore, R. J., Janice L. Stolzy, and J. T. Holdeman. 1976b. Some sensitivity analyses of an hourly soil-plant-water relations model. ORNL/TM-5343. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 59 pp.

Miller, D. R. 1974. Sensitivity analysis and validation of simulation models. J. Theor. Biol. 48:345-360.

Miller, D. R., G. Butler, and L. Bramall. 1976. Validation of ecological system models. J. Environ. Manage. 4:383-401.

Munro, J. K., R. J. Luxmoore, C. L. Begovich, K. R. Dixon, A. P. Watson, M. R. Patterson, and D. R. Jackson. 1976. Application of the unified transport model to the movement of Pb, Cd, Zn, Cu, and S through the Crooked Creek Watershed. ORNL/NSF/EATC-28. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 92 pp.

APPENDIX

The relative output coefficient and sensitivity coefficient described in the Sensitivity Analysis Methods Section are listed for each input parameter investigated in the following tables. The relative output coefficient is a χ^2-like coefficient since it measures the departure of each output response from the "expected" response of the standard run. Large values imply large variation from the standard output. The sensitivity coefficient can be viewed as a measure of rate of change or slope; however, the coefficient can be very misleading as a slope when considering the possibly large order of magnitude in the difference in input. A large coefficient indicates a large deviation from the standard run results for the difference in input values. All coefficients have been averaged over time. The outputs have been arranged in approximate order of decreasing response and sensitivity.

APPENDIX (continued)

```
  MODEL : SCEHM          PARAMETER : KD, DISTRIBUTION COEFFICIENT
 STANDARD VALUE LEAD A1 LAYER = 500.0 (UG/G PER UG/ML)

                    OUTPUT RESPONSES                                  RELATIVE OUTPUT COEFFICIENTS           SENSITIVITY COEFFICIENTS

     INPUT
     VALUES:                                                      2500.00      100.0       5.0      2500.00      100.0        5.0

LEAD IN LEAF LITTER (UG/M**2 LAND)                               0.888E 08  0.735E 07  0.117E 08 -0.212E 04   756.       -190.
LEAD IN ROOT LITTER (UG/M**2 LAND)                               0.813E 07  0.673E 06  0.107E 07  0.208E 04  -742.        187.
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)             7.72      0.355E 04  0.659E 07  0.856E-04 -0.227E-02  0.182E-01
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                             0.731       418.      0.140E 07  0.558E-04 -0.165E-02  0.164E-01
ROOT LEAD CONCENTRATION (UG/G)                                    678.      0.137E 05  0.629E 06  0.555E-01 -0.309      0.417
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)            0.483       222.      0.446E 06  0.535E-05 -0.142E-03  0.120E-02
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)               0.287E 06  0.238E 05  0.377E 05 -6.86         2.44     -0.615
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)       -13.4      -145.     -0.201E 06 -0.758E-05  0.469E-04 -0.348E-03
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                           138.      0.284E 04  0.144E 06  0.113E-01 -0.635E-01  0.904E-01
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)               0.874E 05  0.727E 04  0.116E 05   22.4       -8.00       2.02
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                        0.680E-01   32.2      0.612E 05  0.475E-05 -0.128E-03  0.101E-02
STEM LEAD CONCENTRATION (UG/G)                                   0.174E-01   6.74      0.114E 05  0.210E-04 -0.510E-03  0.423E-02
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)      0.514E-02   2.43      0.615E 04  0.153E-06 -0.406E-05  0.342E-04
FRUIT LEAD CONCENTRATION (UG/G)                                  0.663E-02   3.10      0.553E 04  0.964E-05 -0.258E-03  0.221E-02
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                          1.05       22.3      0.166E 04  0.860E-04 -0.490E-03  0.842E-03
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)       0.155E-01   4.45       275.     -0.398E-05  0.952E-04 -0.138E-03
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                    0.251       5.33       246.     -0.580E-03  0.332E-02 -0.453E-02
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                          0.243E-03  0.907E-01   168.      0.453E-06 -0.109E-04  0.940E-04
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER                  0.486E-05  0.251E-02   159.      0.330E-09 -0.929E-08  0.461E-06
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                        0.741E-04  0.142E-01   7.71      0.170E-05 -0.480E-04  0.190E-03
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                         0.804E-05  0.384E-02   6.86      0.123E-07 -0.333E-06  0.283E-05
LEAD IN FRUIT LITTER (UG/M**2 LAND)                              0.168E-01  0.180E-02   4.59     -0.769E-06 -0.736E-07  0.296E-05
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                         0.341E-05  0.130E-02   2.75      0.938E-08 -0.227E-06  0.214E-05
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                   0.290E-01  0.490       1.44      0.238E-05 -0.121E-04  0.390E-05
LEAF LEAD CONCENTRATION (UG/G)                                   0.0        0.100E-01  0.539      0.0       -0.121E-03  0.589E-03
LEAD IN STEM LITTER (UG/M**2 LAND)                               0.290      0.223E-01  0.449E-01 -0.819E-05  0.281E-05  0.578E-06
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)              0.443E-03  0.147E-04  0.226E-01 -0.177E-07  0.298E-08  0.286E-07
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                          0.0        0.420E-04  0.970E-02  0.0       -0.169E-05  0.111E-04
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)               0.346E-02  0.271E-03  0.105E-03 -0.957E-07  0.331E-07  0.298E-08
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                           0.0        0.0        0.715E-06  0.0        0.0        0.150E-08
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER                  0.0        0.607E-13  0.714E-08  0.0       -0.123E-15  0.857E-14

  MODEL : SCEHM          PARAMETER : KD, DISTRIBUTION COEFFICIENT
 STANDARD VALUE ZINC A1 LAYER = 10.0 (UG/G PER UG/ML)

                    OUTPUT RESPONSES                                  RELATIVE OUTPUT COEFFICIENTS           SENSITIVITY COEFFICIENTS

     INPUT
     VALUES:                                                         1.0       100.0      1000.0       1.0       100.0      1000.0

ZINC IN LEAF LITTER (UG/M**2 LAND)                               0.139E 08  0.120E 06  0.139E 04  -542.        5.04     -0.493E-01
ZINC IN ROOT LITTER (UG/M**2 LAND)                               0.367E 04   80.5      0.153E 07   538.       -5.73      -96.3
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                        0.601E 04  0.570E 04  0.488E 05   23.4       -2.25       0.351
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)               0.487E 05   420.       4.76      -1.89       0.175E-01 -0.170E-03
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                        0.843E 04  0.812E 04  0.146E 05   30.2       -2.97       0.201
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                             0.803E 04  0.455E 04  0.413E 04   28.8       -1.36       0.780E-01
ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)                41.9      0.705      0.117E 05   6.20      -0.710E-01 -0.936
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)       0.127E 04  0.145E 04  0.824E 04  0.804      -0.858E-01  0.587E-02
FRUIT ZINC CONCENTRATION (UG/G)                                  0.273E 04  0.256E 04  0.288E 04   9.92      -0.960      0.822E-01
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)            0.322E 04  0.149E 04   896.       1.88       0.115      0.546E-02
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)            0.199E 04  0.129E 04  0.111E 04   1.15      -0.920E-01  0.716E-02
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)        585.       695.     -0.388E 04  0.339      -0.424E-01  0.392E-02
STEM ZINC CONCENTRATION (UG/G)                                    777.       540.      0.729       2.98      -0.246      0.665E-03
ROOT ZINC CONCENTRATION (UG/G)                                   0.110E 04   38.5      0.196       4.67      -0.540E-01  0.212E-03
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                            3.68       3.68       435.      0.136E-01 -0.136E-02  0.792E-03
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                           300.       15.5      0.127       1.23      -0.265E-01  0.227E-03
LEAF ZINC CONCENTRATION (UG/G)                                    93.5       82.8       10.9       1.28      -0.119      0.267E-02
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                           24.0       19.4      0.719E-01  0.920E-01 -0.827E-02  0.456E-04
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                     14.3       5.82       8.06     -0.158       0.986E-02 -0.111E-02
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                   0.587      0.455       13.1      0.213E-02 -0.188E-03  0.910E-04
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)       22.7      -17.1       1.35      0.133E-01 -0.591E-03 -0.543E-04
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                          4.38       1.31      0.356      0.169E-01 -0.909E-03  0.429E-04
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER                  0.271E-02  0.264E-02   5.62      0.970E-05 -0.958E-06  0.401E-05
ZINC IN FRUIT LITTER (UG/M**2 LAND)                               1.86       1.64      0.909E-01  0.683E-02 -0.640E-03  0.109E-04
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                          1.78       1.56      0.222      0.653E-02 -0.610E-03  0.209E-04
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                           1.81       1.58      0.814E-01  0.249E-01 -0.232E-02  0.391E-04
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                         0.653      0.564      0.219      0.256E-02 -0.238E-03  0.127E-04
ZINC IN STEM LITTER (UG/M**2 LAND)                               0.340      0.392      0.236      0.157E-02 -0.169E-03  0.928E-05
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)              0.233E-01  0.215E-01  0.725E-03  0.854E-04 -0.821E-05  0.125E-06
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)               0.292E-02  0.370E-02  0.325E-02  0.143E-04 -0.161E-05  0.129E-06
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER                  0.135E-10  0.133E-10  0.325E-07  0.110E-12 -0.109E-13  0.493E-13
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APPENDIX (continued)

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 MODEL : SCEHM                PARAMETER : SP, SOLUBILITY OF LEAD
STANDARD VALUE = 3.0 (UG/ML)

                  OUTPUT RESPONSES                          RELATIVE OUTPUT COEFFICIENTS     SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                       30.0          300.0          30.0           300.0

LEAD IN ROOT LITTER (UG/M**2 LAND)                          0.124E 09     0.452E 08     -0.149E 06     -0.805E 04
LEAD IN LEAF LITTER (UG/M**2 LAND)                          0.116E 08     0.105E 08     -0.140E 05     -0.121E 04
LEAD IN FRUIT LITTER (UG/M**2 LAND)                         0.388E 07      3.52          0.214          0.191E-04
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)          0.134E 07     0.383E 06     -0.161E 04     -77.9
LEAD IN STEM LITTER (UG/M**2 LAND)                          0.169E 07      3.34          0.256          0.458E-04
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                   0.273E 06     0.155E 06      4.83          0.352
LEAF LEAD CONCENTRATION (UG/G)                              0.583E 05     0.436E 05      15.5           1.22
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)          0.378E 05     0.332E 05     -45.6          -3.89
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER               0.509E 05     0.188E 05      4.79          0.267
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)  0.201E 05     0.131E 05      0.135          0.992E-02
ROOT LEAD CONCENTRATION (UG/G)                              0.245E 05     0.873E 04      6.09           0.332
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)         0.331E 05     0.299E-01      0.276E-02      0.240E-06
STEM LEAD CONCENTRATION (UG/G)                              0.224E 05     0.935E 04      0.468          0.275E-01
FRUIT LEAD CONCENTRATION (UG/G)                             0.132E 05     0.549E 04      0.272          0.160E-01
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)          0.144E 05     0.417E-01      0.349E-02      0.552E-06
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                     0.565E 04     0.185E 04      1.32           0.690E-01
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)       0.350E 04     0.112E 04      0.329E-01      0.169E-02
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                        0.239E 04      635.          0.572E-01      0.266E-02
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                   0.192E 04      572.          0.660E-02      0.318E-03
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                     0.106E 04      796.          0.282          0.221E-01
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                      738.          298.          0.149E-01      0.862E-03
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)   48.7         -496.          0.681E-03      0.948E-04
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)        238.          74.9          0.211E-02      0.108E-03
ROOT UPTAKE OF LEAD - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)     200.          104.          0.708E-01      0.464E-02
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)  47.6          28.3          0.337E-03      0.233E-04
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                     51.6          14.9          0.110E-01      0.540E-03
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                       41.2          24.6          0.843E-03      0.593E-04
ROOT UPTAKE OF LEAD - DARK PERIOD (UG/M**2/DAY)              43.4          18.3          0.738E-02      0.437E-03
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                     27.8          10.9          0.527E-03      0.300E-04
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                     15.5          6.51          0.321E-03      0.189E-04
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER               2.17          0.687         0.374E-03      0.189E-04
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER             0.594E-04     0.183E-04      0.207E-07      0.105E-08
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER             0.122E-14     0.0            0.191E-15      0.0
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 MODEL : SCEHM                PARAMETER : SP, SOLUBILITY OF ZINC
STANDARD VALUE = 2.0 (UG/ML)

                  OUTPUT RESPONSES                          RELATIVE OUTPUT COEFFICIENTS     SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                       20.0          200.0          20.0           200.0

ZINC IN ROOT LITTER (UG/M**2 LAND)                          0.599E 07     0.599E 07     -0.109E 05     -991.
ZINC IN STEM LITTER (UG/M**2 LAND)                          0.719E 05     0.714E 05      0.263          0.238E-01
ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)          0.701E 05     0.701E 05     -127.          -11.6
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                   0.458E 05     0.458E 05      6.88           0.626
ZINC IN FRUIT LITTER (UG/M**2 LAND)                         0.432E 05     0.433E 05      0.494          0.449E-01
ZINC IN LEAF LITTER (UG/M**2 LAND)                          0.421E 05     0.421E 05      8.75           0.795
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                   0.662E 04     0.662E 04      1.05           0.957E-01
FRUIT ZINC CONCENTRATION (UG/G)                             0.116E 04     0.116E 04      2.48           0.225
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                         647.          646.         -1.77          -0.161
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)           561.          564.          0.305E-02      0.278E-03
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)          501.          504.          0.624E-02      0.569E-03
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)   261.          261.          0.274E-01      0.249E-02
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                       159.          159.          0.233E-01      0.212E-02
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                81.1          81.1          0.160          0.146E-01
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)  20.5          20.5         -0.647E-02     -0.588E-03
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)  -16.4         -16.4          0.210E-01      0.191E-02
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)        13.9          13.9          0.672E-02      0.611E-03
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)           11.0          11.0          0.890E-02      0.812E-03
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)        9.75          9.75          0.343E-01      0.312E-02
LEAF ZINC CONCENTRATION (UG/G)                               8.78          8.78          0.121          0.110E-01
ROOT UPTAKE OF ZINC - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)     2.58          2.65         -0.138E-01     -0.125E-02
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER               1.07          1.07          0.136E-02      0.124E-03
STEM ZINC CONCENTRATION (UG/G)                               0.342         0.342         0.140E-01      0.127E-02
ROOT ZINC CONCENTRATION (UG/G)                               0.173         0.173        -0.735E-02     -0.668E-03
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                     0.105         0.104         0.484E-03      0.438E-04
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                    0.988E-01     0.986E-01      0.124E-02      0.113E-03
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                     0.633E-01     0.633E-01      0.176E-02      0.160E-03
ROOT UPTAKE OF ZINC - DARK PERIOD (UG/M**2/DAY)             0.523E-01     0.523E-01     -0.333E-03     -0.302E-04
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                     0.506E-01     0.505E-01      0.210E-02      0.190E-03
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                    0.451E-01     0.453E-01      0.507E-03      0.462E-04
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                     0.168E-01     0.168E-01      0.413E-02      0.376E-03
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER             0.246E-02     0.246E-02      0.459E-05      0.417E-06
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER             0.336E-11     0.336E-11      0.256E-13      0.233E-14
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APPENDIX (continued)

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 MODEL : DIFMAS            PARAMETER : DL, DIFFUSION COEFFICIENT
STANDARD VALUE = 1.0E-5  (CM2/SEC)

              OUTPUT RESPONSES                                   RELATIVE OUTPUT COEFFICIENTS             SENSITIVITY COEFFICIENTS

   INPUT
   VALUES:                                                    1.0E-07     1.0E-03     1.0E-01     1.0E-07     1.0E-03     1.0E-01

ZINC IN ROOT LITTER (UG/M**2 LAND)                          15.3        15.3        0.144E 07   0.978E 07  -0.978E 05  -0.931E 06
ZINC UPTAKE BY LEAVES (UG/M**2/DAY)                         0.296E 05   0.295E 05   0.236E 05  -0.915E 08   0.913E 06  -0.117E 05
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                   0.601E 04   0.542E 04   0.449E 05   0.213E 08  -0.196E 06   0.326E 04
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                   0.843E 04   0.758E 04   0.129E 05   0.275E 08  -0.260E 06   0.182E 04
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                        0.804E 04   0.318E 04   0.336E 04   0.262E 08  -0.189E 05   676.
ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)          0.0         0.0         0.114E 05   0.0         0.0        -0.912E 04
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)  0.127E 04   0.153E 04   0.710E 04   0.730E 06  -0.799E 04   54.9
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)       0.328E 04   0.507E 04   638.        0.173E 07   0.202E 05   47.7
ROOT LEAD CONCENTRATION (UG/G)                              0.107E 04   747.        0.692E 04   0.348E 07  -0.291E 05   877.
FRUIT ZINC CONCENTRATION (UG/G)                             0.273E 04   0.233E 04   0.266E 04   0.902E 07  -0.832E 05   779.
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)       0.199E 04   917.        924.        0.105E 07  -0.691E 04   65.1
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                     217.        154.        0.155E 04   0.709E 06  -0.598E 04   187.
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)  578.        607.       -0.305E 04   0.307E 06  -0.407E 04   35.6
ROOT ZINC CONCENTRATION (UG/G)                              0.149E 04   11.0        0.190       0.495E 07  -0.185E 04   1.29
STEM ZINC CONCENTRATION (UG/G)                              779.        357.        0.690       0.271E 07  -0.177E 05   6.42
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)       8.40        7.86        634.        0.446E 04  -43.2        3.79
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                     379.        4.60        0.667E-01   0.125E 07  -0.129E 04   1.63
ZINC IN LEAF LITTER (UG/M**2 LAND)                          0.632E-01   0.455E-01   371.        0.248E 05  -215.       -245.
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                      3.68        3.67        360.        0.124E 05  -123.        7.08
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                        0.793       0.768       201.        0.291E 04  -28.6        4.58
LEAF ZINC CONCENTRATION (UG/G)                              93.7        72.6        10.5        0.117E 07  -0.101E 05   25.7
LEAD IN LEAF LITTER (UG/M**2 LAND)                          18.6        15.7        135.        0.228E 08  -0.196E 06   0.123E 05
ROOT UPTAKE OF LEAD - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)    17.6        11.8        67.8        0.574E 05  -459.        11.1
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR) -15.0       -13.9       -33.8       -414.        3.88       -0.894E-01
LEAD IN ROOT LITTER (UG/M**2 LAND)                          0.0         0.0         53.8        0.0         0.0        -0.645E 04
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)       0.525       0.491       37.7        279.       -2.70        0.232
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                     24.0        14.5        0.582E-01   0.837E 05  -647.        0.406
ROOT UPTAKE OF ZINC - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)    23.9        7.46        0.571       0.785E 05   419.       -1.08
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR) 22.8       -52.4        5.78        0.122E 05   0.769      -0.573
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                    1.65        1.22        14.1        0.539E 04  -46.3        1.56
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER               11.6        2.72        0.991E-01  -0.129E 06   586.       -1.14
ROOT UPTAKE OF LEAD - DARK PERIOD (UG/M**2/DAY)             0.876       0.738       10.6        0.287E 04  -26.4        0.989
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                   0.739E-01   0.694E-01   7.42        248.       -2.40        0.240
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                    4.95        1.10        0.276       0.163E 05  -75.5        0.374
ZINC IN FRUIT LITTER (UG/M**2 LAND)                         1.86        1.36        0.890E-01   0.621E 04  -52.9        0.111
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                    1.78        1.28        0.212       0.594E 04  -50.1        0.202
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                     1.81        1.37        0.802E-01   0.226E 05  -196.        0.380
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER               0.387       0.262       2.52       -0.360E 05   297.       -9.14
STEM LEAD CONCENTRATION (UG/G)                              0.191E-01   0.181E-01   1.63        0.110E 04  -10.7        1.03
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                    0.654       0.470       0.164       0.233E 04  -19.7        0.109
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)  0.167E-01   0.157E-01   0.989      -208.        2.00       -0.175
ZINC IN STEM LITTER (UG/M**2 LAND)                          0.429       0.372       0.152       0.161E 04  -15.0        0.740E-01
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)          0.950E-04   0.913E-04   0.894       63.2       -0.600      -0.720
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)          0.247E-02   0.140E-02   0.769       0.652E 04  -32.6        46.5
FRUIT LEAD CONCENTRATION (UG/G)                             0.724E-02   0.663E-02   0.728       502.       -4.82        0.513
ROOT UPTAKE OF ZINC - DARK PERIOD (UG/M**2/DAY)             0.482       0.293E-01   0.900E-01   0.191E 04   1.11       -0.807E-01
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR) 0.558E-02   0.521E-02   0.368       7.95       -0.769E-01   0.677E-02
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER              0.163       0.309E-02   0.150E-01  -993.        1.04       -0.286E-01
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)          0.0         0.0         0.126       0.0         0.0        -35.5
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)         0.233E-01   0.189E-01   0.765E-03   77.7       -0.700       0.130E-02
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                     0.262E-03   0.247E-03   0.255E-01   23.5       -0.229       0.233E-01
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)          0.402E-02   0.361E-02   0.210E-02   15.3       -0.145       0.103E-02
LEAF LEAD CONCENTRATION (UG/G)                              0.0         0.0         0.955E-02   0.0         0.0         0.355
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER              0.665E-03   0.341E-03   0.240E-02  -17.8        0.128      -0.339E-02
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                   0.741E-04   0.741E-04   0.277E-02   85.0       -0.850       0.908E-01
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                    0.880E-05   0.813E-05   0.911E-03   0.643      -0.619E-02   0.653E-03
LEAD IN FRUIT LITTER (UG/M**2 LAND)                         0.606E-05   0.566E-05   0.628E-03   0.681      -0.658E-02   0.706E-03
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                    0.358E-05   0.346E-05   0.398E-03   0.482      -0.472E-02   0.515E-03
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER             0.240E-03   0.227E-04   0.107E-03  -2.56        0.807E-02  -0.173E-03
LEAD IN STEM LITTER (UG/M**2 LAND)                          0.369E-06   0.369E-06   0.247E-04   0.228      -0.228E-02   0.348E-03
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                     0.0         0.0         0.184E-04   0.0         0.0         0.355E-02
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)         0.331E-07   0.301E-07   0.339E-05   0.688E-02  -0.649E-04   0.715E-05
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)          0.293E-08   0.265E-08   0.160E-06   0.303E-02  -0.271E-04   0.315E-05
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER             0.582E-08   0.320E-08   0.359E-07  -0.541E-03   0.398E-05  -0.134E-06
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER             0.233E-12   0.422E-13   0.227E-12  -0.118E-07   0.528E-10  -0.125E-11
FRUIT SULFUR CONCENTRATION (UG/G)                           0.0         0.0         0.0         0.0         0.0         0.0
LEAF BIOMASS (G/M**2 LAND)                                  0.0         0.0         0.0         0.0         0.0         0.0
FRUIT BIOMASS (G/M**2 LAND)                                 0.0         0.0         0.0         0.0         0.0         0.0
STEM BIOMASS (G/M**2 LAND)                                  0.0         0.0         0.0         0.0         0.0         0.0
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)                  0.0         0.0         0.0         0.0         0.0         0.0
STEM SULFUR CONCENTRATION (UG/G)                            0.0         0.0         0.0         0.0         0.0         0.0
ROOT SULFUR CONCENTRATION (UG/G)                            0.0         0.0         0.0         0.0         0.0         0.0
LEAF SULFUR CONCENTRATION (UG/G)                            0.0         0.0         0.0         0.0         0.0         0.0
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                  0.0         0.0         0.0         0.0         0.0         0.0
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER             0.0         0.0         0.0         0.0         0.0         0.0
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)     0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN LEAF LITTER (UG/M**2 LAND)                        0.0         0.0         0.0         0.0         0.0         0.0
STEM RESPIRATION (G/M**2 LAND/HR)                           0.0         0.0         0.0         0.0         0.0         0.0
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)           0.0         0.0         0.0         0.0         0.0         0.0
FRUIT RESPIRATION (G/M**2 LAND/HR)                          0.0         0.0         0.0         0.0         0.0         0.0
LEAF RESPIRATION (G/M**2 LAND/HR)                           0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                   0.0         0.0         0.0         0.0         0.0         0.0
ROOT RESPIRATION (G/M**2 LAND/HR)                           0.0         0.0         0.0         0.0         0.0         0.0
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)           0.0         0.0         0.0         0.0         0.0         0.0
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)          0.0         0.0         0.0         0.0         0.0         0.0
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR 0.0        0.0         0.0         0.0         0.0         0.0
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)     0.0         0.0         0.0         0.0         0.0         0.0
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR) 0.0        0.0         0.0         0.0         0.0         0.0
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR) 0.0        0.0         0.0         0.0         0.0         0.0
CO2 CHLOROPLAST (ML/ML)                                     0.0         0.0         0.0         0.0         0.0         0.0
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                        0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                  0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                   0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                 0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                      0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                 0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                       0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN STEM LITTER (UG/M**2 LAND)                        0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN ROOT LITTER (UG/M**2 LAND)                        0.0         0.0         0.0         0.0         0.0         0.0
SO2 UPTAKE (UG/CM**2 LEAF/DAY)                              0.0         0.0         0.0         0.0         0.0         0.0
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                      0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)        0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                   0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)       0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)        0.0         0.0         0.0         0.0         0.0         0.0
LEAD UPTAKE BY LEAVES (UG/M**2/DAY)                         0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)        0.0         0.0         0.0         0.0         0.0         0.0
ROOT BIOMASS (G/M**2 LAND)                                  0.0         0.0         0.0         0.0         0.0         0.0
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APPENDIX (continued)

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  MODEL : CERES          PARAMETER : FDM, DECOMPOSITION MAXIMUM FOR FRUITS
STANDARD VALUE = 3.5E-4  (G/G)

                    OUTPUT RESPONSES                        RELATIVE OUTPUT COEFFICIENTS      SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                       3.5E-5        3.5E-3        3.5E-5        3.5E-3

ZINC IN FRUIT LITTER (UG/M**2 LAND)                             0.624         0.211E-02      113.          0.654
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                        0.496         0.705E-03      98.4          0.368
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)             0.300         0.196E-01     -8.75         -0.224
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)             0.628E-02     0.139E-03     -0.106        -0.158E-02
LEAD IN FRUIT LITTER (UG/M**2 LAND)                             0.725E-03     0.308E-05      0.272         0.126E-02
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)           0.206E-03     0.204E-05     -0.234E-02    -0.233E-04
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                      0.0           0.388E-04      0.0           0.130E-01
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                        0.0           0.811E-05      0.0          -0.199E-02
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                           0.578E-09     0.171E-06      0.125E-04     0.634E-04
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  MODEL : CERES          PARAMETER : LDM, DECOMPOSITION MAXIMUM FOR LEAVES
STANDARD VALUE = 5.0E-5  (G/G)

                    OUTPUT RESPONSES                        RELATIVE OUTPUT COEFFICIENTS      SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                       5.0E-6        5.0E-4        5.0E-6        5.0E-4

LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)              0.377E 07     0.313E 05     -0.273E 09    -0.249E 07
LEAD IN LEAF LITTER (UG/M**2 LAND)                              0.959E 05      741.         -0.764E 09    -0.667E 07
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)               527.          4.62         -0.393E 05    -367.
ZINC IN LEAF LITTER (UG/M**2 LAND)                               5.46         0.413E-01     -0.544E 05    -437.
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                       0.0           0.487          0.0           0.120E 04
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)            0.405         0.402E-02     -32.3         -0.322
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                         0.733E-04     0.235E-02      11.5          15.6
SULFUR IN LEAF LITTER (UG/M**2 LAND)                            0.143E-06     0.173E-02      0.717E-01     4.90
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                         0.0           0.184E-04      0.0           0.788
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  MODEL : CERES          PARAMETER : SDM, DECOMPOSITION MAXIMUM FOR STEMS
STANDARD VALUE = 1.8E-4  (G/G)

                    OUTPUT RESPONSES                        RELATIVE OUTPUT COEFFICIENTS      SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                       1.8E-5        1.8E-3        1.8E-5        1.8E-3

ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)              0.382         0.438E-02     -9.10         -0.975E-01
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)              0.333E-01     0.503E-03     -0.907        -0.111E-01
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                         0.156E-05     0.176E-01      0.199         13.8
ZINC IN STEM LITTER (UG/M**2 LAND)                              0.516E-02     0.119E-02      9.84          0.517
LEAD IN STEM LITTER (UG/M**2 LAND)                              0.195E-02     0.141E-04      2.02          0.171E-01
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                       0.0           0.160E-02      0.0           0.992
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                         0.0           0.431E-03      0.0          -0.190
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)            0.436E-04     0.432E-06     -0.964E-03    -0.960E-05
SULFUR IN STEM LITTER (UG/M**2 LAND)                            0.451E-10     0.503E-07      0.239E-05     0.283E-04
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  MODEL : CERES          PARAMETER : RDM, DECOMPOSITION MAXIMUM FOR ROOTS
STANDARD VALUE = 1.3E-4  (G/G)

                    OUTPUT RESPONSES                        RELATIVE OUTPUT COEFFICIENTS      SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                       1.3E-5        1.3E-3        1.3E-5        1.3E-3

LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)              0.692E 08     0.109E 07     -0.267E 10    -0.335E 08
LEAD IN ROOT LITTER (UG/M**2 LAND)                              0.540E 07     0.747E 05      0.710E 10     0.830E 08
ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)              0.353E 07     0.578E 05     -0.139E 09    -0.178E 07
ZINC IN ROOT LITTER (UG/M**2 LAND)                              0.344E 06     0.479E 04      0.390E 09     0.458E 07
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                         0.0           0.113E-01      0.0           35.4
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                         0.0           0.936E-02      0.0           48.0
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)            0.173E-02     0.171E-04     -0.528E-01    -0.525E-03
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                       0.0           0.869E-03      0.0           0.730
SULFUR IN ROOT LITTER (UG/M**2 LAND)                            0.384E-09     0.215E-05      0.827E-04     0.196E-02
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APPENDIX (continued)

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MODEL : CERES      PARAMETER : LSPHLO, LEAF TO STEM PHLOEM RESISTANCE
STANDARD VALUE  = 20.0 (HR)

                 OUTPUT RESPONSES                               RELATIVE OUTPUT COEFFICIENTS     SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                            1.00        100.00          1.00        100.00

ZINC IN ROOT LITTER (UG/M**2 LAND)                              0.279E 06     4.76          0.156E 04    -0.403
SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                  0.693E 04     0.184E 06    -203.         -398.
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)     403.         0.123E 06     0.143         0.590
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)       558.         0.238E 05     0.178        -0.114
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                       0.827E 04     0.170E 04    -10.8         -0.987
STEM SULFUR CONCENTRATION (UG/G)                                 29.5         0.932E 04     0.717E-01     0.303
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)       18.0         0.844E 04     0.615E-02     0.316E-01
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                       0.359E 04     0.339E 04     3.48         -1.18
FRUIT ZINC CONCENTRATION (UG/G)                                 0.332E 04     0.121E 04    -5.00         -0.741
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)     13.0         0.400E 04     0.461E-02     0.191E-01
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)      0.353E-01    -0.397E 04     0.834E-04     0.101E-02
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                            0.234E 04     0.138E 04     6.41          0.442
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)           0.174E 04     0.186E 04     0.650         0.145
STEM BIOMASS (G/M**2 LAND)                                      0.132E 04     905.          9.25          1.87
STEM LEAD CONCENTRATION (UG/G)                                   3.57         0.152E 04     0.838E-02     0.412E-01
FRUIT SULFUR CONCENTRATION (UG/G)                                12.8         0.134E 04     0.351E-01     0.847E-01
LEAF SULFUR CONCENTRATION (UG/G)                                 378.         559.         -5.69         -1.18
ROOT SULFUR CONCENTRATION (UG/G)                                 2.42         688.          0.542E-02     0.217E-01
ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)               671.         0.0           9.69          0.0
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)            478.         74.1          0.247        -0.135E-01
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                      19.0         414.         -0.151        -0.169
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)          1.73         405.          0.620E-03     0.225E-02
LEAF BIOMASS (G/M**2 LAND)                                       51.3         341.         -0.879        -0.696
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)      -609.         223.          0.544E-01    -0.336E-01
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                       0.928         373.          0.205E-02     0.975E-02
ROOT BIOMASS (G/M**2 LAND)                                       38.0         331.          0.956         0.697
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)                62.3         294.          0.244E-01     0.418E-02
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR   0.808         249.          0.286E-03     0.119E-02
FRUIT LEAD CONCENTRATION (UG/G)                                  1.72         245.          0.436E-02     0.124E-01
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                       0.481         197.          0.106E-02     0.509E-02
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)      34.5         150.          0.790E-02     0.474E-02
FRUIT BIOMASS (G/M**2 LAND)                                      15.1         154.          0.590E-01     0.458E-01
ROOT LEAD CONCENTRATION (UG/G)                                   18.7         78.2         -0.230        -0.114
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                9.13         78.3          0.270E-02     0.183E-02
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                          0.404         84.2          0.892E-03     0.306E-02
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                       0.903E-01     77.5         -0.394E-02    -0.315E-01
ZINC IN LEAF LITTER (UG/M**2 LAND)                               72.2         0.208E-01     0.411        -0.185E-02
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                         0.137         70.6          0.289E-03     0.156E-02
LEAF LEAD CONCENTRATION (UG/G)                                   8.30         56.7          0.160         0.759E-01
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)         0.921E-01     51.4          0.357E-04     0.191E-03
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                     0.228E-01     42.2          0.491E-04     0.443E-03
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                        11.8         25.2         -0.140        -0.490E-01
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                           16.2         3.27         -0.878E-02    -0.142E-02
LEAD IN STEM LITTER (UG/M**2 LAND)                              0.352E-01     18.6          0.744E-04     0.407E-03
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)     0.260E-01     13.7          0.112E-04     0.631E-04
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                      0.240E-01     10.7          0.530E-04     0.265E-03
LEAF ZINC CONCENTRATION (UG/G)                                   5.62         4.67         -0.915E-01    -0.160E-01
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                      0.250E-01     9.50          0.550E-04     0.255E-03
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                       0.391E-02     8.74         -0.274E-04     0.124E-03
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                            0.427E-01     7.72         -0.294E-03     0.751E-03
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)              0.581         5.91          0.172E-03     0.127E-03
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                         0.370         4.49          0.199E-01     0.167E-01
STEM ZINC CONCENTRATION (UG/G)                                   1.05         2.88         -0.455E-01    -0.152E-01
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                         0.633         3.14         -0.199E-01    -0.105E-01
LEAD IN FRUIT LITTER (UG/M**2 LAND)                             0.634E-02     3.39          0.135E-04     0.742E-04
STEM RESPIRATION (G/M**2 LAND/HR)                                2.04         1.21          0.226E-02     0.414E-03
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                        0.460E-02     2.15          0.963E-05     0.494E-04
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)           0.652         1.32         -0.645E-03    -0.198E-03
ROOT ZINC CONCENTRATION (UG/G)                                  0.472         1.38         -0.146E-01    -0.162E-01
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)                      0.355E-02     1.62          0.781E-05     0.396E-04
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                        0.290E-02     1.54          0.625E-05     0.342E-04
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                         0.668         0.555         0.720E-02     0.157E-02
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                         0.159         0.748        -0.300E-02    -0.175E-02
ZINC IN FRUIT LITTER (UG/M**2 LAND)                             0.121         0.472         0.726E-03     0.332E-03
SULFUR IN ROOT LITTER (UG/M**2 LAND)                            0.143E-02     0.556         0.314E-05     0.147E-04
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                        0.494E-01     0.482         0.473E-03     0.342E-03
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)           0.206         0.238        -0.908E-04    -0.117E-04
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                         0.102E-02     0.346        -0.358E-03    -0.171E-02
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)              0.401E-03     0.213         0.848E-06     0.464E-05
FRUIT RESPIRATION (G/M**2 LAND/HR)                              0.159E-01     0.146         0.102E-04     0.736E-05
SULFUR IN LEAF LITTER (UG/M**2 LAND)                            0.411E-01     0.113        -0.571E-03    -0.230E-03
ROOT RESPIRATION (G/M**2 LAND/HR)                               0.119E-01     0.978E-01     0.531E-04     0.362E-04
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                   0.654E-01     0.375E-01    -0.431E-02    -0.681E-03
ZINC IN STEM LITTER (UG/M**2 LAND)                              0.248E-01     0.484E-01     0.161E-03     0.653E-04
LEAF RESPIRATION (G/M**2 LAND/HR)                               0.188E-02     0.645E-01    -0.308E-04    -0.419E-04
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)             0.111E-03     0.593E-01     0.234E-06     0.129E-05
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)              0.579E-01     0.580E-04     0.806E-03    -0.532E-05
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                           0.136E-03     0.496E-01     0.299E-06     0.136E-05
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                        0.933E-03     0.263E-01    -0.934E-04     0.146E-03
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                        0.679E-02     0.186E-01     0.112E-03     0.485E-04
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                        0.947E-02     0.136E-01    -0.211E-03    -0.592E-04
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                   0.349E-02     0.102E-01     0.985E-03     0.605E-03
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                          0.315E-03     0.119E-01     0.332E-05    -0.485E-05
SULFUR IN STEM LITTER (UG/M**2 LAND)                            0.240E-04     0.111E-01     0.529E-07     0.269E-06
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                            0.217E-02     0.484E-02     0.906E-06     0.308E-06
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                  0.309E-02     0.364E-02     0.578E-04     0.163E-04
CO2 CHLOROPLAST (ML/ML)                                         0.264E-02     0.375E-02    -0.283E-05    -0.837E-06
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)            0.126E-04     0.516E-02     0.278E-07     0.133E-06
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)             0.838E-03     0.157E-02     0.659E-05     0.206E-05
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)              0.948E-04     0.580E-03     0.105E-05     0.712E-06
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)           0.151E-05     0.570E-03     0.332E-08     0.153E-07
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)            0.963E-04     0.214E-03    -0.117E-05    -0.417E-06
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                  0.138E-03     0.171E-03     0.422E-05     0.112E-05
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)            0.319E-06     0.152E-03     0.703E-09     0.364E-08
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER                 0.250E-04     0.129E-04     0.440E-06     0.723E-07
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER                 0.301E-07     0.160E-07     0.676E-09     0.114E-09
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER                 0.164E-12     0.726E-13     0.576E-14     0.863E-15
LEAD IN ROOT LITTER (UG/M**2 LAND)                              0.0           0.0           0.0           0.0
LEAD IN LEAF LITTER (UG/M**2 LAND)                              0.0           0.0           0.0           0.0
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)              0.0           0.0           0.0           0.0
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER                 0.0           0.0           0.0           0.0
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)              0.0           0.0           0.0           0.0
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APPENDIX (continued)

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 MODEL : CERES        PARAMETER : SRPHLO, STEM TO ROOT PHLOEM RESISTANCE
STANDARD VALUE  = 30.0 (HR)

                  OUTPUT RESPONSES                            RELATIVE OUTPUT COEFFICIENTS     SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                        1.00        100.00            1.00        100.00

ZINC IN ROOT LITTER (UG/M**2 LAND)                              0.182E 06    0.0             822.          0.0
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)      147.        -0.192E 05       0.581E-01     0.360E-03
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)    10.4         0.515E 04       0.269E-02     0.239E-01
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)      847.         497.           -0.489E-01    -0.450E-01
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                       204.         0.114E 04      -1.23         -1.17
SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                  78.5         0.122E 04      -11.1         -21.4
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                            194.         639.            0.421        -0.255
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                       134.         572.           -0.740        -0.865
ROOT BIOMASS (G/M**2 LAND)                                      37.9         579.            0.666         1.11
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)      0.879E-01   -597.            0.195E-04     0.409E-03
ROOT SULFUR CONCENTRATION (UG/G)                                1.89         554.            0.314E-02     0.223E-01
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)         1.34         452.            0.357E-03     0.270E-02
ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)              434.         0.0             5.09          0.0
STEM BIOMASS (G/M**2 LAND)                                      17.3         280.           -0.709        -1.19
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)           59.2         113.            0.637E-01     0.253E-01
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                       0.385        168.            0.621E-03     0.537E-02
ROOT LEAD CONCENTRATION (UG/G)                                  19.3         144.           -0.156        -0.180
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)           17.2         79.4           -0.232E-01    -0.121E-02
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)               4.33         62.3            0.122E-02     0.153E-02
LEAF SULFUR CONCENTRATION (UG/G)                                3.59         58.7           -0.359        -0.618
FRUIT ZINC CONCENTRATION (UG/G)                                 3.41         54.6            0.539E-01     0.547E-01
ZINC IN LEAF LITTER (UG/M**2 LAND)                              47.3         0.156E-01       0.218        -0.221E-02
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                          0.316        42.0            0.518E-03     0.246E-02
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)         0.787E-01    33.8            0.216E-04     0.185E-03
LEAD IN LEAF LITTER (UG/M**2 LAND)                              0.0          33.4            0.0          -5.99
STEM SULFUR CONCENTRATION (UG/G)                                0.882E-02    12.1           -0.701E-03    -0.125E-01
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                         0.783        11.3            0.194E-01     0.305E-01
FRUIT BIOMASS (G/M**2 LAND)                                     0.758        8.90           -0.893E-02    -0.128E-01
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                         0.607        8.76           -0.128E-01    -0.201E-01
LEAF BIOMASS (G/M**2 LAND)                                      0.369        7.51           -0.400E-01    -0.839E-01
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)     -2.15        9.78           -0.812E-03     0.289E-03
FRUIT SULFUR CONCENTRATION (UG/G)                               0.167        5.99            0.259E-02     0.649E-02
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                            0.478E-01    5.35           -0.220E-03     0.542E-03
LEAF ZINC CONCENTRATION (UG/G)                                  0.182        4.56           -0.123E-01    -0.293E-01
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)           0.829        3.35           -0.475E-03    -0.390E-03
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                     0.126E-01    3.27            0.237E-04     0.158E-03
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                          0.338E-01    2.53           -0.823E-04    -0.143E-02
LEAF LEAD CONCENTRATION (UG/G)                                  0.897E-01    1.91            0.990E-02     0.187E-01
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                       0.100        1.66           -0.839E-02    -0.142E-01
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)    0.882E-01    1.56           -0.136E-02    -0.237E-02
ROOT ZINC CONCENTRATION (UG/G)                                  0.196        1.20           -0.170E-01    -0.193E-01
FRUIT LEAD CONCENTRATION (UG/G)                                 0.347E-01    1.32            0.410E-03     0.105E-02
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                     0.903E-01    1.22           -0.659E-02    -0.102E-01
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)                      0.282E-02    1.20            0.456E-05     0.389E-04
STEM LEAD CONCENTRATION (UG/G)                                  0.313E-02    0.575           0.160E-03    -0.914E-03
STEM ZINC CONCENTRATION (UG/G)                                  0.271E-01    0.538          -0.256E-02    -0.539E-02
SULFUR IN ROOT LITTER (UG/M**2 LAND)                            0.114E-02    0.502           0.184E-05     0.160E-04
STEM RESPIRATION (G/M**2 LAND/HR)                               0.270E-01    0.437          -0.170E-03    -0.285E-03
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                         0.214E-01    0.395          -0.849E-03    -0.152E-02
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                       0.251E-02    0.414          -0.695E-04    -0.371E-03
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)              0.661E-01    0.171          -0.122E-01    -0.166E-01
ROOT RESPIRATION (G/M**2 LAND/HR)                               0.126E-01    0.203           0.360E-04     0.601E-04
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)           0.391E-01    0.177          -0.258E-04    -0.226E-04
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)               0.218E-01    0.173           0.262E-03     0.267E-03
ZINC IN FRUIT LITTER (UG/M**2 LAND)                             0.757E-02    0.165           0.377E-04    -0.260E-03
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                        0.593E-02    0.138          -0.117E-03    -0.233E-03
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)              0.0          0.142           0.0           0.461E-01
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)              0.152E-01    0.111          -0.178E-04    -0.204E-04
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                         0.344E-02    0.998E-01      -0.286E-03    -0.686E-03
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                        0.481E-02    0.654E-01      -0.992E-04    -0.152E-03
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)              0.377E-01    0.715E-04       0.427E-03    -0.793E-05
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                       0.728E-02    0.256E-01      -0.259E-04    -0.200E-04
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                         0.247E-05    0.296E-01       0.401E-07    -0.365E-04
LEAD IN STEM LITTER (UG/M**2 LAND)                              0.154E-04    0.274E-01      -0.101E-05    -0.178E-04
ZINC IN STEM LITTER (UG/M**2 LAND)                              0.819E-02    0.142E-01       0.438E-04    -0.412E-04
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                   0.347E-02    0.174E-01       0.634E-03     0.106E-02
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                        0.142E-02    0.160E-01      -0.366E-04    -0.513E-04
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                        0.119E-02    0.155E-01       0.756E-04     0.109E-03
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                   0.620E-03    0.112E-01       0.445E-04     0.267E-03
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                      0.735E-04    0.110E-01      -0.191E-05    -0.973E-05
FRUIT RESPIRATION (G/M**2 LAND/HR)                              0.749E-03    0.940E-02      -0.146E-05    -0.214E-05
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)      0.165E-02    0.800E-02       0.235E-04     0.218E-04
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                       0.595E-03    0.860E-02       0.951E-04     0.155E-03
SULFUR IN LEAF LITTER (UG/M**2 LAND)                            0.351E-03    0.581E-02      -0.334E-04    -0.582E-04
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                  0.227E-03    0.499E-02       0.117E-04     0.224E-04
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)            0.101E-04    0.441E-02       0.163E-07     0.141E-06
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)     0.504E-03    0.220E-02      -0.850E-06    -0.692E-06
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)             0.429E-04    0.249E-02       0.670E-06    -0.357E-05
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR    0.126E-03    0.152E-02      -0.215E-05     0.329E-06
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                        0.997E-07    0.105E-02       0.167E-07    -0.125E-05
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)              0.171E-06    0.319E-03      -0.114E-07    -0.205E-06
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                  0.114E-04    0.205E-03       0.798E-06     0.141E-05
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)              0.203E-04    0.144E-03       0.191E-06    -0.409E-06
LEAF RESPIRATION (G/M**2 LAND/HR)                               0.222E-04    0.890E-04      -0.826E-06    -0.123E-05
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                          0.389E-05    0.866E-04       0.241E-06     0.471E-06
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                         0.184E-04    0.522E-04      -0.122E-04    -0.102E-04
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                      0.100E-04    0.485E-04      -0.714E-06    -0.646E-06
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER                 0.181E-05    0.360E-04       0.774E-07     0.144E-06
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                        0.781E-06    0.334E-04       0.605E-07     0.179E-06
LEAD IN FRUIT LITTER (UG/M**2 LAND)                             0.546E-06    0.258E-04       0.790E-07     0.229E-06
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)            0.855E-06    0.133E-04      -0.714E-07    -0.117E-06
CO2 CHLOROPLAST (ML/ML)                                         0.128E-05    0.101E-04      -0.377E-07    -0.461E-07
SULFUR IN STEM LITTER (UG/M**2 LAND)                            0.805E-07    0.111E-04      -0.200E-08    -0.975E-08
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                            0.867E-06    0.886E-05       0.117E-07     0.155E-07
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)             0.129E-07    0.315E-06       0.160E-08     0.334E-08
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                           0.411E-07    0.179E-06      -0.332E-08    -0.287E-08
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)            0.109E-08    0.148E-06      -0.269E-10    -0.130E-09
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER                 0.171E-08    0.340E-07       0.105E-09     0.195E-09
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)           0.522E-09    0.276E-08      -0.399E-10    -0.380E-10
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER                 0.857E-14    0.225E-12       0.857E-15     0.182E-14
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER                 0.0          0.0             0.0           0.0
LEAD IN ROOT LITTER (UG/M**2 LAND)                              0.0          0.0             0.0           0.0
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APPENDIX (continued)

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 MODEL : CERES       PARAMETER : SFPHLO, STEM TO FRUIT PHLOEM RESISTANCE
STANDARD VALUE  = 500.0 (HR)

                  OUTPUT RESPONSES                         RELATIVE OUTPUT COEFFICIENTS      SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                     100.00        1000.00          100.00        1000.00

FRUIT BIOMASS (G/M**2 LAND)                                  9.20          533.            0.227E-02      0.138E-01
FRUIT ZINC CONCENTRATION (UG/G)                              80.1          296.            0.257E-01     -0.523E-01
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)   86.8          31.7           -0.125E-02     -0.299E-03
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                    16.0          34.6           -0.267E-01     -0.726E-02
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR) -7.00         -39.6           -0.790E-04     -0.547E-03
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                    7.48          20.4           -0.191E-01     -0.100E-01
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR 0.336         21.5            0.877E-05      0.560E-04
FRUIT SULFUR CONCENTRATION (UG/G)                            2.40          8.10            0.718E-03      0.102E-02
SO2 UPTAKE (UG/CM**2 LEAF/DAY)                               0.112         9.91           -0.806E-02     -0.116
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)           0.167         9.58            0.437E-05      0.265E-04
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                         1.08          6.14           -0.555E-02      0.208E-02
ZINC IN FRUIT LITTER (UG/M**2 LAND)                          0.217         6.08            0.523E-04      0.220E-03
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                     0.192         5.58            0.482E-04      0.205E-03
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)   2.80          2.21           -0.533E-03      0.232E-03
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)        2.58          2.33           -0.907E-03      0.537E-03
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)        0.560         1.80           -0.845E-03      0.729E-03
STEM BIOMASS (G/M**2 LAND)                                   0.275E-01     1.50           -0.177E-02     -0.121E-01
FRUIT LEAD CONCENTRATION (UG/G)                              0.303         1.12            0.868E-04      0.130E-03
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)  0.180E-01     1.16            0.469E-06      0.301E-05
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                   0.105E-01     0.667           0.169E-05      0.108E-04
FRUIT RESPIRATION (G/M**2 LAND/HR)                           0.974E-02     0.564           0.381E-06      0.232E-05
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                       0.477E-01     0.378           0.238E-04     -0.691E-04
LEAF SULFUR CONCENTRATION (UG/G)                             0.613E-02     0.414          -0.403E-03     -0.445E-02
LEAD IN FRUIT LITTER (UG/M**2 LAND)                          0.250E-02     0.161           0.403E-06      0.259E-05
ROOT BIOMASS (G/M**2 LAND)                                   0.176E-01     0.123          -0.484E-03     -0.194E-02
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                     0.117E-02     0.756E-01       0.189E-06      0.121E-05
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)          0.307E-02     0.636E-01       0.698E-06      0.254E-05
LEAF ZINC CONCENTRATION (UG/G)                               0.646E-02     0.379E-01      -0.145E-03     -0.284E-03
ROOT LEAD CONCENTRATION (UG/G)                               0.234E-02     0.357E-01       0.806E-04      0.361E-03
LEAF BIOMASS (G/M**2 LAND)                                   0.281E-02     0.202E-01      -0.806E-04     -0.516E-03
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)            0.321E-03     0.175E-01      -0.737E-06     -0.442E-05
LEAF LEAD CONCENTRATION (UG/G)                               0.107E-03     0.140E-01       0.807E-05      0.181E-03
STEM ZINC CONCENTRATION (UG/G)                               0.276E-02     0.352E-02      -0.645E-04      0.258E-04
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                  0.106E-04     0.620E-02      -0.806E-06     -0.626E-04
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                    0.433E-03     0.464E-02      -0.106E-04     -0.843E-04
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR) 0.343E-03     0.377E-02      -0.249E-05     -0.150E-04
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                        0.570E-04     0.361E-02       0.919E-08      0.585E-07
ROOT ZINC CONCENTRATION (UG/G)                               0.407E-03     0.302E-02      -0.161E-04      0.710E-04
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                      0.198E-02     0.115E-02      -0.266E-04     -0.220E-04
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)          0.430E-04     0.277E-02       0.694E-08      0.445E-07
STEM RESPIRATION (G/M**2 LAND/HR)                            0.250E-03     0.236E-02      -0.560E-06     -0.286E-05
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR) 0.137E-03     0.225E-02      -0.328E-06     -0.225E-05
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)            0.732E-04     0.188E-02       0.638E-06      0.435E-05
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)        0.798E-04     0.159E-02       0.227E-06      0.117E-05
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                      0.164E-03     0.131E-02      -0.251E-05     -0.118E-04
STEM SULFUR CONCENTRATION (UG/G)                             0.562E-04     0.138E-02      -0.806E-06     -0.148E-04
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                      0.165E-04     0.944E-03       0.887E-06      0.129E-04
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                      0.235E-03     0.513E-03      -0.356E-05     -0.477E-05
ZINC IN LEAF LITTER (UG/M**2 LAND)                           0.407E-03     0.192E-03      -0.161E-04     -0.645E-05
ROOT SULFUR CONCENTRATION (UG/G)                             0.606E-04     0.306E-03      -0.790E-06     -0.219E-05
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                    0.500E-05     0.259E-03      -0.171E-06     -0.127E-05
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)        0.122E-04     0.237E-03       0.261E-07      0.115E-06
STEM LEAD CONCENTRATION (UG/G)                               0.297E-04     0.196E-03       0.565E-06      0.219E-05
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                     0.489E-04     0.104E-03      -0.565E-06     -0.110E-05
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)      0.436E-05     0.144E-03      -0.196E-07     -0.208E-06
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                    0.343E-05     0.112E-03      -0.102E-06     -0.610E-06
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                0.0           0.115E-03       0.0           -0.387E-05
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                         0.407E-05     0.819E-04      -0.129E-06     -0.556E-06
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)   0.104E-05     0.840E-04      -0.115E-07     -0.635E-07
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                       0.575E-05     0.675E-04      -0.115E-06     -0.433E-06
ROOT RESPIRATION (G/M**2 LAND/HR)                            0.869E-05     0.607E-04      -0.195E-07     -0.106E-06
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                    0.543E-05     0.579E-04       0.169E-06      0.176E-05
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                     0.534E-05     0.526E-04      -0.968E-07     -0.400E-06
ZINC IN STEM LITTER (UG/M**2 LAND)                           0.300E-05     0.414E-04      -0.589E-07     -0.305E-06
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)        0.634E-06     0.402E-04       0.102E-09      0.652E-09
SULFUR IN LEAF LITTER (UG/M**2 LAND)                         0.108E-04     0.255E-04      -0.114E-06     -0.392E-06
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)   0.688E-05     0.205E-04      -0.143E-07      0.417E-08
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                    0.436E-06     0.128E-04       0.108E-07      0.609E-07
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER               0.138E-07     0.938E-05       0.806E-09      0.981E-07
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                   0.207E-06     0.744E-05      -0.363E-08     -0.348E-07
LEAF RESPIRATION (G/M**2 LAND/HR)                            0.258E-06     0.722E-05      -0.260E-08     -0.135E-07
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                      0.941E-07     0.343E-05      -0.323E-08     -0.395E-07
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                  0.856E-07     0.252E-05      -0.226E-08     -0.185E-07
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                     0.0           0.255E-05       0.0           -0.645E-08
LEAD IN STEM LITTER (UG/M**2 LAND)                           0.359E-06     0.203E-05      -0.484E-08     -0.194E-07
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)      0.331E-06     0.184E-05       0.483E-09      0.223E-08
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)                   0.430E-07     0.105E-05      -0.766E-09     -0.503E-08
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER               0.0           0.608E-06       0.0            0.555E-08
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)           0.159E-07     0.506E-06      -0.396E-09     -0.335E-08
SULFUR IN ROOT LITTER (UG/M**2 LAND)                         0.430E-08     0.385E-06      -0.194E-09     -0.192E-08
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                       0.0           0.318E-06       0.0            0.400E-08
CO2 CHLOROPLAST (ML/ML)                                      0.441E-07     0.204E-06      -0.130E-09     -0.490E-09
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                     0.153E-07     0.762E-07      -0.323E-09     -0.110E-08
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                         0.850E-08     0.712E-07       0.417E-10      0.185E-09
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER              0.947E-08     0.473E-07       0.105E-09      0.471E-09
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)         0.106E-07     0.440E-07      -0.267E-09     -0.813E-09
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)           0.272E-08     0.230E-07      -0.508E-10     -0.233E-09
SULFUR IN STEM LITTER (UG/M**2 LAND)                         0.248E-09     0.698E-08      -0.565E-11     -0.340E-10
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)         0.594E-09     0.220E-08      -0.704E-11     -0.136E-10
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)         0.224E-11     0.950E-10      -0.590E-13     -0.458E-12
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER              0.0           0.967E-10       0.0            0.968E-12
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER              0.0           0.122E-14       0.0            0.181E-16
LEAD IN ROOT LITTER (UG/M**2 LAND)                           0.0           0.0             0.0            0.0
ZINC IN ROOT LITTER (UG/M**2 LAND)                           0.0           0.0             0.0            0.0
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                      0.0           0.0             0.0            0.0
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                0.0           0.0             0.0            0.0
ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)           0.0           0.0             0.0            0.0
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)           0.0           0.0             0.0            0.0
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER              0.0           0.0             0.0            0.0
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)           0.0           0.0             0.0            0.0
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)           0.0           0.0             0.0            0.0
LEAD IN LEAF LITTER (UG/M**2 LAND)                           0.0           0.0             0.0            0.0
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APPENDIX (continued)

MODEL : CERES   PARAMETER : LRESTD, STANDARD RESPIRATION RATE FOR LEAVES
STANDARD VALUE = 1.8E-4 (G/G/HR)

OUTPUT RESPONSES	RELATIVE OUTPUT COEFFICIENTS		SENSITIVITY COEFFICIENTS	
INPUT VALUES:	1.8E-5	1.8E-3	1.8E-5	1.8E-3
SO2 UPTAKE (UG/CM**2 LEAF/DAY)	0.745E 06	725.	0.405E 09	0.778E 06
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)	0.282E 04	24.0	0.287E 06	0.296E 04
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)	0.231E 04	32.5	-0.104E 05	0.529E 04
LEAF BIOMASS (G/M**2 LAND)	0.179E 04	3.39	0.906E 06	0.225E 04
STEM BIOMASS (G/M**2 LAND)	0.129E 04	15.0	0.108E 07	0.119E 05
LEAF LEAD CONCENTRATION (UG/G)	0.124E 04	0.719	-0.328E 06	-484.
LEAF SULFUR CONCENTRATION (UG/G)	798.	16.0	0.597E 06	0.133E 05
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)	560.	184.	0.279E 05	263.
ZINC CONTENT IN ROOT XYLEM (UG/M**2)	623.	14.3	0.265E 06	125.
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)	296.	3.44	0.142E 05	-311.
FRUIT ZINC CONCENTRATION (UG/G,	286.	3.13	0.753E 04	-0.104E 04
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)	272.	1.32	-0.104E 05	-147.
LEAF RESPIRATION (G/M**2 LAND/HR)	249.	5.85	-0.136E 04	-20.9
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)	-138.	1.91	0.308E 04	63.8
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)	100.	0.410	0.827E 04	52.4
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)	56.6	0.358	0.305E 05	237.
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)	54.6	0.939E-01	0.250E 04	6.49
ROOT LEAD CONCENTRATION (UG/G)	29.0	0.906E-01	0.294E 05	-112.
ROOT BIOMASS (G/M**2 LAND)	25.1	0.667	0.890E 05	0.153E 04
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)	-22.6	0.261	-621.	-6.28
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)	20.5	0.293E-02	-0.688E 04	-3.58
STEM LEAD CONCENTRATION (UG/G)	13.0	0.283E-01	-0.188E 04	-8.74
FRUIT LEAD CONCENTRATION (UG/G)	11.4	0.316E-01	-0.130E 04	-7.01
FRUIT BIOMASS (G/M**2 LAND)	10.2	0.275	0.558E 04	95.4
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)	7.56	0.169E-03	-458.	-0.689E-01
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)	6.78	0.856E-01	270.	2.82
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)	-3.37	-0.486E-04	-8.81	0.135E-01
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)	3.24	0.129E-01	267.	1.67
LEAF ZINC CONCENTRATION (UG/G)	2.77	0.124	0.368E 04	21.9
STEM RESPIRATION (G/M**2 LAND/HR)	2.10	0.229E-01	269.	2.80
STEM SULFUR CONCENTRATION (UG/G)	1.92	0.249E-02	0.198E 04	6.17
STEM ZINC CONCENTRATION (UG/G)	1.57	0.664E-02	-0.181E 04	1.99
FRUIT SULFUR CONCENTRATION (UG/G)	1.15	0.234E-01	316.	-15.0
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)	1.07	0.754E-02	47.4	-0.742
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER	0.505	0.379E-02	-0.163E 04	-13.5
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)	0.475	0.656E-03	34.2	0.108
ROOT SULFUR CONCENTRATION (UG/G)	0.450	0.239E-02	273.	1.95
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)	0.438	0.582E-02	17.3	0.186
ROOT ZINC CONCENTRATION (UG/G)	0.394	0.144E-01	-0.317E 04	-71.7
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER	0.289	0.520E-03	-77.5	-0.322
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR	0.201	0.882E-03	16.6	0.108
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)	0.168	0.153E-02	0.247	-0.887E-01
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)	0.152	0.424E-03	98.6	0.498
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)	0.916E-01	0.611E-03	49.2	0.395
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)	0.724E-01	0.435E-03	119.	0.876
LEAD CONTENT IN ROOT XYLEM (UG/M**2)	0.714E-01	0.330E-03	20.8	-0.277
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)	0.418E-01	0.757E-03	35.9	0.482
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)	0.328E-01	0.637E-04	1.25	-0.848E-02
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)	0.261E-01	0.878E-04	0.211	-0.432E-01
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER	0.174E-01	0.240E-04	-422.	-0.398
FRUIT RESPIRATION (G/M**2 LAND/HR)	0.111E-01	0.301E-03	1.00	0.165E-01
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)	0.107E-01	0.373E-05	-0.823	-0.146E-02
ROOT RESPIRATION (G/M**2 LAND/HR)	0.813E-02	0.234E-03	5.14	0.836E-01
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER	0.662E-02	0.855E-05	-3.42	-0.122E-01
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)	0.568E-02	0.478E-04	3.02	0.276E-01
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)	0.486E-02	0.130E-04	1.95	0.960E-02
CO2 CHLOROPLAST (ML/ML)	0.460E-02	0.144E-04	0.400	0.202E-02
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)	0.383E-02	0.126E-04	-1.03	-0.591E-02
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)	0.273E-02	0.914E-05	-0.114	-0.646E-03
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER	0.251E-02	0.320E-05	-0.517	-0.185E-02
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER	0.195E-05	0.294E-08	-0.638E-03	-0.247E-05
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER	0.176E-10	0.164E-13	-0.695E-08	-0.213E-10
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER	0.0	0.0	0.0	0.0

APPENDIX (continued)

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  MODEL : CERES          PARAMETER : SRESTD, STANDARD RESPIRATION RATE FOR STEMS
STANDARD VALUE = 1.9E-4  (G/G/HR)

                  OUTPUT RESPONSES                              RELATIVE OUTPUT COEFFICIENTS     SENSITIVITY COEFFICIENTS

     INPUT
     VALUES:                                                       1.9E-5       1.9E-3          1.9E-5       1.9E-3

ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                        0.294E 05      572.         -0.450E 06   -0.313E 05
STEM BIOMASS (G/M**2 LAND)                                       0.125E 05      876.          0.326E 07    0.862E 05
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)       0.126E 05      402.         -0.417E 05   -0.168E 04
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                        0.421E 04      194.          0.794E 06   -0.925E 04
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                             0.227E 04      629.          0.772E 06    0.219E 05
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)            0.239E 04      70.9         -0.382E 05   -749.
SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                   423.           0.195E 04     0.600E 07   -0.239E 06
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)            985.           216.          0.530E 05    0.162E 04
FRUIT ZINC CONCENTRATION (UG/G)                                  272.           466.         -0.122E 06   -0.216E 05
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)      -431.           12.5          0.689E 04   -392.
STEM SULFUR CONCENTRATION (UG/G)                                 380.           0.176        -0.285E 05   -60.6
LEAF SULFUR CONCENTRATION (UG/G)                                 7.93           246.          0.894E 05    0.517E 05
ROCT BIOMASS (G/M**2 LAND)                                       48.0           140.          0.122E 06    0.218E 05
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                           178.           0.268        -0.307E 04   -12.0
STEM RESPIRATION (G/M**2 LAND/HR)                                117.           26.0         -0.191E 04   -89.9
FRUIT BIOMASS (G/M**2 LAND)                                      19.6           63.4          0.759E 04    0.140E 04
STEM LEAD CONCENTRATION (UG/G)                                   53.0           0.594        -0.358E 04   -38.0
ROCT LEAD CONCENTRATION (UG/G)                                   17.0           33.0         -0.234E 05   -0.342E 04
FRUIT SULFUR CONCENTRATION (UG/G)                                29.9           5.06         -0.552E 04   -246.
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                8.80           15.2          294.         37.3
LEAF BIOMASS (G/M**2 LAND)                                       2.15           17.1          0.215E 05    0.457E 04
LEAF ZINC CONCENTRATION (UG/G)                                   7.07           2.07         -0.108E 05   -728.
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)     0.222          4.93          362.         172.
FRUIT LEAD CONCENTRATION (UG/G)                                  3.78           1.15         -669.        -40.1
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                      0.169          4.72          0.153E 04    811.
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)            4.75           0.115        -48.3        -0.752
STEM TO FRUIT PHLOEM TRANSLCCATION OF ZINC(UG/M**2 LAND/HR)     -11.5           16.1          481.         60.0
STEM ZINC CONCENTRATION (UG/G)                                   3.44           0.421        -0.470E 04   -228.
LEAF LEAD CONCENTRATION (UG/G)                                   0.533          3.32         -0.466E 04   -928.
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)                0.901          1.53         -279.        -40.3
ROCT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)            0.839          1.15         -79.8        -9.49
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)               0.562          1.11          18.7         2.55
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                    1.45           0.149        -0.266E 04   -86.0
ROCT ZINC CONCENTRATION (UG/G)                                   0.783          0.661        -0.366E 04   -498.
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)          1.18           0.726E-02    -14.1        -0.110
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)      -0.118E-01     -0.750         1.98         0.285
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                         0.361          0.190E-01     100.         2.29
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)     0.767E-02      0.156         12.0         5.49
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                             0.547E-01      0.767E-01    -42.2        -5.20
FRUIT RESPIRATION (G/M**2 LAND/HR)                               0.207E-01      0.621E-01     1.30         0.225
ROOT RESPIRATION (G/M**2 LAND/HR)                                0.154E-01      0.436E-01     6.74         1.14
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                         0.990E-02      0.340E-01     42.1         7.81
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                   0.179E-01      0.755E-02    -19.2        -1.20
ROCT SULFUR CONCENTRATION (UG/G)                                 0.146E-01      0.948E-02    -38.9         1.09
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)          0.109E-01      0.933E-02    -5.23        -0.389
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                        0.541E-02      0.103E-01    -2.29        -0.524
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                        0.345E-02      0.120E-01    -71.6        -8.45
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR     0.431E-03      0.988E-02     0.706        0.344
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                    0.247E-02      0.685E-02     67.9         18.9
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                           0.267E-03      0.749E-02     2.41         1.30
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                      0.524E-02      0.135E-03    -1.51        -0.224E-01
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)       0.355E-03      0.153E-02    -0.743        0.259
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                         0.356E-03      0.132E-02    -3.15        -0.202
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                       0.365E-04      0.114E-02     0.228        0.127
STEM TO FRUIT PHLOEM TRANSLCCATION OF LEAD(UG/M**2 LAND/HR)      0.934E-04      0.676E-03    -0.658E-01   -0.170E-01
LEAF RESPIRATION (G/M**2 LAND/HR)                                0.117E-03      0.160E-03     0.646        0.795E-01
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                         0.112E-04      0.222E-03    -0.528E-01   -0.235E-01
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                           0.203E-04      0.183E-03    -0.936E-01   -0.281E-01
ROCT HEARTWOOD SULFUR CONCENTRATION (UG/G)                       0.620E-05      0.176E-03     0.362E-01    0.192E-01
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                   0.589E-05      0.978E-04    -0.879E-01   -0.381E-01
CO2 CHLOROPLAST (ML/ML)                                          0.392E-04      0.635E-04     0.381E-01    0.479E-02
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                             0.298E-04      0.562E-04    -0.116E-01   -0.159E-02
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER                  0.263E-04      0.438E-04    -0.493E-01   -0.649E-02
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER                  0.219E-08      0.401E-07    -0.202E-04   -0.866E-05
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER                  0.492E-13      0.263E-12    -0.338E-09   -0.809E-10
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER                  0.0            0.0           0.0          0.0
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APPENDIX (continued)

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MODEL : CERES       PARAMETER : FRESTD, STANDARD RESPIRATION RATE FOR FRUITS
STANDARD VALUE  = 1.0E-4 (G/G/HR)

                    OUTPUT RESPONSES                                 RELATIVE OUTPUT COEFFICIENTS      SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                           1.0E-5        1.0E-3          1.0E-5         1.0E-3

FRUIT ZINC CONCENTRATION (UG/G)                                      0.302E 04      18.7          -0.104E 07     -0.821E 04
FRUIT SULFUR CONCENTRATION (UG/G)                                    63.5          0.399          -0.165E 05      -132.
FRUIT BIOMASS (G/M**2 LAND)                                          28.9           1.28           0.180E 05       380.
FRUIT LEAD CONCENTRATION (UG/G)                                      7.75          0.462E-01      -0.197E 04      -15.3
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                            3.94          0.203           0.568E 05      0.119E 04
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)          3.21          0.255           445.            13.7
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                            2.33          0.107           0.368E 05       753.
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)           1.92          0.214           0.243E 04       44.6
FRUIT RESPIRATION (G/M**2 LAND/HR)                                   1.00          0.693E-01      -17.2           -0.452
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                                 0.807         0.808E-01       0.222E 05       509.
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)                0.809         0.418E-01       0.228E 04       45.8
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)           0.622         0.214E-01       0.109E 04       19.8
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)                0.495         0.376E-01       0.227E 04       54.2
STEM ZINC CONCENTRATION (UG/G)                                       0.247E-02     0.355E-03       251.            3.58
LEAF ZINC CONCENTRATION (UG/G)                                       0.214E-02     0.213E-03       358.            3.58
ROOT ZINC CONCENTRATION (UG/G)                                       0.591E-03     0.0             108.           0.0
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                        0.675E-04     0.169E-04      -14.3           -0.358
STEM SULFUR CONCENTRATION (UG/G)                                     0.562E-04     0.0            -3.58           0.0
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                             0.0           0.735E-05      0.0             0.358E-01
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                             0.165E-05     0.741E-06      0.179           0.358E-02
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                       0.235E-05     0.0            -0.186          0.0
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                   0.109E-05     0.120E-06      -0.284E-01      -0.347E-03
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                    0.145E-06     0.0             0.579E-02      0.0
ROCT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)                0.239E-09     0.117E-06       0.579E-05      0.579E-03
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                                 0.117E-06     0.0             0.358E-01      0.0
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)              0.308E-07     0.0            -0.579E-03      0.0
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                            0.238E-07     0.0             0.394E-02      0.0
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)                0.163E-07     0.0             0.585E-03      0.0
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER                      0.925E-08     0.0            -0.394E-03      0.0
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)          -0.212E-08    -0.428E-08      -0.186E-03      -0.116E-04
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER                      0.394E-16     0.0            -0.358E-11      0.0
LEAF BIOMASS (G/M**2 LAND)                                           0.0           0.0            0.0             0.0
STEM BIOMASS (G/M**2 LAND)                                           0.0           0.0            0.0             0.0
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                        0.0           0.0            0.0             0.0
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                       0.0           0.0            0.0             0.0
LEAF LEAD CONCENTRATION (UG/G)                                       0.0           0.0            0.0             0.0
LEAF SULFUR CONCENTRATION (UG/G)                                     0.0           0.0            0.0             0.0
STEM LEAD CONCENTRATION (UG/G)                                       0.0           0.0            0.0             0.0
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                             0.0           0.0            0.0             0.0
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER                      0.0           0.0            0.0             0.0
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER                      0.0           0.0            0.0             0.0
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                             0.0           0.0            0.0             0.0
ROCT SULFUR CONCENTRATION (UG/G)                                     0.0           0.0            0.0             0.0
ROCT LEAD CONCENTRATION (UG/G)                                       0.0           0.0            0.0             0.0
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                           0.0           0.0            0.0             0.0
ROCT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)              0.0           0.0            0.0             0.0
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                            0.0           0.0            0.0             0.0
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)                    0.0           0.0            0.0             0.0
STEM RESPIRATION (G/M**2 LAND/HR)                                    0.0           0.0            0.0             0.0
LEAF RESPIRATION (G/M**2 LAND/HR)                                    0.0           0.0            0.0             0.0
ROOT RESPIRATION (G/M**2 LAND/HR)                                    0.0           0.0            0.0             0.0
CO2 CHLOROPLAST (ML/ML)                                              0.0           0.0            0.0             0.0
PHCTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                                 0.0           0.0            0.0             0.0
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR         0.0           0.0            0.0             0.0
STEM TO FRUIT PHLOEM TRANSLCCATION OF LEAD(UG/M**2 LAND/HR)          0.0           0.0            0.0             0.0
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)         0.0           0.0            0.0             0.0
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)         0.0           0.0            0.0             0.0
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)           0.0           0.0            0.0             0.0
SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                       0.0           0.0            0.0             0.0
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                               0.0           0.0            0.0             0.0
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                          0.0           0.0            0.0             0.0
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                          0.0           0.0            0.0             0.0
ROCT BIOMASS (G/M**2 LAND)                                           0.0           0.0            0.0             0.0
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APPENDIX (continued)

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  MODEL : CERES          PARAMETER : RRESTD, STANDARD RESPIRATION RATE FOR ROOTS
STANDARD VALUE = 1.8E-4  (G/G/HR)

                    OUTPUT RESPONSES                                 RELATIVE OUTPUT COEFFICIENTS      SENSITIVITY COEFFICIENTS

     INPUT
     VALUES:                                                          1.8E-5         1.8E-3          1.8E-5        1.8E-3

ROOT LEAD CONCENTRATION (UG/G)                                      0.112E 05       19.7           -0.684E 06    -0.288E 04
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                                0.429E 04      102.             0.115E 07     0.983E 04
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                           0.359E 04      253.             0.763E 06    -0.210E 05
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                           0.373E 04      106.             0.105E 07    -0.105E 05
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)               0.281E 04      0.596           -0.493E 04    -7.25
ROOT BIOMASS (G/M**2 LAND)                                          0.243E 04       46.3            0.100E 07     0.138E 05
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)               0.213E 04       43.1            0.832E 05     643.
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)               0.140E 04       14.4            0.535E 05    -151.
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)        549.            168.              0.250E 05    -917.
SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                    247.             11.7             0.520E 07    -0.438E 05
FRUIT ZINC CONCENTRATION (UG/G)                                   201.             16.3             0.701E 05    -0.380E 04
ROOT ZINC CONCENTRATION (UG/G)                                    186.             0.480E-01       -0.105E 06    -151.
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)             164.             0.371E-01       -298.          -0.452
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                              161.             0.448E-01       -0.252E 04    -4.24
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)        126.             20.6             0.135E 05    -362.
ROOT RESPIRATION (G/M**2 LAND/HR)                                  53.1             2.57           -420.          -9.24
STEM TO FRUIT PHLOEM TRANSLCCATION OF ZINC(UG/M**2 LAND/HR)        30.5             1.04            870.           12.2
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)        -27.7            -0.335            48.5           0.206
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                          27.7             0.527E-02      -286.          -0.404
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)          3.51            0.117E-02       219.           0.323
STEM LEAD CONCENTRATION (UG/G)                                      3.45            0.137E-02      -852.          -1.79
LEAF ZINC CONCENTRATION (UG/G)                                      2.65            0.554          -0.247E 04    -424.
ROOT SULFUR CONCENTRATION (UG/G)                                    2.99            0.150E-01      -705.          -5.00
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)             2.69            0.125E-01      -90.6          -0.618
STEM ZINC CONCENTRATION (UG/G)                                      2.45            0.149           0.705E 04    -135.
STEM TO FRUIT PHLOEM TRANSLCCATION OF LEAD(UG/M**2 LAND/HR)         1.64            0.379E-03      -8.82          -0.129E-01
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                            1.60            0.744E-02      -323.          -2.21
FRUIT LEAD CONCENTRATION (UG/G)                                     1.58            0.930E-03      -425.          -1.12
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                       0.520           0.724E-02       0.253E 04     21.9
LEAF SULFUR CONCENTRATION (UG/G)                                    0.380           0.564E-02      -0.131E 05    -99.6
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                       0.257           0.227E-02      -0.120E 04    -10.2
STEM BIOMASS (G/M**2 LAND)                                          0.182           0.372E-01      -0.916E 04     518.
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                            0.179           0.416E-02       188.           2.81
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)             0.150           0.744E-03      -5.34          -0.376E-01
LEAF BIOMASS (G/M**2 LAND)                                          0.999E-01       0.0            -0.279E 04     0.0
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)        0.546E-01       0.485E-03       84.1          -0.736
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                         0.449E-01       0.546E-03       380.          -2.19
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                            0.439E-01       0.949E-03      -34.3          -0.516
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                   0.307E-01       0.109E-01      -17.4          -1.06
LEAF LEAD CONCENTRATION (UG/G)                                      0.292E-01       0.0             398.           0.0
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                         0.247E-01       0.115E-03      -5.93          -0.406E-01
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                           0.840E-02       0.277E-04      -102.          -0.201
FRUIT BIOMASS (G/M**2 LAND)                                         0.374E-02       0.171E-02      -104.           6.97
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)                   0.530E-02       0.100E-03       14.0          -0.203
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)        0.177E-02       0.104E-03       0.198         -0.643E-01
FRUIT SULFUR CONCENTRATION (UG/G)                                   0.413E-03       0.127E-02       9.16          -3.44
STEM SULFUR CONCENTRATION (UG/G)                                    0.717E-03       0.929E-03      -21.9          -3.58
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                      0.120E-02       0.155E-04       3.59           0.356E-01
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                      0.769E-03       0.459E-05       1.17           0.892E-02
STEM RESPIRATION (G/M**2 LAND/HR)                                   0.303E-03       0.289E-03      -1.67           0.161
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                            0.434E-03       0.251E-06      -0.307         -0.737E-03
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR        0.117E-03       0.378E-05      -0.195E-01     -0.162E-02
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                              0.875E-04       0.822E-06      -0.194         -0.398E-02
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                  0.430E-04       0.293E-04       0.745E-01      0.136E-01
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER                     0.145E-04       0.947E-07       0.392E-01      0.233E-03
LEAF RESPIRATION (G/M**2 LAND/HR)                                   0.973E-05       0.258E-06       0.418E-01      0.643E-03
FRUIT RESPIRATION (G/M**2 LAND/HR)                                  0.283E-05       0.167E-05      -0.157E-01      0.120E-02
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                          0.212E-05       0.180E-06      -0.534E-01     -0.617E-03
CO2 CHLOROPLAST (ML/ML)                                             0.613E-06       0.441E-07       0.273E-02      0.322E-04
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                                0.355E-06       0.877E-08       0.473E-03     -0.109E-04
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER                     0.255E-07       0.173E-09       0.715E-04      0.558E-06
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER                     0.845E-13       0.121E-14       0.476E-09      0.558E-11
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER                     0.0             0.0             0.0            0.0
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APPENDIX (continued)

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 MODEL : CERES              PARAMETER : ARY, LEAF AREA WEIGHT RATIO
STANDARD VALUE = 100.0 (CM2/G)

                 OUTPUT RESPONSES                              RELATIVE OUTPUT COEFFICIENTS     SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                             50.0         200.0          50.0         200.0

SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                    0.205E 07    0.437E 07    -0.221E 04   -0.162E 04
LEAF SULFUR CONCENTRATION (UG/G)                                  0.660E 05    0.999E 04    -29.5         -5.75
ZINC UPTAKE BY LEAVES (UG/M**2/DAY)                               0.267E 04    0.288E 05    -6.32          8.88
LEAF LEAD CONCENTRATION (UG/G)                                     7.77        0.125E 05     0.520E-01     1.91
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                       0.976E 04     372.        -1.30         -0.128
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)      0.843E 04     604.        -0.243        -0.332E-01
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                          908.        0.780E 04     0.877        -2.59
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                              0.127E 04    0.599E 04    -0.806        -2.02
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                         0.139E 04    0.541E 04     1.56         -1.17
STEM BIOMASS (G/M**2 LAND)                                        0.304E 04    0.332E 04    -5.36         -2.81
LEAF BIOMASS (G/M**2 LAND)                                         44.9        0.594E 04    -0.265        -2.84
FRUIT ZINC CONCENTRATION (UG/G)                                   0.118E 04    0.212E 04     1.17         -0.785
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)              542.        0.267E 04    -0.532E-01    -0.154
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)              150.        0.194E 04     0.123E-01    -0.102
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                         0.130E 04     427.        -0.561        -0.161
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)         883.         570.         0.915E-01    -0.487E-01
ROOT LEAD CONCENTRATION (UG/G)                                     81.4         878.         0.181        -0.313
ROOT BIOMASS (G/M**2 LAND)                                         786.         26.2        -1.81         -0.139
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)         7.38         658.        -0.900E-02    -0.325E-01
STEM SULFUR CONCENTRATION (UG/G)                                   557.         48.7        -0.118        -0.175E-01
ZINC IN ROOT LITTER (UG/M**2 LAND)                                 4.76         579.         0.645         19.0
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                         0.294E-01     507.         0.612E-03     0.637E-01
FRUIT BIOMASS (G/M**2 LAND)                                        429.         10.3        -0.125        -0.872E-02
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)        301.         15.8        -0.971E-02    -0.101E-02
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)       273.         19.5        -0.785E-02    -0.107E-02
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)        0.229E-02     211.         0.139E-05     0.399E-02
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)        -2.67        -183.        -0.208E-04     0.168E-03
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                           0.329         183.        -0.417E-03    -0.645E-01
STEM ZINC CONCENTRATION (UG/G)                                     1.65         178.         0.413E-02    -0.124
ROOT ZINC CONCENTRATION (UG/G)                                     1.73         151.         0.309E-01    -0.126
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)                  1.17         109.         0.748E-03    -0.614E-02
STEM LEAD CONCENTRATION (UG/G)                                     2.16         88.8         0.247E-02     0.785E-02
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                            19.0         63.0        -0.554E-01    -0.500E-01
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                  51.6         9.54        -0.228E-02    -0.520E-03
ROOT SULFUR CONCENTRATION (UG/G)                                   45.4         3.64        -0.883E-02    -0.127E-02
FRUIT SULFUR CONCENTRATION (UG/G)                                  17.7         27.8        -0.153E-01    -0.992E-02
FRUIT LEAD CONCENTRATION (UG/G)                                    2.64         42.2         0.208E-02     0.396E-02
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                          35.3         1.37        -0.479E-02    -0.473E-03
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)            19.0         2.89        -0.741E-03    -0.152E-03
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                          18.3         0.703       -0.248E-02    -0.243E-03
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR       16.9         1.21        -0.488E-03    -0.666E-04
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                             16.1         0.599       -0.212E-02    -0.207E-03
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                            4.20         11.4        -0.693E-02    -0.571E-02
ROOT UPTAKE OF LEAD - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)           1.16         14.3         0.290E-02    -0.512E-02
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                           0.279E-01     12.4         0.487E-03    -0.589E-02
LEAF ZINC CONCENTRATION (UG/G)                                     6.97         4.49         0.488E-01     0.132E-02
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)              2.75         8.37         0.493E-03    -0.441E-03
STEM RESPIRATION (G/M**2 LAND/HR)                                  3.63         5.15        -0.115E-02    -0.683E-03
SULFUR IN LEAF LITTER (UG/M**2 LAND)                               5.17         2.09        -0.247E-02    -0.790E-03
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                             1.88         4.41         0.173E-02    -0.407E-03
ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)                0.0           6.23         0.0           0.213
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                 4.85         0.605       -0.178E-03    -0.330E-04
ROOT UPTAKE OF ZINC - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)           1.86         3.02        -0.429E-02    -0.257E-02
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                    0.890E-01     4.50         0.140E-03     0.506E-03
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                     0.612         3.83         0.587E-02     0.706E-02
ZINC IN FRUIT LITTER (UG/M**2 LAND)                                2.59         1.37        -0.139E-02    -0.528E-03
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                           2.63         1.32        -0.138E-02    -0.505E-03
LEAF RESPIRATION (G/M**2 LAND/HR)                                 0.651E-03     3.25        -0.693E-05    -0.252E-03
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                          0.603         2.06        -0.112E-02    -0.103E-02
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                          0.142         1.40        -0.277E-03    -0.491E-03
LEAD UPTAKE BY LEAVES (UG/M**2/DAY)                               0.0           1.32         0.0          -0.681E-01
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                         1.21        0.353E-01    -0.143E-03    -0.122E-04
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)           0.964        0.183        -0.407E-04    -0.956E-05
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                       0.986        0.349E-01    -0.116E-03    -0.115E-04
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                        0.805        0.369E-01    -0.118E-03    -0.127E-04
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)             0.220        0.527         0.351E-04    -0.277E-04
ROOT UPTAKE OF LEAD - DARK PERIOD (UG/M**2/DAY)                   0.214E-01    0.710         0.863E-04    -0.256E-03
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                           0.438E-01    0.663         0.621E-04     0.121E-03
ZINC IN STEM LITTER (UG/M**2 LAND)                                0.454        0.150        -0.323E-03    -0.936E-04
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                              0.156        0.447         0.249E-03    -0.177E-03
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                          0.236        0.296        -0.275E-03    -0.155E-03
FRUIT RESPIRATION (G/M**2 LAND/HR)                                0.437        0.105E-01    -0.204E-04    -0.157E-05
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                     0.673E-02    0.351        -0.477E-03     0.339E-02
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)       0.159E-02    0.293         0.919E-06     0.717E-05
ROOT UPTAKE OF ZINC - DARK PERIOD (UG/M**2/DAY)                   0.231        0.517E-01    -0.260E-03     0.453E-04
ROOT RESPIRATION (G/M**2 LAND/HR)                                 0.262        0.759E-02    -0.954E-04    -0.801E-05
ZINC IN LEAF LITTER (UG/M**2 LAND)                                0.175E-02    0.187         0.581E-03    -0.100E-02
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)                        0.179        0.514E-02    -0.210E-04    -0.179E-05
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                            0.471E-03    0.130         0.154E-05     0.128E-04
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                    0.336E-02    0.100         0.785E-05     0.218E-04
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                         0.247E-01    0.723E-01     0.273E-04    -0.181E-04
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER                   0.728E-03    0.896E-01     0.904E-06     0.501E-05
SULFUR IN ROOT LITTER (UG/M**2 LAND)                              0.478E-01    0.208E-02    -0.688E-05    -0.721E-06
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)               0.178E-01    0.175E-01    -0.130E-04    -0.667E-05
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                          0.794E-03    0.163E-01     0.124E-05     0.282E-05
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                          0.193E-02    0.139E-01     0.237E-05     0.316E-05
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)              0.108E-01    0.365E-02    -0.472E-05    -0.138E-05
LEAD IN FRUIT LITTER (UG/M**2 LAND)                               0.629E-03    0.117E-01     0.156E-05     0.325E-05
CO2 CHLOROPLAST (ML/ML)                                           0.107E-02    0.940E-02    -0.709E-06    -0.107E-05
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)                0.523E-02    0.128E-02    -0.343E-05    -0.852E-06
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                           0.335E-03    0.404E-02    -0.603E-04    -0.146E-03
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                             0.385E-02    0.200E-03    -0.603E-06    -0.688E-07
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                              0.151E-02    0.908E-03     0.281E-06     0.863E-07
LEAD IN STEM LITTER (UG/M**2 LAND)                                0.483E-03    0.143E-02     0.325E-05     0.272E-05
SULFUR IN STEM LITTER (UG/M**2 LAND)                              0.132E-02    0.352E-04    -0.149E-06    -0.122E-07
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)              0.476E-03    0.184E-04    -0.648E-07    -0.638E-08
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)                0.263E-04    0.120E-03     0.323E-05     0.568E-05
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)               0.684E-05    0.964E-04     0.217E-07     0.399E-07
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)             0.479E-04    0.223E-05    -0.710E-08    -0.767E-09
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER                   0.101E-05    0.427E-04     0.149E-08     0.483E-08
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)              0.189E-04    0.466E-06    -0.206E-08    -0.162E-09
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)                0.419E-05    0.103E-04     0.327E-07     0.254E-07
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER                   0.485E-11    0.102E-08     0.119E-13     0.843E-13
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER                   0.0          0.221E-14     0.0           0.935E-16
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)                0.0          0.0           0.0           0.0
LEAD IN LEAF LITTER (UG/M**2 LAND)                                0.0          0.0           0.0           0.0
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)                0.0          0.0           0.0           0.0
LEAD IN ROOT LITTER (UG/M**2 LAND)                                0.0          0.0           0.0           0.0
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APPENDIX (continued)

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  MODEL : CERES              PARAMETER : WATER POTENTIAL EFFECTS
STANDARD VALUE = 4 (BARS)

                 OUTPUT RESPONSES                              RELATIVE OUTPUT COEFFICIENTS     SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                             2.0          8.0           2.0          8.0

SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                 0.236E 05    0.199E 05     0.543E 04   -0.235E 04
LEAF SULFUR CONCENTRATION (UG/G)                               0.439E 04    123.         -187.        -13.6
STEM BIOMASS (G/M**2 LAND)                                     0.132E 04    95.2         -89.2        -12.0
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                        154.       418.          14.3        -2.82
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                        33.9       384.         -3.62        -4.09
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                             222.       190.         -5.80        -2.59
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)       117.       255.          0.954       -0.428
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)            82.3       183.          1.28         0.963
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)            92.3       135.          1.11         0.630
FRUIT ZINC CONCENTRATION (UG/G)                                  114.       75.5          8.95        -3.43
LEAF BIOMASS (G/M**2 LAND)                                       39.0       58.6         -4.85        -4.71
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                        89.5       4.72         -3.64        -0.421
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                      79.0       3.22         -2.85        -0.293
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)     72.9       4.22         -0.566       -0.681E-01
ROCT BIOMASS (G/M**2 LAND)                                       55.0       0.808        -12.1         0.710
FRUIT BIOMASS (G/M**2 LAND)                                      24.4       0.392        -0.742        0.465E-01
LEAF LEAD CONCENTRATION (UG/G)                                   6.80       16.4          0.908        1.09
STEM TO FRUIT PHLOEM TRANSLCCATION OF ZINC(UG/M**2 LAND/HR)    0.546        16.7          0.480E-02    0.303E-01
ROOT LEAD CONCENTRATION (UG/G)                                   8.73       1.90          1.43        -0.357
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)       6.50       2.58         -0.117        0.394E-01
ZINC IN ROOT LITTER (UG/M**2 LAND)                               4.76       0.0           16.1         0.0
STEM SULFUR CONCENTRATION (UG/G)                                 4.13       0.342E-01    -0.253       -0.976E-02
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                3.61       0.470        -0.131E-01    0.110E-02
LEAF ZINC CONCENTRATION (UG/G)                                   1.29       1.55          0.271       -0.468E-01
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR'     2.35       0.138        -0.183E-01   -0.221E-02
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                          2.17       0.926E-01    -0.124       -0.128E-01
STEM LEAD CONCENTRATION (UG/G)                                   1.66       0.271         0.540E-01    0.110E-01
STEM RESPIRATION (G/M**2 LAND/HR)                                1.64       0.159        -0.192E-01   -0.301E-02
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                          1.64       0.207E-01    -0.408        0.222E-01
FRUIT LEAD CONCENTRATION (UG/G)                                  1.42       0.150E-01     0.380E-01    0.181E-02
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)              0.484        0.651         0.174E-01   -0.977E-02
ROOT SULFUR CONCENTRATION (UG/G)                               0.865        0.326E-01    -0.302E-01   -0.299E-02
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                         0.223        0.548        -0.466E-02    0.179E-02
FRUIT SULFUR CONCENTRATION (UG/G)                              0.511E-01    0.649        -0.887E-02   -0.378E-01
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                      0.609        0.116E-01    -0.157E-01   -0.108E-02
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)          0.551        0.286E-01     0.545E-02   -0.522E-03
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                        0.123        0.363        -0.458E-01   -0.710E-01
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                      0.314        0.555E-02    -0.810E-02   -0.540E-03
SULFUR IN LEAF LITTER (UG/M**2 LAND)                           0.297        0.168E-01    -0.145E-01   -0.174E-02
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                  0.253        0.312E-01     0.908E-01    0.152E-01
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)             0.243        0.345E-01    -0.852E-03    0.894E-04
ROOT ZINC CONCENTRATION (UG/G)                                 0.229        0.468E-01     0.269       -0.202E-01
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)    -0.237       -0.104E-01    -0.135E-03    0.236E-04
STEM ZINC CONCENTRATION (UG/G)                                 0.104        0.123        -0.100E 00    0.968E-02
ZINC IN STEM LITTER (UG/M**2 LAND)                             0.170        0.377E-02    -0.497E-02   -0.372E-03
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR   0.146        0.843E-02    -0.114E-02   -0.136E-03
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                       0.150        0.135E-02    -0.139E-01   -0.637E-03
ZINC IN FRUIT LITTER (UG/M**2 LAND)                            0.124        0.227E-01    -0.749E-02    0.144E-02
ROCT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)        0.127        0.181E-01    -0.144E-02   -0.275E-03
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                      0.195E-01    0.121         0.290E-02    0.113E-01
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                         0.128        0.512E-02    -0.461E-02   -0.469E-03
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                       0.113        0.396E-02    -0.476E-02   -0.448E-03
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                       0.880E-01    0.258E-01    -0.628E-02    0.165E-02
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)          0.813E-01    0.160E-02     0.536E-03    0.144E-04
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                        0.363E-02    0.704E-01    -0.322E-02   -0.101E-01
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                       0.449E-01    0.547E-02    -0.397E-02   -0.756E-03
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                        0.372E-01    0.388E-02     0.143E-02    0.231E-03
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                 0.323E-01    0.564E-02     0.205E-02    0.433E-03
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                           0.249E-01    0.397E-02     0.241E-02   -0.471E-03
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                     0.231E-01    0.300E-03    -0.489E-03   -0.281E-04
FRUIT RESPIRATION (G/M**2 LAND/HR)                             0.218E-01    0.243E-03    -0.114E-03    0.600E-05
ROOT RESPIRATION (G/M**2 LAND/HR)                              0.169E-01    0.168E-03    -0.605E-03    0.286E-04
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                     0.124E-01    0.280E-03    -0.366E-03   -0.276E-04
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)     0.927E-03    0.758E-02    -0.278E-03    0.466E-03
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                      0.589E-02    0.379E-03     0.326E-03   -0.279E-04
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                  0.333E-02    0.191E-02    -0.548E-02    0.306E-02
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)                     0.339E-02    0.413E-04    -0.720E-04   -0.400E-05
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                    0.288E-02    0.248E-03    -0.148E-03   -0.207E-04
ZINC IN LEAF LITTER (UG/M**2 LAND)                             0.610E-03    0.231E-02    -0.484E-02   -0.968E-02
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)            0.227E-02    0.882E-04    -0.117E-03    0.830E-05
LEAF RESPIRATION (G/M**2 LAND/HR)                              0.628E-04    0.199E-02    -0.315E-04   -0.126E-03
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)        0.157E-02    0.471E-03     0.131E-04   -0.413E-06
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)             0.189E-02    0.390E-04    -0.517E-04   -0.372E-05
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                       0.162E-02    0.100E-03     0.542E-04    0.675E-05
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                 0.926E-03    0.119E-03     0.102E-03    0.185E-04
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                         0.435E-03    0.447E-03     0.370E-04    0.187E-04
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)           0.724E-03    0.390E-04    -0.303E-04   -0.354E-05
SULFUR IN ROOT LITTER (UG/M**2 LAND)                           0.745E-03    0.157E-04    -0.213E-04   -0.156E-05
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                       0.659E-03    0.733E-04     0.282E-04    0.470E-05
LEAD IN FRUIT LITTER (UG/M**2 LAND)                            0.524E-03    0.542E-04     0.357E-04    0.569E-05
LEAD IN STEM LITTER (UG/M**2 LAND)                             0.390E-03    0.146E-04     0.729E-04    0.694E-05
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                        0.325E-03    0.522E-04    -0.147E-02   -0.179E-03
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER                0.271E-03    0.302E-04     0.138E-04    0.230E-05
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR     0.271E-03    0.155E-04     0.931E-05   -0.144E-06
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                          0.538E-04    0.138E-05    -0.177E-05   -0.143E-06
CO2 CHLOROPLAST (ML/ML)                                        0.124E-04    0.395E-04    -0.849E-06   -0.911E-06
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                           0.185E-04    0.277E-04     0.647E-06    0.385E-06
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)             0.0          0.348E-04     0.0         -0.565E-04
SULFUR IN STEM LITTER (UG/M**2 LAND)                           0.259E-04    0.303E-06    -0.519E-06   -0.282E-07
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)           0.812E-05    0.140E-06    -0.211E-06   -0.139E-07
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)            0.576E-05    0.545E-06     0.498E-06    0.760E-07
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)             0.342E-05    0.114E-06     0.739E-06    0.664E-07
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)          0.727E-06    0.171E-07    -0.218E-07   -0.168E-08
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)           0.377E-06    0.410E-08    -0.725E-08   -0.378E-09
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER                0.310E-06    0.273E-07     0.206E-07    0.306E-08
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER                0.179E-11    0.194E-12     0.181E-12    0.295E-13
LEAD MINERALIZATION FROM ROCT LITTER (UG/M**2/DAY)             0.0          0.0           0.0          0.0
ZINC MINERALIZATION FROM ROCT LITTER (UG/M**2/DAY)             0.0          0.0           0.0          0.0
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)             0.0          0.0           0.0          0.0
LEAD IN LEAF LITTER (UG/M**2 LAND)                             0.0          0.0           0.0          0.0
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER                0.0          0.0           0.0          0.0
LEAD IN ROOT LITTER (UG/M**2 LAND)                             0.0          0.0           0.0          0.0

IHC002I STOP       0
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APPENDIX (continued)

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MODEL : CERES                PARAMETER : R, ROOT RADIUS
STANDARD VALUE = 0.05 (CM)

                 OUTPUT RESPONSES                               RELATIVE OUTPUT COEFFICIENTS            SENSITIVITY COEFFICIENTS

   INPUT
   VALUES:                                                    0.005       0.5         5.0         0.005       0.5         5.0

LEAD IN LEAF LITTER (UG/M**2 LAND)                            0.110E 10   0.259E 09   0.949E 07   -0.820E 08  0.398E 07   -0.693E 05
LEAD IN ROOT LITTER (UG/M**2 LAND)                            0.101E 09   0.237E 08   0.867E 06   0.806E 08   -0.391E 07  0.680E 05
ZINC IN LEAF LITTER (UG/M**2 LAND)                            0.148E 08   0.128E 06   0.132E 04   -0.112E 06  0.104E 04   -9.63
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)            0.355E 07   0.839E 06   0.307E 05   -0.265E 06  0.129E 05   -224.
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)            0.108E 07   0.255E 06   0.933E 04   0.868E 06   -0.421E 05  732.
ZINC IN ROOT LITTER (UG/M**2 LAND)                            0.387E 04   80.5        0.153E 06   0.110E 06   -0.115E 04  -0.442E 04
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)            0.520E 05   450.        4.59        -390.       3.63        -0.333E-01
ZINC UPTAKE BY LEAVES (UG/M**2/DAY)                           0.464E 04   0.420E 04   0.519E 04   -0.908E 04  867.        -106.
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                     0.159E 04   0.134E 04   0.117E 04   0.203E 04   -168.       12.0
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                     0.125E 04   902.        207.        0.168E 04   -135.       6.01
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)    914.        751.        51.0        106.        -8.38       0.263E-01
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)         732.        545.        33.7        -149.       12.6        0.343
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                          616.        464.        92.3        -973.       82.6        -1.62
FRUIT ZINC CONCENTRATION (UG/G)                               357.        275.        87.0        684.        -59.5       2.85
ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)            45.0        0.705       363.        0.128E 04   -14.2       -27.3
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)         150.        113.        21.0        -25.7       2.33        0.195
ROOT LEAD CONCENTRATION (UG/G)                                130.        106.        31.2        268.        -24.1       1.18
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)    33.9        15.0        10.9        18.9        -1.30       0.731E-01
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                       27.5        22.3        5.50        55.5        -5.00       0.225
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)   20.7        23.3        1.32        -4.23       0.373       -0.499E-02
LEAF ZINC CONCENTRATION (UG/G)                                10.1        7.80        2.10        68.1        -5.90       0.238
STEM ZINC CONCENTRATION (UG/G)                                4.86        3.35        0.158       26.1        -2.03       0.463E-01
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)         2.65        2.23        1.76        0.551       -0.505E-01  0.394E-02
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                        2.62        2.44        1.38        2.28        -0.220      0.444E-02
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)    -3.16       -2.54       -0.624E-01  -0.265E-01  0.229E-02   -0.637E-04
ROOT UPTAKE OF LEAD - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)      1.85        1.50        1.26        4.10        -0.368      0.306E-01
ROOT UPTAKE OF ZINC - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)      2.49        1.94        0.824E-01   -5.55       0.490       -0.849E-02
LEAD IN STEM LITTER (UG/M**2 LAND)                            3.59        0.846       0.309E-01   -0.317      0.154E-01   -0.268E-03
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                          0.269       0.228       0.374E-01   0.372       -0.342E-01  -0.669E-03
ROOT UPTAKE OF ZINC - DARK PERIOD (UG/M**2/DAY)               0.146       0.111       0.191       -0.230      0.200E-01   -0.239E-02
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                      0.224       0.182       0.129E-01   0.436       -0.394E-01  0.835E-03
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)         0.165       0.139       0.101       0.344E-01   -0.316E-02  0.238E-03
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                       0.197       0.132       0.364E-02   1.55        -0.125      0.182E-02
ROOT UPTAKE OF LEAD - DARK PERIOD (UG/M**2/DAY)               0.113       0.921E-01   0.742E-01   0.228       -0.205E-01  -0.166E-02
LEAD IN FRUIT LITTER (UG/M**2 LAND)                           0.212       0.498E-01   0.179E-02   -0.301E-01  0.146E-02   -0.250E-04
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                       0.141       0.104       0.176E-01   1.29        -0.110      0.370E-02
ROOT ZINC CONCENTRATION (UG/G)                                0.878E-01   0.680E-01   0.111E-01   -2.08       0.215       -0.391E-02
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                      0.602E-01   0.480E-01   0.463E-01   0.389       -0.348E-01  -0.309E-02
ZINC IN FRUIT LITTER (UG/M**2 LAND)                           0.801E-01   0.624E-01   0.923E-02   0.264       -0.233E-01  -0.502E-03
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                 0.520E-01   0.459E-01   0.132E-01   -2.83       0.265       -0.119E-01
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                 0.607E-01   0.441E-01   0.179E-02   -1.65       0.140       -0.241E-02
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                      0.542E-01   0.411E-01   0.112E-02   0.218       -0.191E-01  0.289E-03
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                     0.235E-01   0.198E-01   0.154E-01   0.307E-01   -0.282E-02  0.213E-03
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                0.263E-02   0.200E-02   0.532E-01   -0.254E-01  0.218E-02   -0.106E-02
ZINC IN STEM LITTER (UG/M**2 LAND)                            0.176E-01   0.309E-01   0.913E-02   0.712E-01   -0.940E-02  -0.372E-03
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)            0.428E-01   0.101E-01   0.370E-03   -0.370E-02  0.180E-03   -0.313E-05
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                      0.268E-01   0.196E-01   0.342E-03   0.990E-01   -0.846E-02  0.102E-03
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                       0.135E-01   0.130E-01   0.149E-01   1.51        -0.148      -0.145E-01
STEM LEAD CONCENTRATION (UG/G)                                0.599E-02   0.487E-02   0.291E-02   0.135       -0.123E-01  0.841E-03
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)    0.532E-02   0.459E-02   0.260E-02   -0.260E-01  0.239E-02   -0.179E-03
LEAF LEAD CONCENTRATION (UG/G)                                0.0         0.0         0.943E-02   0.0         0.0         0.652E-02
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)           0.554E-02   0.130E-02   0.472E-04   -0.688E-03  0.334E-04   -0.577E-06
FRUIT LEAD CONCENTRATION (UG/G)                               0.246E-02   0.202E-02   0.122E-02   0.652E-01   -0.595E-02  0.398E-03
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)   0.174E-02   0.147E-02   0.101E-02   0.982E-03   -0.901E-04  0.704E-05
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)           0.158E-02   0.123E-02   0.705E-04   0.433E-02   -0.382E-03  -0.619E-05
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)            0.158E-03   0.345E-03   0.379E-04   0.664E-03   -0.982E-04  -0.264E-05
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                0.610E-04   0.518E-04   0.418E-03   -0.119E-02  0.110E-03   -0.284E-04
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                       0.940E-04   0.791E-04   0.372E-04   0.306E-02   -0.282E-03  0.173E-04
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                     0.638E-04   0.638E-04   0.277E-04   0.166E-01   -0.166E-02  0.847E-04
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER               0.817E-05   0.607E-05   0.943E-04   -0.106E-03  0.915E-05   -0.325E-05
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                      0.289E-05   0.240E-05   0.161E-05   0.812E-04   -0.738E-05  0.546E-06
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                      0.119E-05   0.107E-05   0.474E-06   0.616E-04   -0.581E-05  0.326E-06
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER               0.701E-09   0.453E-09   0.416E-08   -0.401E-07  0.330E-08   -0.886E-09
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER               0.163E-13   0.117E-13   0.789E-13   -0.724E-12  0.616E-13   -0.132E-13
STEM BIOMASS (G/M**2 LAND)                                    0.0         0.0         0.0         0.0         0.0         0.0
LEAF BIOMASS (G/M**2 LAND)                                    0.0         0.0         0.0         0.0         0.0         0.0
FRUIT BIOMASS (G/M**2 LAND)                                   0.0         0.0         0.0         0.0         0.0         0.0
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                    0.0         0.0         0.0         0.0         0.0         0.0
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER               0.0         0.0         0.0         0.0         0.0         0.0
ROOT SULFUR CONCENTRATION (UG/G)                              0.0         0.0         0.0         0.0         0.0         0.0
STEM SULFUR CONCENTRATION (UG/G)                              0.0         0.0         0.0         0.0         0.0         0.0
FRUIT SULFUR CONCENTRATION (UG/G)                             0.0         0.0         0.0         0.0         0.0         0.0
LEAF SULFUR CONCENTRATION (UG/G)                              0.0         0.0         0.0         0.0         0.0         0.0
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)                    0.0         0.0         0.0         0.0         0.0         0.0
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)       0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN LEAF LITTER (UG/M**2 LAND)                          0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN STEM LITTER (UG/M**2 LAND)                          0.0         0.0         0.0         0.0         0.0         0.0
STEM RESPIRATION (G/M**2 LAND/HR)                             0.0         0.0         0.0         0.0         0.0         0.0
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)             0.0         0.0         0.0         0.0         0.0         0.0
FRUIT RESPIRATION (G/M**2 LAND/HR)                            0.0         0.0         0.0         0.0         0.0         0.0
LEAF RESPIRATION (G/M**2 LAND/HR)                             0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                     0.0         0.0         0.0         0.0         0.0         0.0
ROOT RESPIRATION (G/M**2 LAND/HR)                             0.0         0.0         0.0         0.0         0.0         0.0
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)             0.0         0.0         0.0         0.0         0.0         0.0
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)            0.0         0.0         0.0         0.0         0.0         0.0
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR  0.0         0.0         0.0         0.0         0.0         0.0
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)       0.0         0.0         0.0         0.0         0.0         0.0
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)  0.0         0.0         0.0         0.0         0.0         0.0
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)  0.0         0.0         0.0         0.0         0.0         0.0
CO2 CHLOROPLAST (ML/ML)                                       0.0         0.0         0.0         0.0         0.0         0.0
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                          0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                    0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                     0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                        0.0         0.0         0.0         0.0         0.0         0.0
SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                   0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                   0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN ROOT LITTER (UG/M**2 LAND)                          0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                         0.0         0.0         0.0         0.0         0.0         0.0
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                        0.0         0.0         0.0         0.0         0.0         0.0
LEAD UPTAKE BY LEAVES (UG/M**2/DAY)                           0.0         0.0         0.0         0.0         0.0         0.0
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                       0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                     0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)          0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)         0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)          0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)          0.0         0.0         0.0         0.0         0.0         0.0
ROOT BIOMASS (G/M**2 LAND)                                    0.0         0.0         0.0         0.0         0.0         0.0

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APPENDIX (continued)

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 MODEL : CERES          PARAMETER : L  MAX, MAXIMUM LEAF
STANDARD VALUE = 5.0 (CM2/CM2)

                  OUTPUT RESPONSES                              RELATIVE OUTPUT COEFFICIENTS      SENSITIVITY COEFFICIENTS

   INPUT
   VALUES:                                                              2.5          0.5          2.5          0.5

SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                    0.508E 07    0.132E 07    0.700E 05    0.197E 05
ZINC IN ROOT LITTER (UG/M**2 LAND)                                0.853E 06    200.         0.268E 05    -244.
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                         0.347E 06    126.         -61.7        -0.714
LEAF LEAD CONCENTRATION (UG/G)                                    0.200E 06    0.379E 04    -310.        -23.4
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)        0.541E 05    42.6         -2.54        -0.399E-01
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)       -0.288E 05    -35.2        -0.842E-01   -0.143E-02
LEAF BIOMASS (G/M**2 LAND)                                        0.107E 05    0.370E 04    153.         49.7
STEM LEAD CONCENTRATION (UG/G)                                    0.121E 05    44.8         -3.59        -0.126
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                         0.832E 04    0.285E 04    108.         26.6
FRUIT LEAD CONCENTRATION (UG/G)                                   0.940E 04    35.4         -2.30        -0.835E-01
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                              0.782E 04    984.         102.         1.65
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                         0.420E 04    0.172E 04    70.1         4.26
ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)                0.511E 04    2.28         241.         -2.80
STEM BIOMASS (G/M**2 LAND)                                        0.340E 04    0.137E 04    114.         40.7
ZINC UPTAKE BY LEAVES (UG/M**2/DAY)                               0.419E 04    18.4         172.         -4.21
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                         0.391E 04    0.599E-01    -0.506E-01   0.191E-03
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)             0.323E 04    652.         6.79         1.59
LEAF SULFUR CONCENTRATION (UG/G)                                  0.236E 04    468.         112.         26.6
FRUIT ZINC CONCENTRATION (UG/G)                                   0.233E 04    488.         33.0         6.17
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)             0.159E 04    180.         4.14         0.475
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)        629.         978.         2.05         0.177
ROOT LEAD CONCENTRATION (UG/G)                                    974.         193.         13.2         3.16
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)      621.         211.         1.35         0.435
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                         507.         196.         7.03         2.43
ROOT ZINC CONCENTRATION (UG/G)                                    569.         0.298        11.8         -0.996E-01
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)        592.         -25.7        1.23         0.172
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                       377.         119.         5.17         1.60
STEM ZINC CONCENTRATION (UG/G)                                    360.         11.7         7.26         0.309
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                           201.         56.8         2.70         0.795
ZINC IN LEAF LITTER (UG/M**2 LAND)                                242.         0.128        7.39         0.423E-01
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                              207.         0.273        -0.933E-01   0.242E-02
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                           193.         0.585        3.54         0.105
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)                 113.         30.3         0.250        0.718E-01
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                            111.         0.548E-01    -0.149E-01   -0.184E-03
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                           102.         0.677        -0.598E-01   -0.271E-02
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)       92.0         0.575E-01    -0.509E-02   -0.682E-04
ROOT BIOMASS (G/M**2 LAND)                                        46.6         25.2         8.05         3.24
STEM SULFUR CONCENTRATION (UG/G)                                  51.5         14.2         0.720        0.208
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)       19.9         -55.5        0.451E-01    -0.274E-01
FRUIT SULFUR CONCENTRATION (UG/G)                                 28.3         6.50         0.400        0.995E-01
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                           21.8         7.31         0.313        0.100
FRUIT BIOMASS (G/M**2 LAND)                                       18.5         10.2         0.496        0.202
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)      20.1         6.84         0.435E-01    0.141E-01
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                           16.0         2.58         0.271        0.601E-01
ROOT UPTAKE OF LEAD - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)          16.4         1.06         0.219        0.295E-01
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                 10.4         5.96         0.219E-01    0.920E-02
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                            2.78         13.1         0.416E-01    -0.272E-01
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)             7.89         3.71         0.170E-01    0.628E-02
LEAF ZINC CONCENTRATION (UG/G)                                    8.40         1.50         -0.799       -0.616E-01
ROOT UPTAKE OF ZINC - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)          7.87         0.254        0.175        0.668E-02
LEAF RESPIRATION (G/M**2 LAND/HR)                                 5.50         1.83         0.136E-01    0.421E-02
STEM RESPIRATION (G/M**2 LAND/HR)                                 5.25         2.12         0.276E-01    0.576E-02
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                    5.43         1.30         -0.222E-01   -0.589E-02
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                     5.55         0.944        -0.344       -0.793E-01
ROOT SULFUR CONCENTRATION (UG/G)                                  3.72         1.42         0.515E-01    0.175E-01
LEAD IN STEM LITTER (UG/M**2 LAND)                                4.82         0.646E-01    -0.662E-02   -0.426E-03
LEAD UPTAKE BY LEAVES (UG/M**2/DAY)                               4.55         0.163E-01    9.65         0.789E-01
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)           2.94         1.15         0.614E-02    0.209E-02
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                          3.57         0.446        0.547E-01    0.106E-01
SULFUR IN LEAF LITTER (UG/M**2 LAND)                              2.49         0.878        0.345E-01    0.114E-01
LEAD IN FRUIT LITTER (UG/M**2 LAND)                               2.95         0.200E-01    -0.216E-02   -0.101E-03
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                          2.77         0.139E-01    -0.146E-02   -0.578E-04
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                          1.53         0.592        0.206E-01    0.706E-02
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                          2.05         0.202E-01    -0.154E-02   -0.851E-04
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                         1.42         0.645        0.192E-01    0.720E-02
ZINC IN FRUIT LITTER (UG/M**2 LAND)                               1.64         0.348        0.231E-01    0.580E-02
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)             1.72         0.248        0.920E-03    0.384E-03
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                          1.54         0.284        0.219E-01    0.517E-02
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR      1.25         0.424        0.270E-02    0.873E-03
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                         0.729        0.324        0.991E-02    0.367E-02
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                0.654        0.391        0.138E-02    0.594E-03
ROOT UPTAKE OF LEAD - DARK PERIOD (UG/M**2/DAY)                   0.807        0.149        0.109E-01    0.260E-02
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                            0.607        0.192        0.832E-02    0.257E-02
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                           0.646        0.340E-02    0.747E-01    0.297E-02
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                          0.380        0.110        0.702E-02    0.209E-02
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                     0.369        0.783E-01    -0.139       -0.352E-01
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)                0.441        0.512E-04    0.199E-01    -0.215E-04
ZINC IN STEM LITTER (UG/M**2 LAND)                                0.231        0.627E-01    0.457E-02    0.135E-02
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)           0.184        0.731E-01    0.384E-03    0.126E-03
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                    0.111        0.319E-01    -0.918E-03   -0.272E-03
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER                   0.109        0.195E-01    -0.221E-03   -0.519E-04
ROOT UPTAKE OF ZINC - DARK PERIOD (UG/M**2/DAY)                   0.199E-01    0.380E-01    0.153E-03    0.108E-02
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                        0.367E-01    0.182E-01    0.498E-03    0.195E-03
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)                0.531E-01    0.716E-03    -0.742E-04   -0.479E-05
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                        0.381E-01    0.155E-01    0.516E-03    0.183E-03
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                       0.360E-01    0.112E-01    0.468E-03    0.123E-03
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)               0.339E-01    0.302E-03    -0.309E-04   -0.163E-05
FRUIT RESPIRATION (G/M**2 LAND/HR)                                0.197E-01    0.109E-01    0.865E-04    0.357E-04
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)               0.206E-01    0.566E-02    0.290E-03    0.834E-04
ROOT RESPIRATION (G/M**2 LAND/HR)                                 0.147E-01    0.794E-02    0.450E-03    0.183E-03
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)                        0.537E-02    0.262E-02    0.730E-04    0.283E-04
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)              0.433E-02    0.166E-02    0.600E-04    0.206E-04
CO2 CHLOROPLAST (ML/ML)                                           0.310E-02    0.811E-04    0.243E-04    0.964E-06
SULFUR IN ROOT LITTER (UG/M**2 LAND)                              0.216E-02    0.876E-03    0.294E-04    0.104E-04
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)                0.172E-02    0.550E-03    0.392E-04    0.124E-04
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                              0.625E-03    0.704E-04    0.298E-05    -0.417E-06
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                             0.207E-03    0.761E-04    0.280E-05    0.942E-06
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER                   0.477E-04    0.123E-04    -0.204E-06   -0.576E-07
SULFUR IN STEM LITTER (UG/M**2 LAND)                              0.367E-04    0.189E-04    0.497E-06    0.198E-06
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)              0.191E-04    0.841E-05    0.260E-06    0.558E-07
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)             0.230E-05    0.929E-06    0.312E-07    0.110E-07
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)              0.487E-06    0.259E-06    0.660E-08    0.268E-08
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER                   0.125E-08    0.179E-09    -0.373E-11   -0.798E-12
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER                   0.542E-14    0.122E-14    -0.555E-14   -0.115E-14
LEAD IN ROOT LITTER (UG/M**2 LAND)                                0.0          0.0          0.0          0.0
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)                0.0          0.0          0.0          0.0
LEAD IN LEAF LITTER (UG/M**2 LAND)                                0.0          0.0          0.0          0.0
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)                0.0          0.0          0.0          0.0

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APPENDIX (continued)

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 MODEL : DRYADS            PARAMETER : PERM,LEAF CUTICLE PERMEABILITY
STANDARD VALUE = 1.0E-11 (CM/SEC)

                    OUTPUT RESPONSES                            RELATIVE OUTPUT COEFFICIENTS      SENSITIVITY COEFFICIENTS

   INPUT
   VALUES:                                                      1.0E-07     1.0E-9      1.0E-13     1.0E-07     1.0E-9      1.0E-13

LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                          0.687E 16   0.550E 13   0.121E-01  -0.273E 17   0.835E 13  -0.390E 04
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                       0.118E 14   0.242E 14   0.148E-03  -0.279E 15   0.184E 13   115.
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                          0.305E 12   0.446E 09   3.92       -0.236E 16   0.873E 12  -0.126E 07
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)           0.423E 11   0.111E 11   0.269E-03  -0.906E 13   0.512E 11   587.
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                       0.267E 10   0.109E 11   79.2       -0.949E 15   0.656E 13  -0.256E 08
FRUIT LEAD CONCENTRATION (UG/G)                                 0.456E 10   0.305E 10   3.62       -0.429E 15   0.351E 13  -0.122E 07
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)     -0.287E 10  -0.102E 10   0.961E-01  -0.819E 13   0.474E 11  -0.156E 05
LEAD IN LEAF LITTER (UG/M**2 LAND)                              0.395E 09   0.493E 09   0.117E 08  -0.223E 18   0.249E 16  -0.381E 13
ZINC IN LEAF LITTER (UG/M**2 LAND)                              0.512E 09   0.422E 07   0.157E 04  -0.281E 16   0.256E 13  -0.519E 09
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)      0.306E 09   0.161E 09   28.1       -0.362E 14   0.263E 12  -0.146E 07
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                            0.113E 09   0.176E 09   0.190E-01  -0.121E 14   0.660E 11  -0.182E 05
LEAD IN ROOT LITTER (UG/M**2 LAND)                              0.106E 09   0.108E 09   0.128E 07   0.377E 18  -0.379E 16   0.409E 13
LEAD IN STEM LITTER (UG/M**2 LAND)                              0.210E 09   0.104E 06   0.544E-01  -0.110E 14   0.245E 10  -0.176E 05
STEM LEAD CONCENTRATION (UG/G)                                  0.768E 08   0.715E 08   6.25       -0.745E 14   0.718E 12  -0.211E 07
ZINC IN STEM LITTER (UG/M**2 LAND)                              0.352E 08   43.1        0.452E-02  -0.110E 14   0.124E 09   0.162E 05
LEAD IN FRUIT LITTER (UG/M**2 LAND)                             0.159E 08   0.391E 06   0.956E-02  -0.122E 13   0.197E 10  -0.315E 04
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)     0.395E 07   0.287E 07   0.459E-01   0.140E 12  -0.120E 10  -0.290E 04
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                         0.279E 07   0.261E 07   0.199      -0.250E 13   0.242E 11  -0.662E 05
ZINC IN ROOT LITTER (UG/M**2 LAND)                              0.266E 07   0.174E 07   0.344E 05   0.130E 17  -0.101E 15   0.147E 12
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)              0.139E 07   0.171E 07   0.377E 05  -0.752E 15   0.836E 13  -0.123E 11
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)              0.267E 07   0.113E 04   0.621E-03  -0.133E 12   0.274E 08  -201.
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)              0.114E 07   0.115E 07   0.138E 05   0.405E 16  -0.407E 14   0.441E 11
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)              0.224E 07   0.183E 05   5.50       -0.115E 14   0.104E 11  -0.180E 07
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)           0.137E 07   0.387E 06   0.490E-02  -0.111E 13   0.616E 10   0.976E 04
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                        0.706E 06   0.537E 06   0.426E-02  -0.186E 12   0.163E 10  -0.144E 04
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                       0.505E 06   0.719E 06   0.190E 04  -0.705E 14   0.956E 12  -0.105E 10
ROOT LEAD CONCENTRATION (UG/G)                                  0.592E 06   0.321E 06   0.129      -0.797E 14   0.584E 12   0.377E 07
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)              0.527E 06   0.636       0.483E-04  -0.163E 12   0.180E 07   166.
LEAF LEAD CONCENTRATION (UG/G)                                  0.263E 06   0.260E 06   0.284E 04  -0.892E 14   0.889E 12  -0.926E 09
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)             0.398E 06   0.429E 04   0.168E-03  -0.266E 11   0.275E 08  -54.8
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                        0.162E 06   0.132E 06   0.672E-02  -0.109E 12   0.987E 09  -0.221E 04
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                         0.161E 06   0.883E 05   0.239E-01  -0.192E 14   0.142E 12   0.718E 06
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                       0.679E 05   0.985E 05   0.192E 05  -0.277E 14   0.434E 12   0.301E 10
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)      0.628E 05   0.522E 05   0.168E 04  -0.109E 13   0.160E 11  -0.739E 08
FRUIT ZINC CONCENTRATION (UG/G)                                 0.261E 05   0.304E 05   0.649E 04  -0.250E 14   0.276E 12   0.136E 10
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)     -0.217E 05  -0.401E 05   865.       -0.496E 12   0.767E 10   0.183E 08
ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)              0.242E 05   0.128E 05   332.        0.135E 15  -0.976E 12   0.157E 10
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                            0.720E 04   0.108E 05   0.734E 04   0.125E 13   0.509E 11   0.217E 10
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                         0.482E 04   0.478E 04   51.2       -0.163E 13   0.163E 11  -0.167E 08
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)           0.141E 04   0.394E 04   0.283E 04  -0.525E 12   0.101E 11   0.995E 08
ZINC IN FRUIT LITTER (UG/M**2 LAND)                             0.648E 04   2.31        0.979      -0.169E 12   0.656E 08   0.445E 06
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)           593.        0.134E 04   0.454E 04   0.316E 12  -0.274E 09   0.181E 09
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                        0.105E 04   506.        0.149E-03  -0.136E 12   0.942E 09   0.503E 04
STEM TO FRUIT PHLOEM TRANSLCCATION OF ZINC(UG/M**2 LAND/HR)     64.8        67.9        31.3        0.210E 11  -0.206E 09  -0.617E 06
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)             154.        0.296E-01   0.116E-01  -0.478E 10   0.853E 06   0.542E 04
LEAF ZINC CONCENTRATION (UG/G)                                  15.4        15.6        60.0       -0.288E 12   0.285E 10  -0.666E 08
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                   6.23        6.50        1.08       -0.944E 11   0.964E 09  -0.397E 07
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                        2.71        3.49        0.934      -0.731E 10   0.830E 08   0.424E 06
STEM ZINC CONCENTRATION (UG/G)                                  0.990       1.33        1.28       -0.616E 11   0.743E 09   0.484E 07
ROOT ZINC CONCENTRATION (UG/G)                                  1.15        1.22        0.768       0.293E 11  -0.130E 09   0.623E 07
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                        0.582       0.524       0.181E-02  -0.206E 10   0.196E 08   0.109E 05
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                         0.848E-01   0.907E-01   0.633      -0.366E 10   0.370E 08  -0.115E 07
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                         0.112       0.599E-01   0.180E-02  -0.570E 10   0.416E 08  -0.482E 05
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                  0.587E-01   0.729E-01   0.918E-02  -0.603E 09   0.669E 07  -0.239E 05
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                   0.414E-01   0.579E-01   0.824E-03  -0.111E 11   0.136E 09  -0.387E 05
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                        0.257E-01   0.235E-01   0.392E-03   0.115E 10  -0.111E 08   0.119E 05
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                         0.204E-01   0.181E-01   0.893E-02   0.730E 10  -0.638E 08   0.493E 06
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER                 0.290E-04   0.871E-04   0.957E-05  -0.680E 06   0.151E 05  -48.9
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                  0.464E-04   0.719E-04   0.110E-06  -0.438E 07   0.582E 05  -6.45
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER                 0.129E-08   0.413E-09   0.0         248.        1.40        0.0
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER                 0.950E-13   0.638E-13   0.415E-14   0.802E-02   0.596E-04  -0.132E-06
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)                      0.0         0.0         0.0         0.0         0.0         0.0
ROOT SULFUR CONCENTRATION (UG/G)                                0.0         0.0         0.0         0.0         0.0         0.0
STEM BIOMASS (G/M**2 LAND)                                      0.0         0.0         0.0         0.0         0.0         0.0
FRUIT BIOMASS (G/M**2 LAND)                                     0.0         0.0         0.0         0.0         0.0         0.0
LEAF BIOMASS (G/M**2 LAND)                                      0.0         0.0         0.0         0.0         0.0         0.0
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER                 0.0         0.0         0.0         0.0         0.0         0.0
LEAF SULFUR CONCENTRATION (UG/G)                                0.0         0.0         0.0         0.0         0.0         0.0
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                      0.0         0.0         0.0         0.0         0.0         0.0
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)         0.0         0.0         0.0         0.0         0.0         0.0
FRUIT SULFUR CONCENTRATION (UG/G)                               0.0         0.0         0.0         0.0         0.0         0.0
STEM SULFUR CONCENTRATION (UG/G)                                0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN LEAF LITTER (UG/M**2 LAND)                            0.0         0.0         0.0         0.0         0.0         0.0
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)               0.0         0.0         0.0         0.0         0.0         0.0
STEM RESPIRATION (G/M**2 LAND/HR)                               0.0         0.0         0.0         0.0         0.0         0.0
FRUIT RESPIRATION (G/M**2 LAND/HR)                              0.0         0.0         0.0         0.0         0.0         0.0
LEAF RESPIRATION (G/M**2 LAND/HR)                               0.0         0.0         0.0         0.0         0.0         0.0
ROCT RESPIRATION (G/M**2 LAND/HR)                               0.0         0.0         0.0         0.0         0.0         0.0
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)               0.0         0.0         0.0         0.0         0.0         0.0
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)              0.0         0.0         0.0         0.0         0.0         0.0
CO2 CHLOROPLAST (ML/ML)                                         0.0         0.0         0.0         0.0         0.0         0.0
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)         0.0         0.0         0.0         0.0         0.0         0.0
STEM TO FRUIT PHLOEM TRANSLCCATION OF SULFUR(UG/M**2 LAND/HR    0.0         0.0         0.0         0.0         0.0         0.0
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)    0.0         0.0         0.0         0.0         0.0         0.0
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)    0.0         0.0         0.0         0.0         0.0         0.0
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                            0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                       0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                      0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                     0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                     0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                           0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN ROOT LITTER (UG/M**2 LAND)                            0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN STEM LITTER (UG/M**2 LAND)                            0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                          0.0         0.0         0.0         0.0         0.0         0.0
SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                  0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)            0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                       0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                       0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)            0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)           0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)            0.0         0.0         0.0         0.0         0.0         0.0
ROOT BIOMASS (G/M**2 LAND)                                      0.0         0.0         0.0         0.0         0.0         0.0

IHC002I STOP      0
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APPENDIX (continued)

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MODEL : UNIFADS        PARAMETER : FILM,  CUTICLE THICKNESS
STANDARD VALUE = 1.0E-04 (CM)

                 OUTPUT RESPONSES                                     RELATIVE OUTPUT COEFFICIENTS            SENSITIVITY COEFFICIENTS

   INPUT
   VALUES:                                                          1.0E-06     1.0E-05     1.0E-02     1.0E-06     1.0E-05     1.0E-02

LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                          0.148E-03   0.624E 07   0.242E 14  -0.116       -0.620E 05   0.184E 06
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                             0.121E-01   0.224E 07   0.550E 13   3.94        -0.590E 05   0.835E 06
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)              0.269E-03   0.210E 05   0.111E 11  -0.593       -0.153E 04   0.512E 04
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                          79.2        0.173E 08   0.109E 11   0.258E 05  -0.123E 08   0.656E 06
FRUIT LEAD CONCENTRATION (UG/G)                                    3.62        0.371E 06   0.305E 10   0.123E 04  -0.433E 06   0.351E 06
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)         0.961E-01  -0.159E 07  -0.102E 10   15.7       -0.174E 05   0.474E 04
LEAD IN LEAF LITTER (UG/M**2 LAND)                                 0.117E 08   0.217E 09   0.493E 09   0.385E 10  -0.182E 11   0.249E 09
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                             3.92        0.195E 07   0.446E 09   0.128E 04  -0.562E 06   0.873E 05
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                               0.190E-01   0.143E 05   0.176E 09   18.4       -0.228E 05   0.660E 04
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)         28.1        0.274E 07   0.161E 09   0.147E 04  -0.502E 06   0.263E 05
LEAD IN ROOT LITTER (UG/M**2 LAND)                                 0.128E 07   0.282E 08   0.108E 09  -0.413E 10   0.213E 11  -0.379E 09
LEAD UPTAKE BY LEAVES (UG/M**2/DAY)                                0.190E 06   0.150E 08   0.115E 09   0.627E 08  -0.611E 09   0.136E 08
STEM LEAD CONCENTRATION (UG/G)                                     6.25        0.582E 06   0.715E 08   0.214E 04  -0.716E 06   0.718E 05
ZINC IN LEAF LITTER (UG/M**2 LAND)                                 0.157E 04   0.456E 05   0.422E 07   0.524E 06  -0.297E 07   0.256E 06
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)        0.459E-01   0.536E 04   0.287E 07   2.93       -0.108E 04  -120.
ZINC IN ROOT LITTER (UG/M**2 LAND)                                 0.344E 05   0.107E 07   0.174E 07  -0.149E 09   0.859E 09  -0.101E 08
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                            0.199       0.181E 05   0.261E 07   66.8       -0.222E 05   0.242E 04
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)                 0.377E 05   0.702E 06   0.171E 07   0.124E 08  -0.590E 08   0.836E 06
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)                 0.138E 05   0.304E 06   0.115E 07  -0.445E 08   0.230E 09  -0.407E 07
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                          0.190E 04   0.488E 06   0.719E 06   0.106E 07  -0.541E 07   0.956E 05
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                           0.426E-02   429.        0.537E 06   1.45       -508.        163.
LEAF LEAD CONCENTRATION (UG/G)                                     0.284E 04   0.164E 06   0.260E 06   0.936E 06  -0.782E 07   0.889E 05
LEAD IN FRUIT LITTER (UG/M**2 LAND)                                0.956E-02   398.        0.391E 06   3.19       -694.        197.
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)              0.490E-02   220.        0.387E 06  -9.85       -0.154E 04   616.
ZINC UPTAKE BY LEAVES (UG/M**2/DAY)                                0.560E 05   0.739E 05   0.243E 06   0.185E 08  -0.204E 08   0.345E 06
ROOT LEAD CONCENTRATION (UG/G)                                     0.129       2.12        0.321E 06  -0.381E 04  -0.131E 05   0.584E 05
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                          0.192E 05   0.581E 05   0.985E 05  -0.304E 07  -0.180E 07   0.434E 05
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                           0.672E-02   657.        0.132E 06   2.23       -768.        98.7
LEAD IN STEM LITTER (UG/M**2 LAND)                                 0.544E-01   470.        0.104E 06   17.8       -0.181E 04   245.
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                            0.239E-01   0.732       0.883E 05  -725.       -0.426E 04   0.142E 05
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)         0.168E 04   0.184E 05   0.522E 05   0.746E 05  -0.648E 05   0.160E 04
FRUIT ZINC CONCENTRATION (UG/G)                                    0.649E 04   0.124E 05   0.304E 05  -0.137E 07  -0.187E 07   0.276E 05
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)         865.       -0.557E 04  -0.401E 05  -0.185E 05  -0.266E 05   767.
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                               0.734E 04   0.481E 04   0.108E 05  -0.219E 07   0.463E 06   0.509E 04
ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)                 332.        0.729E 04   0.128E 05  -0.159E 07   0.806E 07  -0.976E 05
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)                 5.50        192.        0.183E 05   0.182E 04  -0.118E 05   0.104E 04
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                            51.2        0.298E 04   0.478E 04   0.169E 05  -0.141E 06   0.163E 04
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)              0.283E 04   272.        0.394E 04  -0.100E 06  -0.192E 05   0.101E 04
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)              0.454E 04   386.        0.134E 04  -0.183E 06   0.469E 05  -27.4
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)                0.168E-03   4.40        0.429E 04   0.553E-01  -9.73        2.75
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)                 0.621E-03   4.74        0.113E 04   0.203      -19.4         2.74
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                           0.149E-03   0.242E-01   506.       -5.08       -68.3         94.2
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)        31.3        47.4        67.9        623.        0.204E 04  -20.6
LEAF ZINC CONCENTRATION (UG/G)                                     60.0        14.1        15.6        0.673E 05  -0.291E 05   285.
ROOT UPTAKE OF ZINC - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)           15.7        16.6        21.6       -0.636E 04   0.719E 04  -74.5
ZINC IN STEM LITTER (UG/M**2 LAND)                                 0.452E-02   1.42        43.1       -16.4       -265.         12.4
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                      1.08        4.53        6.50        0.401E 04  -0.885E 04   96.4
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                           0.934       1.17        3.49       -428.       -528.         8.30
ROOT UPTAKE OF LEAD - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)           0.323E-02   0.565       3.80       -77.5        762.        -26.7
ZINC IN FRUIT LITTER (UG/M**2 LAND)                                0.979       0.743       2.31       -449.       -407.         6.56
STEM ZINC CONCENTRATION (UG/G)                                     1.28        0.973       1.33       -0.489E 04  -0.455E 04   74.3
ROOT ZINC CONCENTRATION (UG/G)                                     0.768       0.921       1.22       -0.629E 04   0.358E 04  -13.0
ROOT UPTAKE OF ZINC - DARK PERIOD (UG/M**2/DAY)                    0.470       0.481       0.619      -188.        209.        -2.16
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                           0.181E-02   0.347       0.524      -11.0       -176.         1.96
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                            0.633       0.857E-01   0.907E-01   0.116E 04  -394.         3.70
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)                 0.483E-04   0.197E-01   0.636      -0.167      -3.54         0.180
ROOT UPTAKE OF LEAD - DARK PERIOD (UG/M**2/DAY)                    0.236E-03   0.195E-01   0.247      -4.70        47.2        -1.53
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                            0.180E-02   0.764E-01   0.599E-01   48.7       -518.         4.16
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                     0.918E-02   0.488E-01   0.729E-01   24.1       -60.3         0.669
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                      0.824E-03   0.869E-02   0.579E-01   39.1       -470.         13.6
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                            0.893E-02   0.264E-01   0.181E-01  -498.        996.        -6.38
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)                0.116E-01   0.984E-02   0.296E-01  -5.47       -5.41         0.853E-01
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                           0.392E-03   0.268E-01   0.235E-01  -12.1        130.        -1.11
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER                    0.957E-05   0.558E-04   0.871E-04   0.494E-01  -0.133       0.151E-02
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                     0.110E-06   0.459E-05   0.719E-04   0.652E-02  -0.161       0.582E-02
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER                    0.0         0.397E-10   0.413E-09   0.0        -0.287E-05   0.140E-06
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER                    0.415E-14   0.413E-13   0.638E-13   0.134E-09  -0.538E-09   0.596E-11
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)                         0.0         0.0         0.0         0.0         0.0         0.0
ROOT SULFUR CONCENTRATION (UG/G)                                   0.0         0.0         0.0         0.0         0.0         0.0
STEM BIOMASS (G/M**2 LAND)                                         0.0         0.0         0.0         0.0         0.0         0.0
FRUIT BIOMASS (G/M**2 LAND)                                        0.0         0.0         0.0         0.0         0.0         0.0
LEAF BIOMASS (G/M**2 LAND)                                         0.0         0.0         0.0         0.0         0.0         0.0
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER                    0.0         0.0         0.0         0.0         0.0         0.0
LEAF SULFUR CONCENTRATION (UG/G)                                   0.0         0.0         0.0         0.0         0.0         0.0
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                         0.0         0.0         0.0         0.0         0.0         0.0
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)            0.0         0.0         0.0         0.0         0.0         0.0
FRUIT SULFUR CONCENTRATION (UG/G)                                  0.0         0.0         0.0         0.0         0.0         0.0
STEM SULFUR CONCENTRATION (UG/G)                                   0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN LEAF LITTER (UG/M**2 LAND)                               0.0         0.0         0.0         0.0         0.0         0.0
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)                  0.0         0.0         0.0         0.0         0.0         0.0
STEM RESPIRATION (G/M**2 LAND/HR)                                  0.0         0.0         0.0         0.0         0.0         0.0
FRUIT RESPIRATION (G/M**2 LAND/HR)                                 0.0         0.0         0.0         0.0         0.0         0.0
LEAF RESPIRATION (G/M**2 LAND/HR)                                  0.0         0.0         0.0         0.0         0.0         0.0
ROOT RESPIRATION (G/M**2 LAND/HR)                                  0.0         0.0         0.0         0.0         0.0         0.0
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                  0.0         0.0         0.0         0.0         0.0         0.0
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                 0.0         0.0         0.0         0.0         0.0         0.0
CO2 CHLOROPLAST (ML/ML)                                            0.0         0.0         0.0         0.0         0.0         0.0
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)            0.0         0.0         0.0         0.0         0.0         0.0
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR       0.0         0.0         0.0         0.0         0.0         0.0
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)       0.0         0.0         0.0         0.0         0.0         0.0
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)       0.0         0.0         0.0         0.0         0.0         0.0
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                               0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                          0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                         0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                        0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                        0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                              0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN ROOT LITTER (UG/M**2 LAND)                               0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN STEM LITTER (UG/M**2 LAND)                               0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                             0.0         0.0         0.0         0.0         0.0         0.0
SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                     0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)               0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                          0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                          0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)               0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)              0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)               0.0         0.0         0.0         0.0         0.0         0.0
ROOT BIOMASS (G/M**2 LAND)                                         0.0         0.0         0.0         0.0         0.0         0.0
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APPENDIX (continued)

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MODEL : DRYADS            PARAMETER : CONDUC, ROOT CONDUCTIVITY TO SOLUTES
STANDARD VALUE = 1.0E-8 (CM/SEC)

                  OUTPUT RESPONSES                                    RELATIVE OUTPUT COEFFICIENTS        SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                           1.0E-12     1.0E-10     1.0E-6      1.0E-12     1.0E-10     1.0E-6

ZINC IN LEAF LITTER (UG/M**2 LAND)                                    0.159E 04   0.148E 08   0.125E 11   0.522E 10  -0.509E 12   0.148E 12
LEAD IN LEAF LITTER (UG/M**2 LAND)                                    0.117E 08   0.110E 10   0.137E 10   0.381E 14  -0.373E 15   0.417E 13
LEAD IN ROOT LITTER (UG/M**2 LAND)                                    0.107E 07   0.101E 09   0.125E 09  -0.375E 14   0.366E 15  -0.409E 13
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)                    5.55        0.519E 05   0.437E 08   0.181E 08  -0.177E 10   0.514E 09
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)                    0.377E 05   0.355E 07   0.444E 07   0.123E 12  -0.121E 13   0.135E 11
ZINC IN ROOT LITTER (UG/M**2 LAND)                                    0.277E 07   0.387E 04   0.320E 07   0.129E 14   0.502E 12  -0.145E 12
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)                    0.116E 05   0.108E 07   0.135E 07  -0.403E 12   0.394E 13  -0.441E 11
ROOT LEAD CONCENTRATION (UG/G)                                        0.130E 06   0.104E 04   0.107E 04  -0.379E 11   0.344E 10  -0.349E 08
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)                 0.101E 06   8.39        8.40       -0.478E 09   0.446E 07  -0.446E 05
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                             0.624E 05   0.601E 04   0.601E 04  -0.431E 11   0.213E 11  -0.213E 09
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                                  0.666E 05   0.793       0.793      -0.837E 09   0.291E 07  -0.291E 05
ZINC MINERALIZATION FROM ROCT LITTER (UG/M**2/DAY)                    0.226E 05   46.0        0.372E 05   0.129E 12   0.590E 10  -0.168E 10
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                             0.234E 05   0.843E 04   0.843E 04  -0.264E 11   0.275E 11  -0.275E 09
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                               0.301E 05   212.        218.       -0.826E 10   0.701E 09  -0.710E 07
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                                  0.875E 04   0.803E 04   0.804E 04  -0.107E 11   0.262E 11  -0.262E 09
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)            0.143E 05   0.127E 04   0.127E 04  -0.814E 09   0.731E 09  -0.730E 07
FRUIT ZINC CONCENTRATION (UG/G)                                       0.484E 04   0.273E 04   0.273E 04  -0.106E 11   0.902E 10  -0.902E 08
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)                 0.231E 04   0.319E 04   0.328E 04  -0.710E 09   0.170E 10  -0.173E 08
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)                 0.635E 04   0.525       0.525      -0.300E 08   0.279E 06  -0.279E 04
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)                 0.215E 04   0.198E 04   0.199E 04  -0.958E 09   0.105E 10  -0.105E 08
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)           -0.712E 04   586.        578.       -0.548E 09   0.309E 09  -0.307E 07
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)           -0.445E 04  -15.0       -15.0        0.101E 08  -0.414E 06   0.414E 04
ROOT ZINC CONCENTRATION (UG/G)                                        0.410       0.106E 04   0.153E 04  -0.416E 08   0.416E 10  -0.502E 08
STEM ZINC CONCENTRATION (UG/G)                                        0.951       776.        779.       -0.768E 08   0.271E 10  -0.271E 08
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                             0.123E 04   0.739E-01   0.739E-01  -0.310E 08   0.248E 06  -0.248E 04
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                                967.        3.68        3.68       -0.120E 09   0.124E 08  -0.124E 06
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                               0.509       292.        388.       -0.453E 08   0.110E 10  -0.127E 08
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                              337.        1.61        1.65       -0.759E 08   0.533E 07  -0.539E 05
STEM LEAD CONCENTRATION (UG/G)                                        264.        0.191E-01   0.191E-01  -0.131E 09   0.110E 07  -0.110E 05
LEAF ZINC CONCENTRATION (UG/G)                                        11.9        93.4        93.7       -0.281E 09   0.117E 10  -0.117E 08
FRUIT LEAD CONCENTRATION (UG/G)                                       124.        0.724E-02   0.724E-02  -0.671E 08   0.502E 06  -0.502E 04
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)           76.9        0.558E-02   0.558E-02  -0.876E 06   0.795E 04  -79.5
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                         48.3        0.380       0.387       0.401E 09  -0.356E 08   0.360E 06
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                               0.153       23.9        24.0       -0.659E 07   0.836E 08  -0.837E 06
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)          -21.4        22.7        22.8        0.609E 07   0.121E 08  -0.122E 06
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                         0.196       10.3        11.7        0.163E 08  -0.121E 09   0.129E 07
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)            22.1        0.167E-01   0.167E-01   0.103E 08  -0.208E 06   0.208E 04
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                              1.23        4.33        5.03       -0.792E 07   0.152E 08  -0.164E 06
LEAD IN STEM LITTER (UG/M**2 LAND)                                    0.198E-01   3.59        4.47        0.104E 06  -0.144E 07   0.161E 05
ZINC IN STEM LITTER (UG/M**2 LAND)                                    0.737       0.337       3.60       -0.136E 07   0.142E 07   0.382E 05
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                               4.21        0.262E-03   0.262E-03  -0.299E 07   0.235E 05  -235.
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                              0.388       1.78        1.78       -0.274E 07   0.593E 07  -0.594E 05
ZINC IN FRUIT LITTER (UG/M**2 LAND)                                   0.182       1.86        1.82       -0.119E 07   0.621E 07  -0.614E 05
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                               0.933E-01   1.80        1.81       -0.427E 07   0.226E 08  -0.226E 06
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                              0.507       0.653       0.654      -0.191E 07   0.233E 07  -0.233E 05
LEAD IN FRUIT LITTER (UG/M**2 LAND)                                   0.901E-01   0.211       0.263      -0.781E 05  -0.137E 06   0.153E 04
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                        0.498E-01   0.147       0.164       0.506E 06  -0.941E 06   0.996E 04
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                             0.213       0.741E-04   0.741E-04  -0.827E 07   0.850E 05  -850.
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                              0.155       0.880E-05   0.880E-05  -0.853E 05   643.       -6.43
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)                    0.276E-03   0.428E-01   0.534E-01   0.133E 04  -0.168E 05   188.
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                              0.697E-01   0.358E-05   0.358E-05  -0.686E 05   482.       -4.82
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)                    0.968E-02   0.288E-02   0.533E-01  -0.214E 05   0.129E 05   528.
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)                   0.108E-02   0.232E-01   0.222E-01  -0.127E 05   0.777E 05  -759.
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                        0.352E-01   0.658E-03   0.670E-03   0.130E 06  -0.177E 05   179.
LEAF LEAD CONCENTRATION (UG/G)                                        0.270E-01   0.0         0.0        -0.187E 08   0.0         0.0
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)                   0.331E-03   0.553E-02   0.691E-02  -618.       -0.313E 04   34.9
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER                       0.703E-03   0.227E-03   0.240E-03   0.441E 04  -0.249E 04   25.7
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                               0.383E-03   0.0         0.0        -0.352E 06   0.0         0.0
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER                       0.824E-06   0.575E-08   0.591E-08   6.58       -0.538       0.544E-02
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                                0.795E-07   0.0         0.0        -100.        0.0         0.0
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER                       0.262E-11   0.215E-12   0.234E-12   0.433E-04  -0.114E-04   0.118E-06
FRUIT BIOMASS (G/M**2 LAND)                                           0.0         0.0         0.0         0.0         0.0         0.0
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)                            0.0         0.0         0.0         0.0         0.0         0.0
LEAF BIOMASS (G/M**2 LAND)                                            0.0         0.0         0.0         0.0         0.0         0.0
STEM BIOMASS (G/M**2 LAND)                                            0.0         0.0         0.0         0.0         0.0         0.0
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                            0.0         0.0         0.0         0.0         0.0         0.0
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER                       0.0         0.0         0.0         0.0         0.0         0.0
STEM SULFUR CONCENTRATION (UG/G)                                      0.0         0.0         0.0         0.0         0.0         0.0
ROOT SULFUR CONCENTRATION (UG/G)                                      0.0         0.0         0.0         0.0         0.0         0.0
FRUIT SULFUR CONCENTRATION (UG/G)                                     0.0         0.0         0.0         0.0         0.0         0.0
LEAF SULFUR CONCENTRATION (UG/G)                                      0.0         0.0         0.0         0.0         0.0         0.0
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)               0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN LEAF LITTER (UG/M**2 LAND)                                  0.0         0.0         0.0         0.0         0.0         0.0
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)                     0.0         0.0         0.0         0.0         0.0         0.0
STEM RESPIRATION (G/M**2 LAND/HR)                                     0.0         0.0         0.0         0.0         0.0         0.0
FRUIT RESPIRATION (G/M**2 LAND/HR)                                    0.0         0.0         0.0         0.0         0.0         0.0
LEAF RESPIRATION (G/M**2 LAND/HR)                                     0.0         0.0         0.0         0.0         0.0         0.0
ROCT RESPIRATION (G/M**2 LAND/HR)                                     0.0         0.0         0.0         0.0         0.0         0.0
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                     0.0         0.0         0.0         0.0         0.0         0.0
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)                    0.0         0.0         0.0         0.0         0.0         0.0
CO2 CHLOROPLAST (ML/ML)                                               0.0         0.0         0.0         0.0         0.0         0.0
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)               0.0         0.0         0.0         0.0         0.0         0.0
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR          0.0         0.0         0.0         0.0         0.0         0.0
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)          0.0         0.0         0.0         0.0         0.0         0.0
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)          0.0         0.0         0.0         0.0         0.0         0.0
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                                  0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                             0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                            0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                             0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                           0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                           0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                                 0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN ROOT LITTER (UG/M**2 LAND)                                  0.0         0.0         0.0         0.0         0.0         0.0
SULFUR IN STEM LITTER (UG/M**2 LAND)                                  0.0         0.0         0.0         0.0         0.0         0.0
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                                0.0         0.0         0.0         0.0         0.0         0.0
SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                        0.0         0.0         0.0         0.0         0.0         0.0
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                             0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)                  0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)                 0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)                  0.0         0.0         0.0         0.0         0.0         0.0
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)                  0.0         0.0         0.0         0.0         0.0         0.0
ROCT BIOMASS (G/M**2 LAND)                                            0.0         0.0         0.0         0.0         0.0         0.0

IHC002I STOP      0
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APPENDIX (continued)

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 MODEL : DRYADS          PARAMETER : GASEX, EXTERNAL GAS COEFFICIENT
STANDARD VALUE = 2.0E-08 (CC/CC)

                  OUTPUT RESPONSES                           RELATIVE OUTPUT COEFFICIENTS     SENSITIVITY COEFFICIENTS

    INPUT
    VALUES:                                                     2.0E-09      2.0E-07       2.0E-09      2.0E-07

SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                0.965E 08    0.459E 07    -0.422E 14   -0.924E 12
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                   0.727E 07     418.        -0.991E 11   -0.756E 08
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)  0.255E 07     657.        -0.101E 11   -0.192E 08
LEAF SULFUR CONCENTRATION (UG/G)                              0.726E 06    0.256E 05    -0.273E 12   -0.514E 10
STEM SULFUR CONCENTRATION (UG/G)                              0.220E 06     59.2        -0.653E 10   -0.107E 08
FRUIT SULFUR CONCENTRATION (UG/G)                             0.125E 06     33.2        -0.369E 10   -0.602E 07
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)  0.866E 05     21.2        -0.330E 09   -0.621E 06
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                   0.585E 05    0.359E-01    -0.686E 08   -0.649E 04
ROOT SULFUR CONCENTRATION (UG/G)                              0.158E 05     4.13        -0.462E 09   -0.749E 06
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                     0.133E 05     467.        -0.499E 10   -0.937E 08
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                        0.128E 05    0.672        -0.167E 09   -0.122E 06
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)       0.633E 04     2.89        -0.386E 08   -0.647E 05
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                     0.614E 04     1.53        -0.176E 09   -0.278E 06
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)       0.560E 04    0.101        -0.810E 07   -0.528E 04
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR  0.525E 04     1.32        -0.205E 08   -0.386E 05
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                     0.323E 04    0.793        -0.916E 08   -0.184E 06
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                     174.        0.397E-01    -0.875E 07   -0.710E 04
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                     155.        0.411E-01    -0.457E 07   -0.745E 04
SULFUR IN LEAF LITTER (UG/M**2 LAND)                           58.1         2.29        -0.231E 08   -0.460E 06
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)                     26.2        0.584E-02    -0.707E 06   -0.106E 04
SULFUR IN ROOT LITTER (UG/M**2 LAND)                           8.96        0.235E-02    -0.262E 06    -425.
LEAD IN LEAF LITTER (UG/M**2 LAND)                             4.78        0.0           0.358E 10    0.0
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)     2.09        0.178E-07    -0.133E 07   -0.289
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                         0.786        0.223E-03    -0.240E 05    -40.4
SULFUR IN STEM LITTER (UG/M**2 LAND)                          0.179        0.396E-04    -0.482E 04    -7.17
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)          0.112        0.399E-02    -0.424E 05    -800.
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)          0.845E-01    0.208E-04    -0.240E 04    -3.77
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                     0.791E-01    0.0          -0.212E 08    0.0
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                          0.564E-01    0.0           0.538E 06    0.0
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                     0.494E-01    0.0          -0.412E 07    0.0
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)         0.482E-01    0.0           0.307E 07    0.0
FRUIT ZINC CONCENTRATION (UG/G)                               0.321E-01    0.0           0.124E 08    0.0
STEM BIOMASS (G/M**2 LAND)                                    0.241E-01    0.0          -0.341E 08    0.0
ROOT BIOMASS (G/M**2 LAND)                                    0.238E-01    0.0          -0.183E 08    0.0
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)         0.146E-01    0.0           0.722E 06    0.0
LEAF LEAD CONCENTRATION (UG/G)                                0.117E-01    0.0           0.717E 06    0.0
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)    0.109E-01    0.0          -0.211E 06    0.0
LEAF BIOMASS (G/M**2 LAND)                                    0.105E-01    0.0          -0.717E 07    0.0
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)         0.928E-02    0.248E-05     -275.       -0.450
FRUIT BIOMASS (G/M**2 LAND)                                   0.260E-02    0.0          -0.806E 06    0.0
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)          0.245E-02    0.526E-06     -65.0       -0.953E-01
ROOT LEAD CONCENTRATION (UG/G)                                0.234E-02    0.0           0.179E 07    0.0
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                       0.198E-02    0.0          -0.591E 06    0.0
ROOT ZINC CONCENTRATION (UG/G)                                0.598E-03    0.0           0.538E 06    0.0
LEAF ZINC CONCENTRATION (UG/G)                                0.449E-03    0.0           0.0          0.0
FRUIT LEAD CONCENTRATION (UG/G)                               0.386E-03    0.0           0.645E 05    0.0
STEM ZINC CONCENTRATION (UG/G)                                0.355E-03    0.0          -0.179E 06    0.0
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)   0.204E-03    0.0           0.748E 04    0.0
ZINC IN LEAF LITTER (UG/M**2 LAND)                            0.152E-03    0.0           0.179E 06    0.0
STEM RESPIRATION (G/M**2 LAND/HR)                             0.189E-03    0.0          -0.926E 04    0.0
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                       0.164E-03    0.0          -0.557E 05    0.0
STEM LEAD CONCENTRATION (UG/G)                                0.151E-03    0.0           0.556E 05    0.0
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)         0.110E-03    0.0           0.642E 04    0.0
ROOT UPTAKE OF ZINC - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)      0.107E-03    0.123E-07     0.265E 05   -1.79
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                       0.105E-03    0.0          -0.254E 05    0.0
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                        0.101E-03    0.0          -0.380E 04    0.0
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                      0.540E-04    0.0          -0.143E 05    0.0
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                       0.528E-04    0.0          -0.538E 05    0.0
ZINC IN FRUIT LITTER (UG/M**2 LAND)                           0.507E-04    0.0          -0.153E 05    0.0
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                 0.472E-04    0.0           0.358E 05    0.0
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)             0.445E-04    0.0           0.260E 04    0.0
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                      0.436E-04    0.0          -0.145E 05    0.0
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)             0.429E-04    0.0          -0.547E 04    0.0
ROOT UPTAKE OF LEAD - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)      0.357E-04    0.154E-06     0.361E 05   -5.38
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                     0.328E-04    0.0          -0.102E 05    0.0
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)            0.164E-04    0.0           0.376E 04    0.0
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)         0.147E-04    0.0            662.        0.0
ROOT RESPIRATION (G/M**2 LAND/HR)                             0.137E-04    0.0           -694.        0.0
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)    0.128E-04    0.0           -605.        0.0
ZINC UPTAKE BY LEAVES (UG/M**2/DAY)                           0.107E-04    0.0          -0.179E 05    0.0
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                0.693E-05    0.0           0.235E 04    0.0
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                      0.630E-05    0.0          -0.251E 04    0.0
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                       0.556E-05    0.0           0.159E 04    0.0
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                      0.462E-05    0.0          -0.376E 04    0.0
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                          0.407E-05    0.0           0.287E 04    0.0
ZINC IN STEM LITTER (UG/M**2 LAND)                            0.400E-05    0.0          -0.151E 04    0.0
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)            0.390E-05    0.0           -377.        0.0
ROOT UPTAKE OF ZINC - DARK PERIOD (UG/M**2/DAY)               0.260E-05    0.0            855.        0.0
FRUIT RESPIRATION (G/M**2 LAND/HR)                            0.206E-05    0.0           -121.        0.0
ROOT UPTAKE OF LEAD - DARK PERIOD (UG/M**2/DAY)               0.157E-05    0.0           0.108E 04    0.0
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                     0.103E-05    0.0            421.        0.0
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)           0.531E-06    0.0           -175.        0.0
LEAD IN STEM LITTER (UG/M**2 LAND)                            0.267E-06    0.0            89.6        0.0
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                0.174E-06    0.0            60.9        0.0
LEAF RESPIRATION (G/M**2 LAND/HR)                             0.144E-06    0.0           -28.9        0.0
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                      0.144E-06    0.0            52.0        0.0
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER               0.132E-06    0.0            29.9        0.0
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)   0.116E-06    0.0            13.9        0.0
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)   -0.104E-06   -0.408E-09     -146.        0.289E-02
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                      0.757E-07    0.0            31.1        0.0
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                        0.795E-07    0.0            55.6        0.0
LEAD IN FRUIT LITTER (UG/M**2 LAND)                           0.736E-07    0.0            39.4        0.0
CO2 CHLOROPLAST (ML/ML)                                       0.230E-07    0.0           -1.45        0.0
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)            0.168E-07    0.0           -9.34        0.0
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                          0.872E-08    0.0           0.955        0.0
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)            0.298E-08    0.0            1.72        0.0
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)           0.135E-08    0.0           0.559        0.0
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER               0.920E-10    0.0           0.305E-01    0.0
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER               0.178E-15    0.0           0.717E-07    0.0
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                 0.0          0.0           0.0          0.0
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                       0.0          0.0           0.0          0.0
ZINC MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)            0.0          0.0           0.0          0.0
LEAD IN ROOT LITTER (UG/M**2 LAND)                            0.0          0.0           0.0          0.0
ZINC IN ROOT LITTER (UG/M**2 LAND)                            0.0          0.0           0.0          0.0
LEAD UPTAKE BY LEAVES (UG/M**2/DAY)                           0.0          0.0           0.0          0.0
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)            0.0          0.0           0.0          0.0
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER               0.0          0.0           0.0          0.0
LEAD MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)            0.0          0.0           0.0          0.0

IHO002I STOP      0
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APPENDIX (continued)

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 MODEL : CERES                    PARAMETER : CO2I, AMBIENT CO2 CONCENTRATION
STANDARD VALUE = 0.00032 (CM3/CM3)

                OUTPUT RESPONSES                                RELATIVE OUTPUT COEFFICIENTS         SENSITIVITY COEFFICIENTS

   INPUT
   VALUES:                                                     0.00064    0.00096    0.00128    0.00064    0.00096    0.00128

SO2 UPTAKE (UG/CM**2 LEAF/DAY)                                 0.240E 05  0.198E 05  0.125E 05 -0.342E 08 -0.151E 08 -0.733E 07
ZINC UPTAKE BY LEAVES (UG/M**2/DAY)                            0.187E 05  0.153E 05  0.477E 04  0.237E 07  0.109E 07  0.432E 06
LEAF SULFUR CONCENTRATION (UG/G)                               0.568E 04  0.465E 04  0.299E 04  0.133E 07  0.601E 06  0.322E 06
STEM BIOMASS (G/M**2 LAND)                                     0.462E 04  0.424E 04  0.315E 04  0.102E 07  0.491E 06  0.285E 06
ZINC CONTENT IN LEAF XYLEM (UG/M**2 LAND)                      0.381E 04  0.328E 04  0.185E 04 -0.411E 06 -0.193E 06 -0.106E 06
ZINC CONTENT IN ROOT XYLEM (UG/M**2)                           0.425E 04  0.292E 04  0.155E 04  0.336E 06  0.119E 06  0.398E 05
ZINC CONTENT IN STEM XYLEM (UG/M**2 LAND)                      0.355E 04  0.278E 04  0.114E 04 -0.414E 06 -0.181E 06 -0.711E 05
FRUIT ZINC CONCENTRATION (UG/G)                                0.221E 04  0.197E 04  0.124E 04 -0.251E 06 -0.118E 06 -0.625E 05
LEAF TO STEM PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)     0.191E 04  0.177E 04  0.115E 04 -0.262E 05 -0.126E 05 -0.598E 04
ROOT BIOMASS (G/M**2 LAND)                                     0.219E 04  0.175E 04  808.       0.479E 06  0.212E 06  0.947E 05
FRUIT BIOMASS (G/M**2 LAND)                                    0.205E 04  0.125E 04  429.       0.425E 05  0.166E 05  0.649E 04
ROOT TO STEM XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)          0.147E 04  774.       392.       0.244E 05  0.693E 04  0.231E 04
STEM TO LEAF XYLEM TRANSPORT OF ZINC(UG/M**2 LAND/HR)          292.       268.       160.      -0.102E 05 -0.473E 04 -0.212E 04
STEM TO ROOT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)     371.       221.       6.68      -0.107E 05 -0.406E 04 -767.
ROOT LEAD CONCENTRATION (UG/G)                                 255.       211.       114.      -0.522E 05 -0.236E 05 -0.114E 05
STEM TO FRUIT PHLOEM TRANSLOCATION OF ZINC(UG/M**2 LAND/HR)    103.       123.       218.       0.107E 04  554.       431.
SULFUR INPUT TO LEAF LITTER (UG/M**2/DAY)                      127.       105.       67.7       0.272E 05  0.123E 05  0.660E 04
SULFUR CONTENT IN LEAF XYLEM (UG/M**2 LAND)                    112.       90.0       56.9       0.212E 05  0.951E 04  0.503E 04
LEAF TO STEM PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)   104.       84.7       54.8       0.422E 04  0.190E 04  0.102E 04
STEM TO ROOT SUGAR TRANSLOCATION (G/M**2 LAND/HR)              27.0       73.1       70.5       199.       199.       138.
LEAF BIOMASS (G/M**2 LAND)                                     54.0       52.0       47.9       0.546E 05  0.258E 05  0.154E 05
ZINC INPUT TO ROOT LITTER (UG/M**2/DAY)                        60.4       40.9       15.5       0.155E 05  0.635E 04  0.260E 04
STEM TO FRUIT SUGAR TRANSLOCATION (G/M**2 LAND/HR)             29.4       17.7       6.58       67.4       26.2       10.7
LEAF ZINC CONCENTRATION (UG/G)                                 25.1       19.6       8.82      -0.164E 05 -0.708E 04 -0.297E 04
FRUIT SULFUR CONCENTRATION (UG/G)                              17.1       15.0       10.2      -0.243E 04 -0.114E 04 -623.
ZINC IN ROOT LITTER (UG/M**2 LAND)                             10.0       10.0       10.0      -0.202E 06 -0.101E 06 -0.672E 05
LEAF LEAD CONCENTRATION (UG/G)                                 9.18       8.80       8.23      -0.107E 05 -0.507E 04 -0.305E 04
STEM ZINC CONCENTRATION (UG/G)                                 13.6       7.60       2.02      -0.704E 04 -0.227E 04 -457.
LEAF TO STEM SUGAR TRANSLOCATION (G/M**2 LAND/HR)              13.9       5.52       1.16      -645.      -185.      -26.1
STEM TO ROOT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)    -6.66      -5.86      -3.34       6.43       2.89       1.26
ROOT TO STEM XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)          5.80       5.28       3.56      -115.      -54.6      -29.8
LEAD INPUT TO ROOT LITTER (UG/M**2/DAY)                        7.87       5.05       1.49      -0.408E 04 -0.161E 04 -554.
STEM RESPIRATION (G/M**2 LAND/HR)                              5.08       4.81       3.86       212.       103.       61.6
ROOT UPTAKE OF ZINC - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)       6.02       4.90       2.40       0.120E 04  546.       255.
ZINC INPUT TO STEM LITTER (UG/M**2/DAY)                        2.92       3.69       3.86       902.       507.       346.
ZINC LEACHED FROM LEAVES (UG/M**2/DAY)                         3.43       3.38       2.83      -369.      -183.      -112.
FRUIT LEAD CONCENTRATION (UG/G)                                3.21       3.02       2.50      -359.      -174.      -106.
ROOT UPTAKE OF LEAD - SUNLIGHT PERIOD (UG/M**2 LAND/DAY)       3.54       2.83       1.46      -795.      -355.      -169.
STEM TO ROOT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR)   3.32       2.71       1.75       136.       61.2       32.8
STEM LEAD CONCENTRATION (UG/G)                                 2.46       2.29       1.87      -411.      -199.      -120.
ROOT ZINC CONCENTRATION (UG/G)                                 1.43       1.94       2.34      -0.406E 04 -0.265E 04 -0.188E 04
FRUIT RESPIRATION (G/M**2 LAND/HR)                             2.14       1.30       0.445      7.06       2.75       1.07
STEM SULFUR CONCENTRATION (UG/G)                               2.03       1.12       0.285      0.111E 04  411.       136.
ZINC INPUT TO FRUIT LITTER (UG/M**2/DAY)                       0.154      0.427      2.05       41.2       40.8       63.7
ZINC IN FRUIT LITTER (UG/M**2 LAND)                            0.157      0.427      2.03       41.6       41.2       64.2
EXCHANGEABLE ZINC (UG/G) IN 0-3 CM SOIL LAYER                  0.765      0.750      0.601     -0.104E 04 -515.      -305.
SULFUR INPUT TO STEM LITTER (UG/M**2/DAY)                      0.902      0.674      0.373      119.       51.6       25.6
ROOT RESPIRATION (G/M**2 LAND/HR)                              0.787      0.632      0.273      25.9       11.6       5.08
ROOT HEARTWOOD ZINC CONCENTRATION (UG/G)                       0.660      0.450      0.190      184.       76.0       32.9
CO2 CHLOROPLAST (ML/ML)                                        0.734      0.320      0.775E-01  2.97       0.981      0.322
LEAD CONTENT IN ROOT XYLEM (UG/M**2)                           0.450      0.395      0.245     -67.9      -31.8      -16.6
STEM TO LEAF XYLEM TRANSPORT OF LEAD(UG/M**2 LAND/HR)          0.408      0.381      0.287     -7.60      -3.67      -2.12
SULFUR INPUT TO ROOT LITTER (UG/M**2/DAY)                      0.487      0.365      0.200      63.1       27.3       13.5
SULFUR IN LEAF LITTER (UG/M**2 LAND)                           0.429      0.353      0.228      109.       49.5       26.5
ROOT UPTAKE OF ZINC - DARK PERIOD (UG/M**2/DAY)                0.470      0.367      0.167      57.6       25.5       11.5
ZINC IN STEM LITTER (UG/M**2 LAND)                             0.205      0.214      0.183      34.1       17.4       10.8
STEM TO FRUIT PHLOEM TRANSLOCATION OF SULFUR(UG/M**2 LAND/HR   0.206      0.169      0.109      8.43       3.81       2.04
STEM HEARTWOOD ZINC CONCENTRATION (UG/G)                       0.132      0.155      0.153      32.3       17.5       11.6
ROOT UPTAKE OF LEAD - DARK PERIOD (UG/M**2/DAY)                0.201      0.160      0.770E-01 -42.5      -19.0      -8.72
ZINC INPUT TO LEAF LITTER (UG/M**2/DAY)                        0.224      0.154      0.416E-01 -232.      -95.3      -31.5
SULFUR CONTENT IN ROOT XYLEM (UG/M**2)                         0.180      0.145      0.916E-01  34.2       15.3       8.11
ROOT SULFUR CONCENTRATION (UG/G)                               0.145      0.122      0.114      64.6       26.9       17.9
LEAD CONTENT IN LEAF XYLEM (UG/M**2 LAND)                      0.555E-01  0.485E-01  0.369E-01 -176.      -78.9      -41.6
ROOT TO STEM XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)        0.595E-01  0.549E-01  0.259E-01 -5.62      -2.56      -0.700
LEAD CONTENT IN STEM XYLEM (UG/M**2 LAND)                      0.514E-01  0.463E-01  0.312E-01 -6.38      -3.03      -1.65
LEAD INPUT TO STEM LITTER (UG/M**2/DAY)                        0.471E-01  0.420E-01  0.314E-01 -10.1      -4.75      -2.74
EXCHANGEABLE ZINC (UG/G) IN 3-15 CM SOIL LAYER                 0.409E-01  0.378E-01  0.308E-01 -14.8      -7.13      -4.29
STEM HEARTWOOD SULFUR CONCENTRATION (UG/G)                     0.350E-01  0.251E-01  0.128E-01  3.77       1.60       0.762
EXCHANGEABLE LEAD (UG/G) IN 0-3 CM SOIL LAYER                  0.332E-01  0.270E-01  0.881E-02  289.       128.       41.7
STEM TO LEAF XYLEM TRANSPORT OF SULFUR(UG/M**2 LAND/HR)        0.240E-01  0.227E-01  0.155E-01 -1.07      -0.517     -0.282
ROOT HEARTWOOD LEAD CONCENTRATION (UG/G)                       0.203E-01  0.183E-01  0.169E-01  1.83       2.55       3.48
SULFUR INPUT TO FRUIT LITTER (UG/M**2/DAY)                     0.181E-01  0.138E-01  0.783E-02  2.77       1.21       0.607
LEAF TO STEM PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)     0.827E-02  0.680E-02  0.401E-02 -1.92      -0.702     -0.287
ZINC MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)            0.301E-03  0.178E-02  0.142E-01  0.133      0.301      0.607
ROOT HEARTWOOD SULFUR CONCENTRATION (UG/G)                     0.527E-02  0.377E-02  0.190E-02  0.561      0.238      0.113
ZINC IN LEAF LITTER (UG/M**2 LAND)                             0.543E-02  0.347E-02  0.175E-02 -202.      -80.6      -30.2
STEM TO FRUIT PHLOEM TRANSLOCATION OF LEAD(UG/M**2 LAND/HR)    0.394E-02  0.353E-02  0.229E-02 -0.218     -0.103     -0.560E-01
ZINC MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)             0.231E-02  0.235E-02  0.195E-02  0.357      0.180      0.110
STEM HEARTWOOD LEAD CONCENTRATION (UG/G)                       0.202E-02  0.176E-02  0.123E-02 -0.378     -0.176     -0.983E-01
LEAF RESPIRATION (G/M**2 LAND/HR)                              0.212E-02  0.163E-02  0.955E-03  1.97       0.856      0.438
PHOTOSYNTHESIS (G CO2/CM**2 LEAF/HR)                           0.199E-02  0.121E-02  0.443E-03 -0.261E-01 -0.795E-02 -0.160E-02
SULFUR IN ROOT LITTER (UG/M**2 LAND)                           0.117E-02  0.881E-03  0.492E-03  0.167      0.725E-01  0.362E-01
SULFUR MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)           0.103E-02  0.845E-03  0.549E-03  0.226      0.102      0.549E-01
LEAD INPUT TO FRUIT LITTER (UG/M**2/DAY)                       0.867E-03  0.777E-03  0.583E-03 -0.202     -0.958E-01 -0.553E-01
EXCHANGEABLE LEAD (UG/G) IN 3-15 CM SOIL LAYER                 0.793E-03  0.667E-03  0.461E-03 -0.571     -0.263     -0.147
LEAD IN FRUIT LITTER (UG/M**2 LAND)                            0.683E-03  0.611E-03  0.453E-03 -0.254     -0.120     -0.689E-01
SULFUR CONTENT IN STEM XYLEM (UG/M**2 LAND)                    0.564E-03  0.531E-03  0.476E-03 -0.161E-02 -0.967E-02  0.257E-01
LEAD LEACHED FROM LEAVES (UG/M**2/DAY)                         0.534E-03  0.522E-03  0.496E-03 -0.256     -0.127     -0.823E-01
LEAD IN STEM LITTER (UG/M**2 LAND)                             0.494E-03  0.412E-03  0.266E-03 -0.512     -0.234     -0.125
LEAD INPUT TO LEAF LITTER (UG/M**2/DAY)                        0.335E-03  0.330E-03  0.320E-03  9.42       4.66       3.03
EXCHANGEABLE ZINC (UG/G) IN 15-30 CM SOIL LAYER                0.319E-03  0.268E-03  0.186E-03 -0.933E-01 -0.420E-01 -0.230E-01
SULFUR IN FRUIT LITTER (UG/M**2 LAND)                          0.779E-04  0.598E-04  0.344E-04  0.133E-01  0.584E-02  0.296E-02
ZINC MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)             0.442E-04  0.412E-04  0.167E-04 -1.01      -0.454     -0.134
SULFUR IN STEM LITTER (UG/M**2 LAND)                           0.394E-04  0.280E-04  0.141E-04  0.400E-02  0.169E-02  0.799E-03
SULFUR MINERALIZATION FROM ROOT LITTER (UG/M**2/DAY)           0.126E-04  0.947E-05  0.519E-05  0.164E-02  0.713E-03  0.352E-03
LEAD MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)            0.733E-05  0.651E-05  0.482E-05 -0.350E-02 -0.165E-02 -0.946E-03
LEAD MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)             0.424E-05  0.355E-05  0.230E-05 -0.514E-02 -0.235E-02 -0.126E-02
SULFUR MINERALIZATION FROM FRUIT LITTER (UG/M**2/DAY)          0.106E-05  0.807E-06  0.459E-06  0.165E-03  0.718E-04  0.361E-04
SULFUR MINERALIZATION FROM STEM LITTER (UG/M**2/DAY)           0.579E-06  0.409E-06  0.202E-06  0.561E-04  0.236E-04  0.111E-04
EXCHANGEABLE LEAD (UG/G) IN 15-30 CM SOIL LAYER                0.350E-06  0.281E-06  0.180E-06 -0.136E-03 -0.611E-04 -0.327E-04
EXCHANGEABLE ZINC (UG/G) IN 30-90 CM SOIL LAYER                0.205E-11  0.169E-11  0.111E-11 -0.121E-08 -0.550E-09 -0.296E-09
LEAD MINERALIZATION FROM LEAF LITTER (UG/M**2/DAY)             0.0        0.0        0.0        0.0        0.0        0.0
LEAD UPTAKE BY LEAVES (UG/M**2/DAY)                            0.0        0.0        0.0        0.0        0.0        0.0
LEAD IN LEAF LITTER (UG/M**2 LAND)                             0.0        0.0        0.0        0.0        0.0        0.0
EXCHANGEABLE LEAD (UG/G) IN 30-90 CM SOIL LAYER                0.0        0.0        0.0        0.0        0.0        0.0
ZINC MINERALIZATION FRCM ROOT LITTER (UG/M**2/DAY)             0.0        0.0        0.0        0.0        0.0        0.0
LEAD MINERALIZATION FRCM ROOT LITTER (UG/M**2/DAY)             0.0        0.0        0.0        0.0        0.0        0.0
LEAD IN ROOT LITTER (UG/M**2 LAND)                             0.0        0.0        0.0        0.0        0.0        0.0

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