

Crop Growth

Root Growth and Development

K. Raja Reddy
Mississippi State University
Mississippi State, MS

Roots: The Hidden Half

Crop growth and Development and Environment

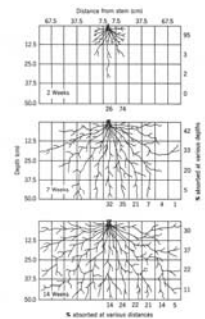
The Roots, the Hidden Half

- ✓ Temporal trends in root growth and development
- ✓ Effects of environmental factors on root growth and development.

Environment - Crop Growth Root Growth and Development

Temporal Trends in root growth, development and distribution

Maize



2 Weeks

7 Weeks

14 Weeks

Figure 5.6. Expansion of a maize root system growing in a clay loam soil, based on the uptake of radioactive phosphorus placed in the soil at various depths and distances horizontally from the seedlings. Numbers at right are percentage of total ³²P absorbed from various depths, those across the bottom are percentages absorbed at various distances horizontally from the seedlings. From Kramer (1983), after Hall et al. (1973).

Environment - Crop Root Growth Temporal Trends in Root Growth and Development

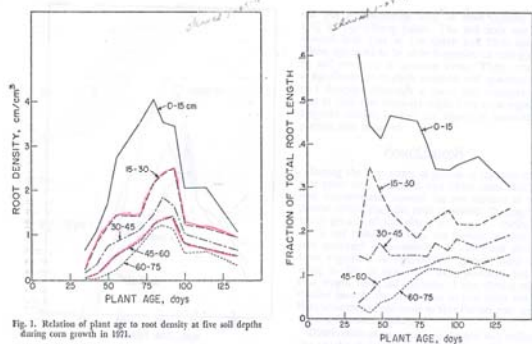


Fig. 3. Relation of plant age to root density at five soil depths during corn growth in 1951.

Environment - Crop Growth Root Growth and Developmental - Mass Partitioning - Acock

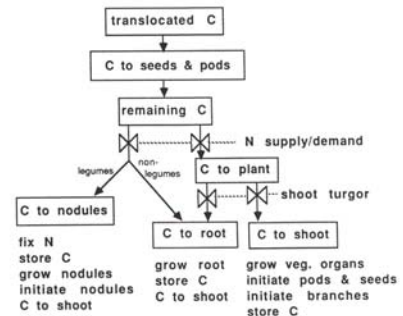


Fig. 4-5. A hypothetical scheme for partitioning C between organs on plants.

Environment - Crop Growth
Root Growth and Development

Effect of Soil Temperature on Root Growth
Pinus seedlings

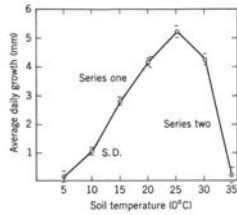


Figure 5.20 Relationship between soil temperature and root elongation of *Pinus taeda* seedlings under controlled conditions. From Kramer (1983), after Barney (1951).

Environment - Crop Growth
Root Growth and Development

Root Weight

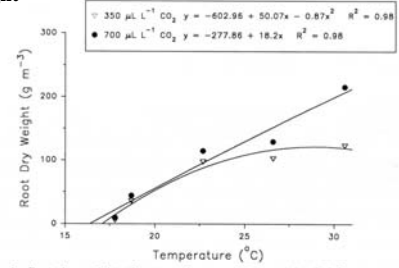


Fig. 1. Root dry weight of cotton plants as influenced by [CO₂] and temperature harvested at 70 DAE.

VOL. 23 (1994)

Environment - Crop Growth
Root Growth and Development

Root Numbers

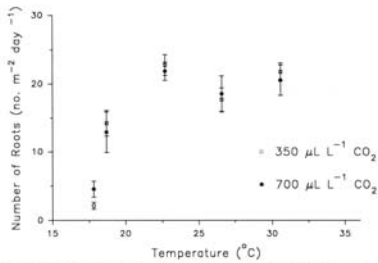


Fig. 2. The average number of roots produced on the glass face over the season as influenced by [CO₂] and temperature treatments.

Environment - Crop Growth
Root Growth and Development

Root Growth Rate

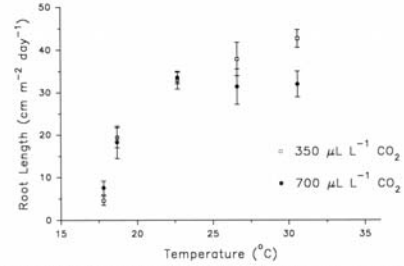


Fig. 3. The average root length visible at the vertical glass face over the season as influenced by [CO₂] and temperature treatments.

Environment - Crop Growth
Root Growth and Development

Root Growth Rate

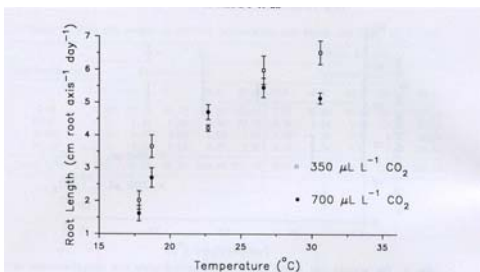


Fig. 4. The average root length per root axis at the vertical soil/glass interface over the season as influenced by [CO₂] and temperature treatments.

Environment - Crop Growth
Root Growth and Development

Competition between plants

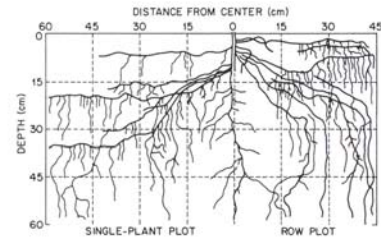


Figure 5.21 Difference in lateral root extension of an isolated soybean root system (left side) and that of a plant growing in a row. From Kramer (1983), after Raper and Barber (1970a).

Environment - Crop Growth Root Growth and Development

Soil compaction and root growth, development and distribution

11 week-old oat plants

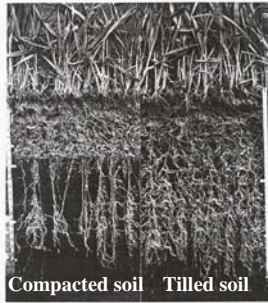


Figure 5.18. Effect of a compacted layer of soil on root penetration by 11-week-old oat plants. Each undisturbed soil core shows roots above the compacted layer, but few below it. Right: Excessive penetration of roots into soil fractured by tillage to a depth of 50 cm. The restriction of root penetration was caused by mechanical resistance, an increase was not limiting below the compacted layer. From Kramer (1985). Courtesy of H. H. Dekker, Connecticut Agricultural Experiment Station.

Wilted Maize in Flooded Field:

Deficient aeration of soil root not only reduces root growth but also reduces the absorption of water and minerals.

The decrease in water absorption is caused chiefly by an increase in the resistance to radial movement into roots, but a decrease in the osmotic driving force (probably resulted a decreased uptake of salt).

There are wide differences among species of plants in respect to the effects of flooding on water absorption.



Figure 6.10. Wilted maize in a flooded field. Water is standing between the rows which were flooded for 3 weeks. Photograph by J. S. Boyer.

Environment - Crop Growth Root Growth and Development

Water and Root and Shoot Growth

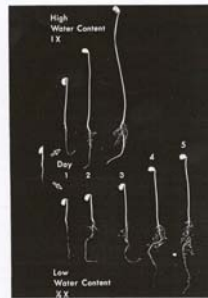


Figure 11.7. Soybean root and shoot growth in the dark and continuous light in variable water-saturated water (IX) or limited water (XX). The 1.8 x 1.8 cm soil cores contained one eighth of the water in IX. In continuous light and a water potential of -0.1 MPa compared to -0.25 MPa in the IX control. Note the marked inhibition of stem (hypocotyl) growth for the first 2 days in XX. A noticeable increase in a number emergence of growth. Arrows continued to develop on line at 1.8 x 1.8 cm.

Environment - Crop Growth Root Growth and Developmental Responses to CO₂

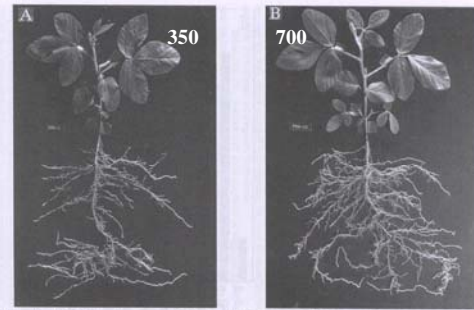
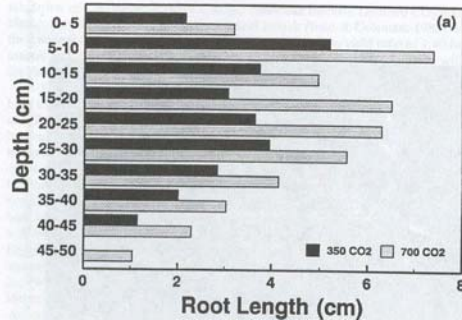


Fig. 1-1. Photographs of 18-d-old soybean plants grown at (a) 350 $\mu\text{mol mol}^{-1}$ and (b) 700 $\mu\text{mol mol}^{-1}$ CO₂. Photographs show the median plant, based on root length, for each treatment (Rogers et al., 1992a).

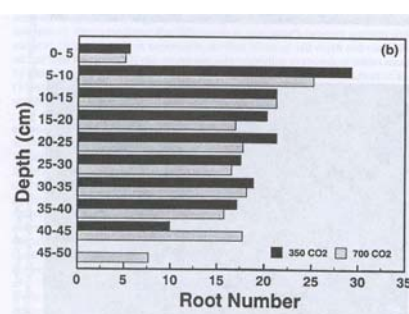
Environment - Crop Growth Root Growth and Developmental Responses to CO₂

Soybean, 18 days old



Environment - Crop Growth Root Growth and Developmental Responses to CO₂

Soybean, 18 days old



Environment - Crop Growth
Root Growth and Developmental – Mass Partitioning - Cotton

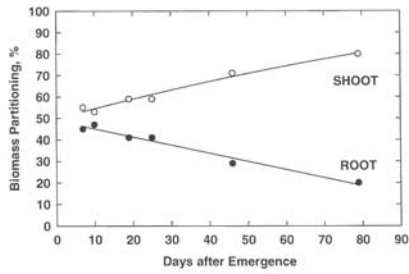


Figure 16 The effect of plant age on biomass partitioning of biomass to roots and aboveground parts (Hodges *et al.*, 1993).

Environment - Crop Growth
Root Growth and Developmental – Mass Partitioning - Cotton

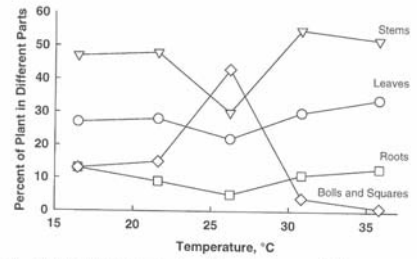


Figure 17 The role of temperature on cotton plant partitioning among different organs (V. R. Reddy *et al.*, 1991).

Environment - Crop Root Growth and Development
Concluding Remarks

- Progress has been made in recent years in understanding crop root growth and developmental responses to environmental stresses.
- However, quantitative relationships between root growth and developmental responses and environmental stresses are still inadequate.
- New techniques are needed to quantify the responses.
- Models systems may be useful to test hypothesis and validate certain assumptions.