Crop Growth

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Root Growth and Development

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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

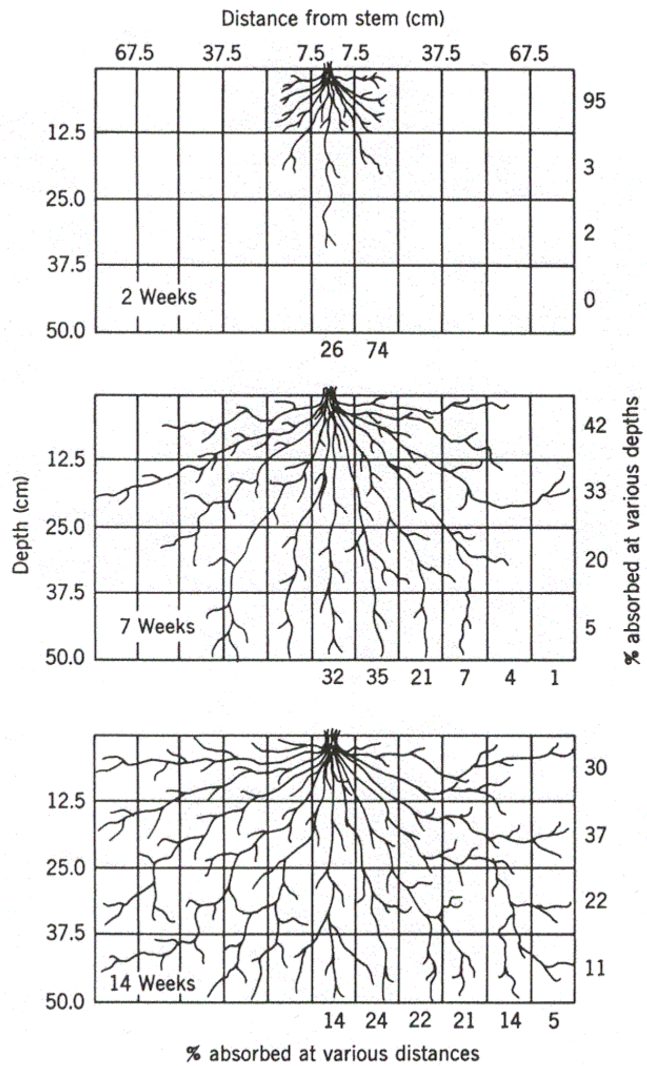


Figure 5.6 Expansion of a maize root system growing in a clay loam soil, based on the uptake of radioactive phosphorus placed in the soil at various depths and distances horizontally from the seedlings. Numbers at right are percentages of total ^{32}P absorbed from various depths, those across the bottom are percentages absorbed at various distances horizontally from the seedlings. From Kramer (1983), after Hall *et al.* (1953).

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

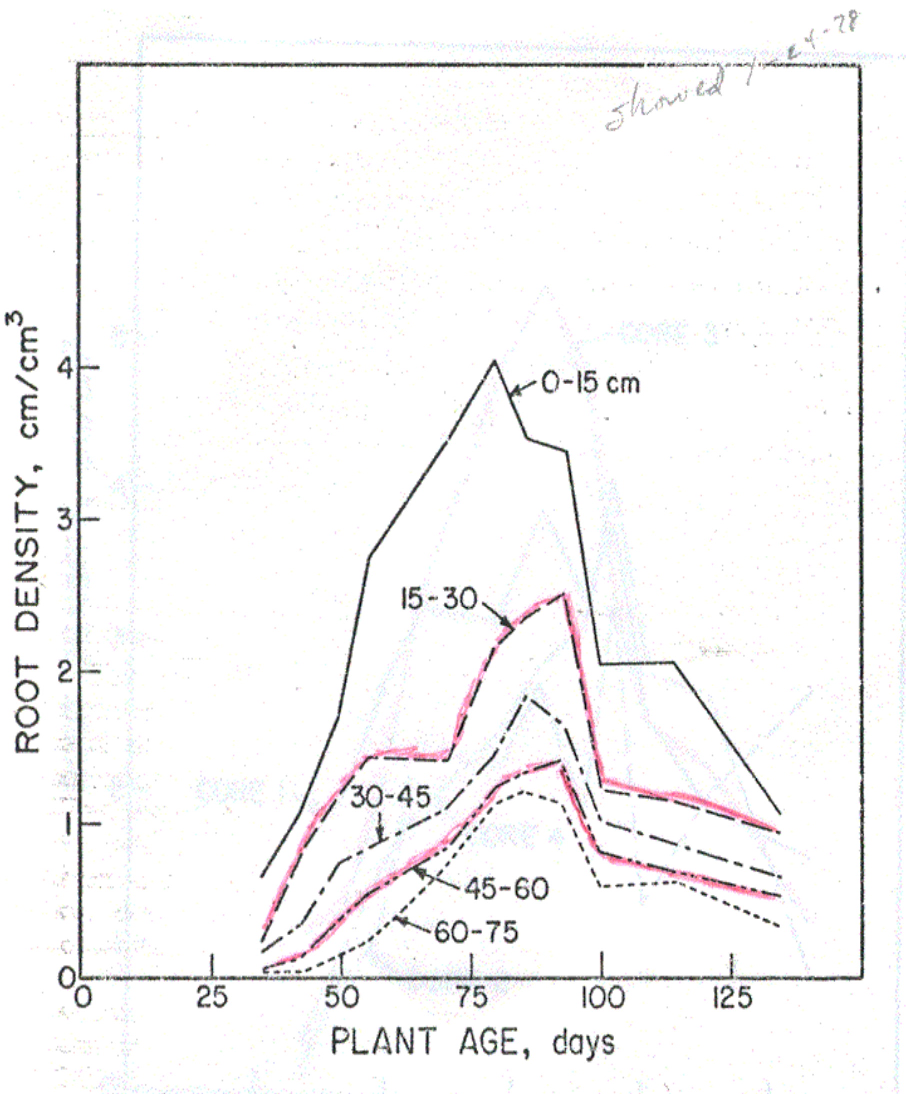
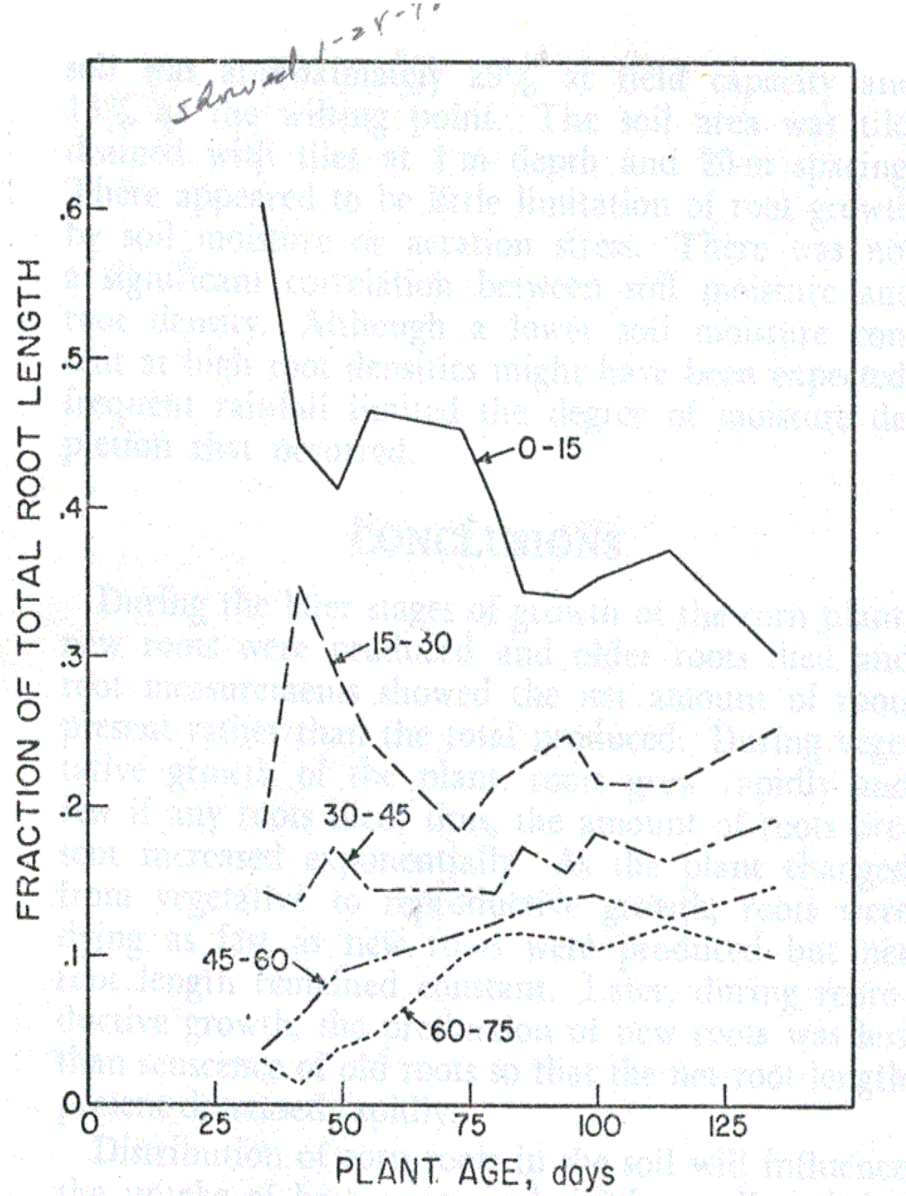


Fig. 1. Relation of plant age to root density at five soil depths during corn growth in 1971.



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Root Growth and Developmental – Mass Partitioning - Acock

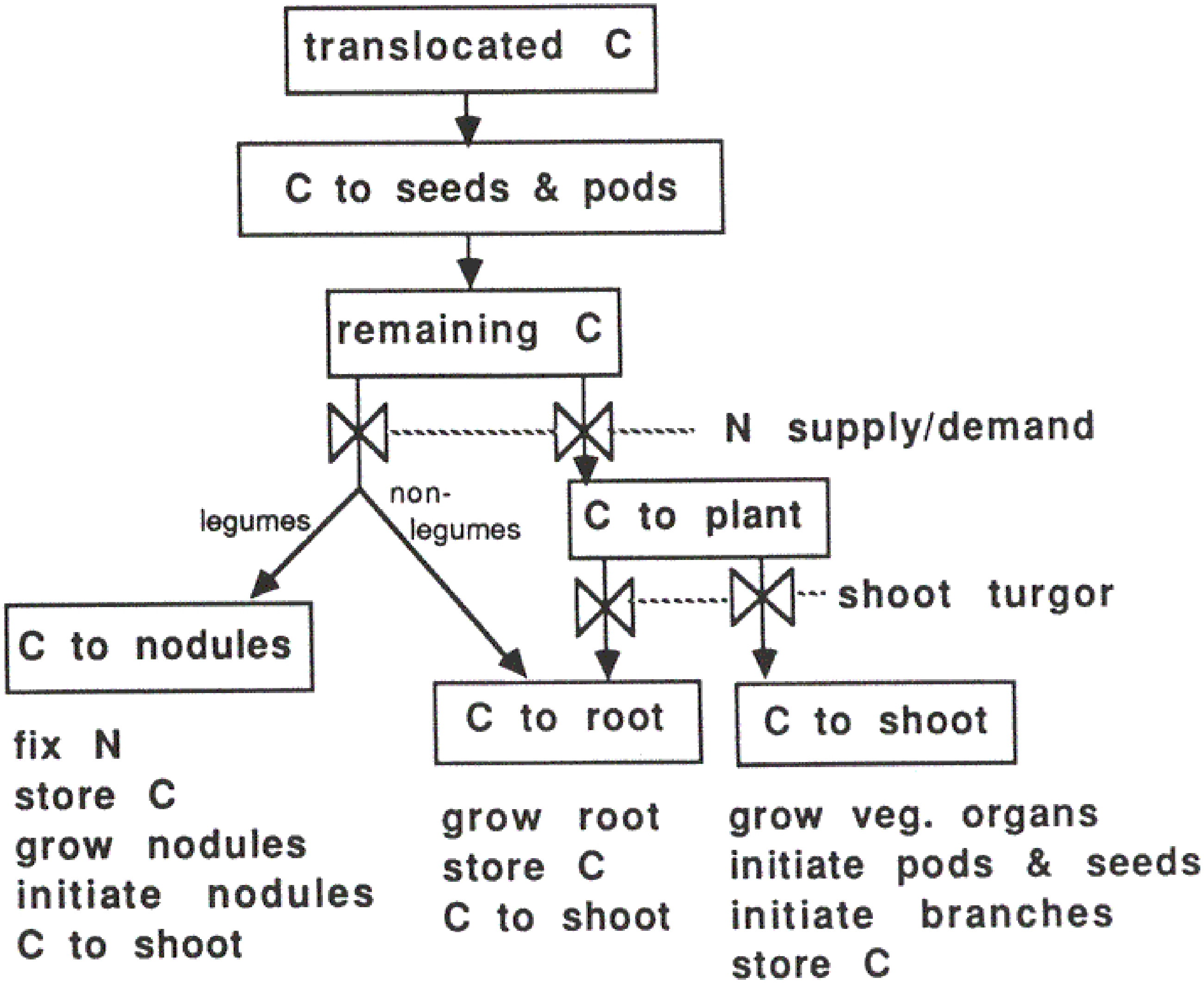

Fig. 4-5. A hypothetical scheme for partitioning C between organs on plants.

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Effect of Soil Temperature on Root Growth

Pinus seedlings

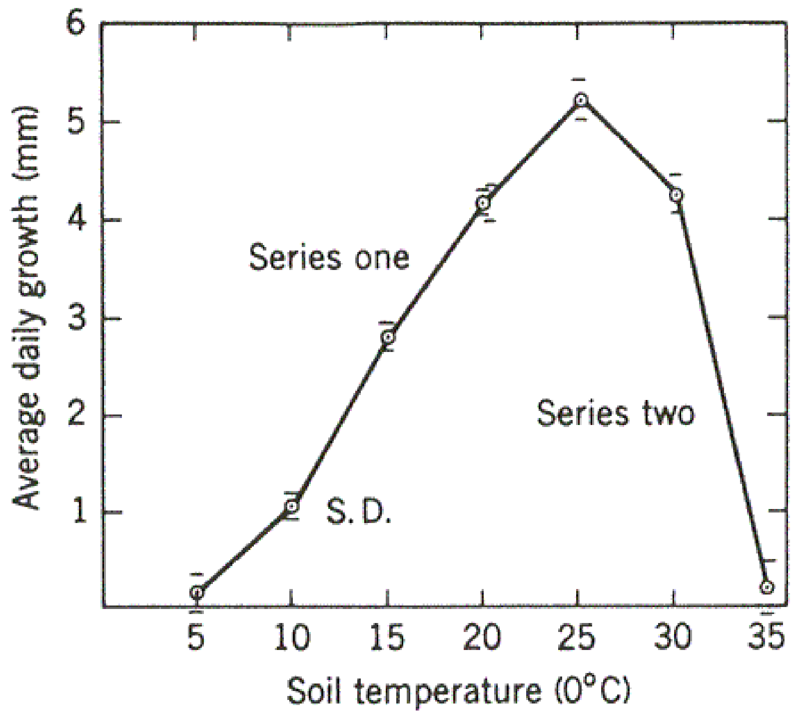

Figure 5.20 Relationship between soil temperature and root elongation of *Pinus taeda* seedlings under controlled conditions. From Kramer (1983), after Barney (1951).

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Root Weight

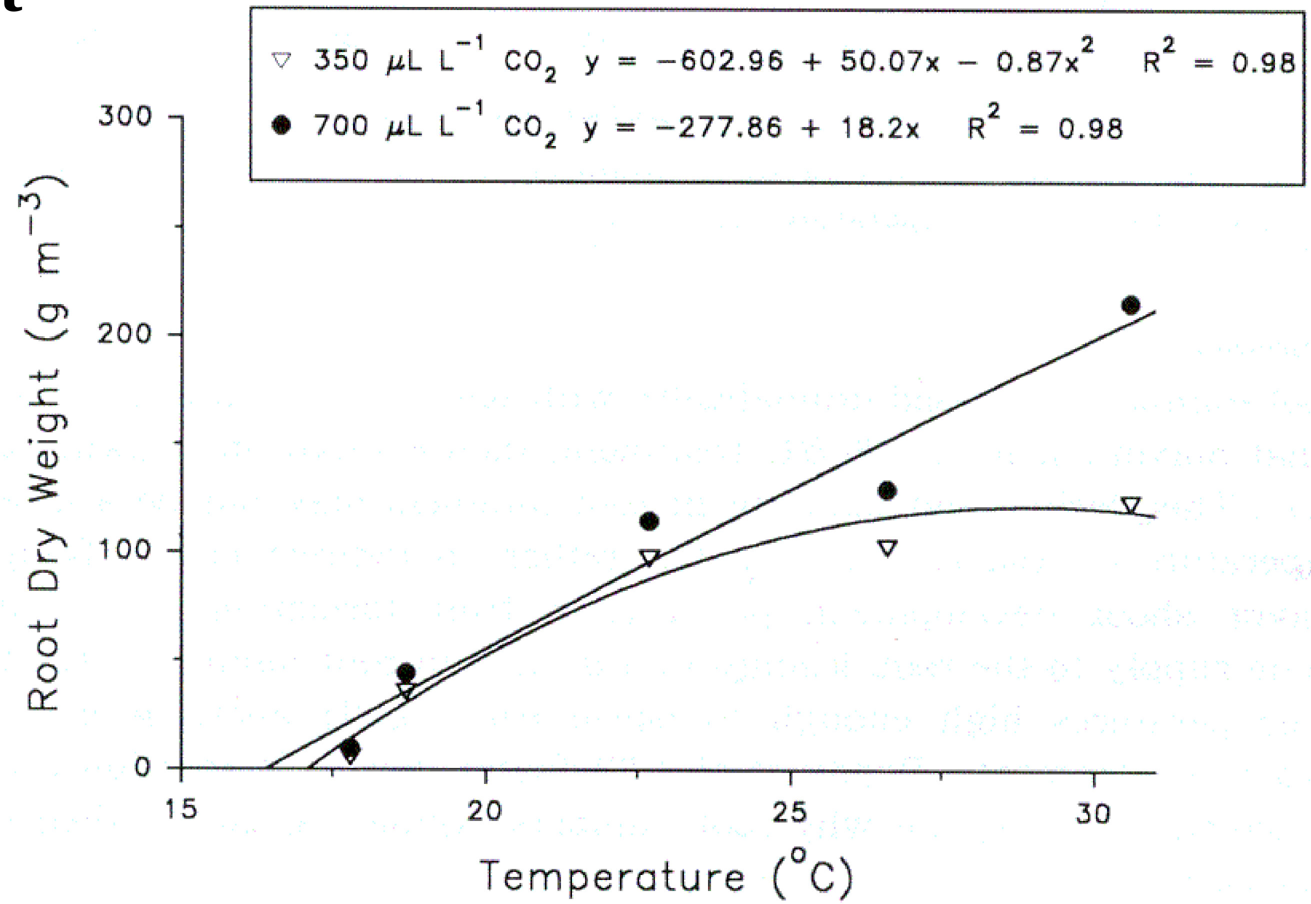

Fig. 1. Root dry weight of cotton plants as influenced by $[CO_2]$ and temperature harvested at 70 DAE.

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Root Numbers

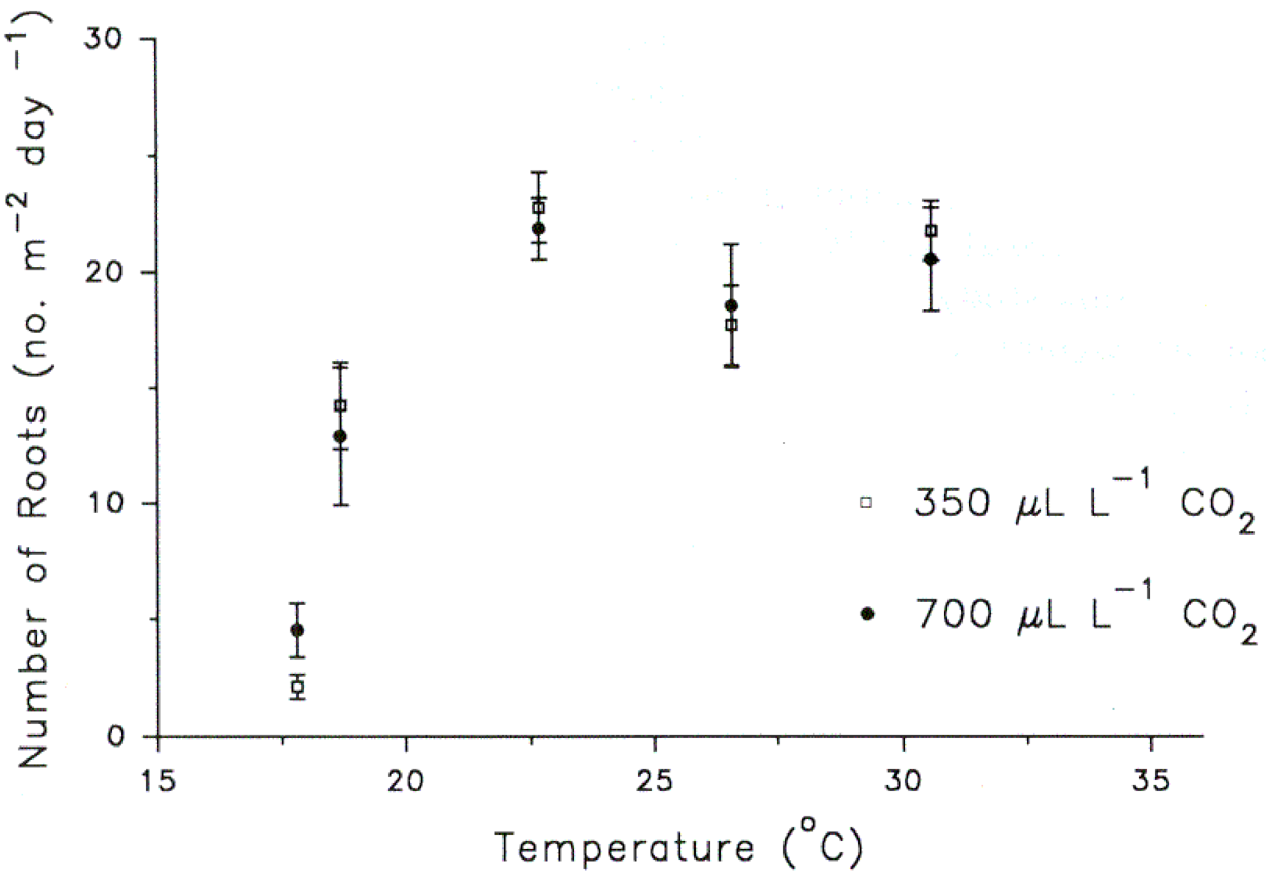

Fig. 2. The average number of roots produced on the glass face over the season as influenced by [CO_2] and temperature treatments.

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Root Growth Rate

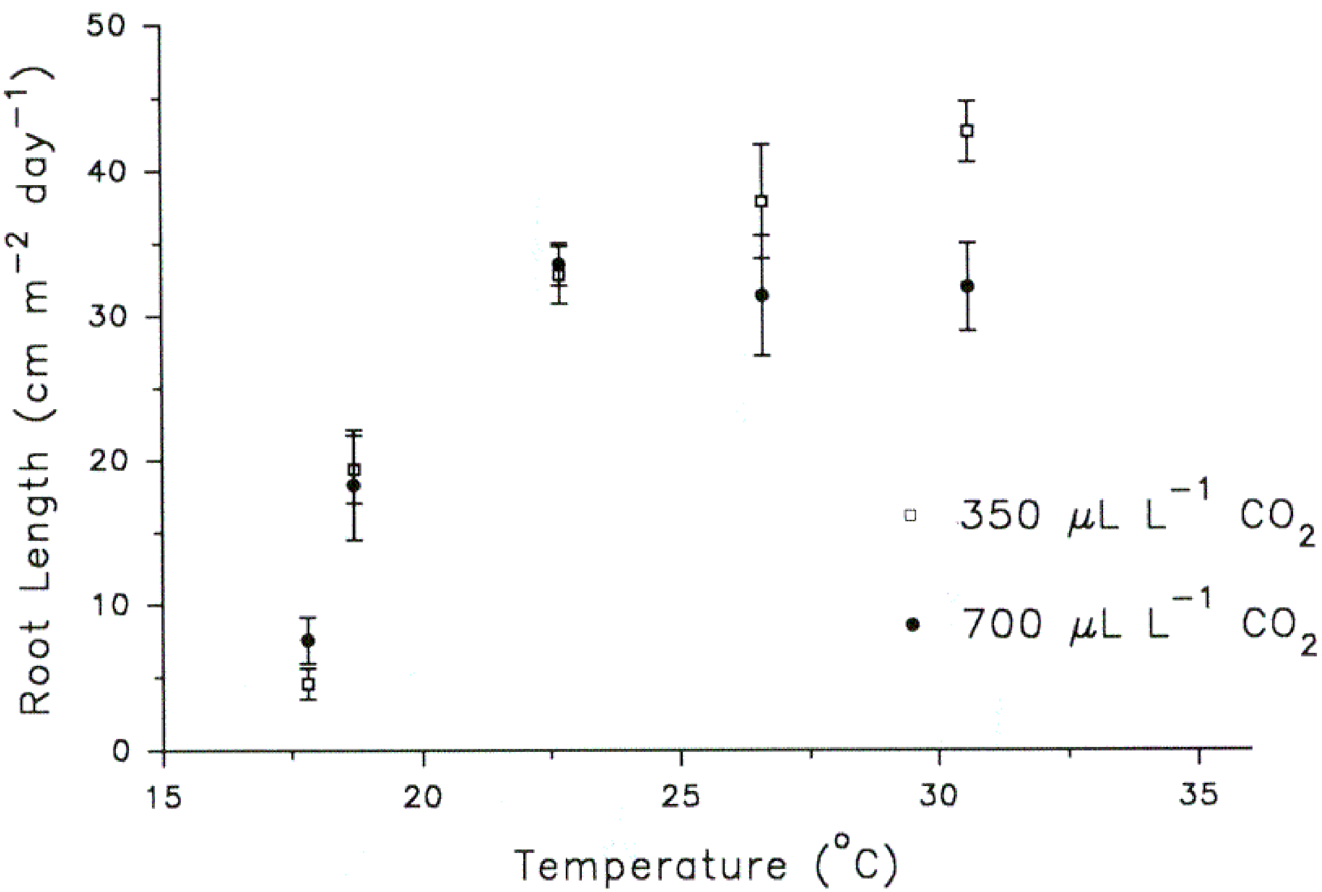

Fig. 3. The average root length visible at the vertical glass face over the season as influenced by [CO_2] and temperature treatments.

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Root Growth Rate

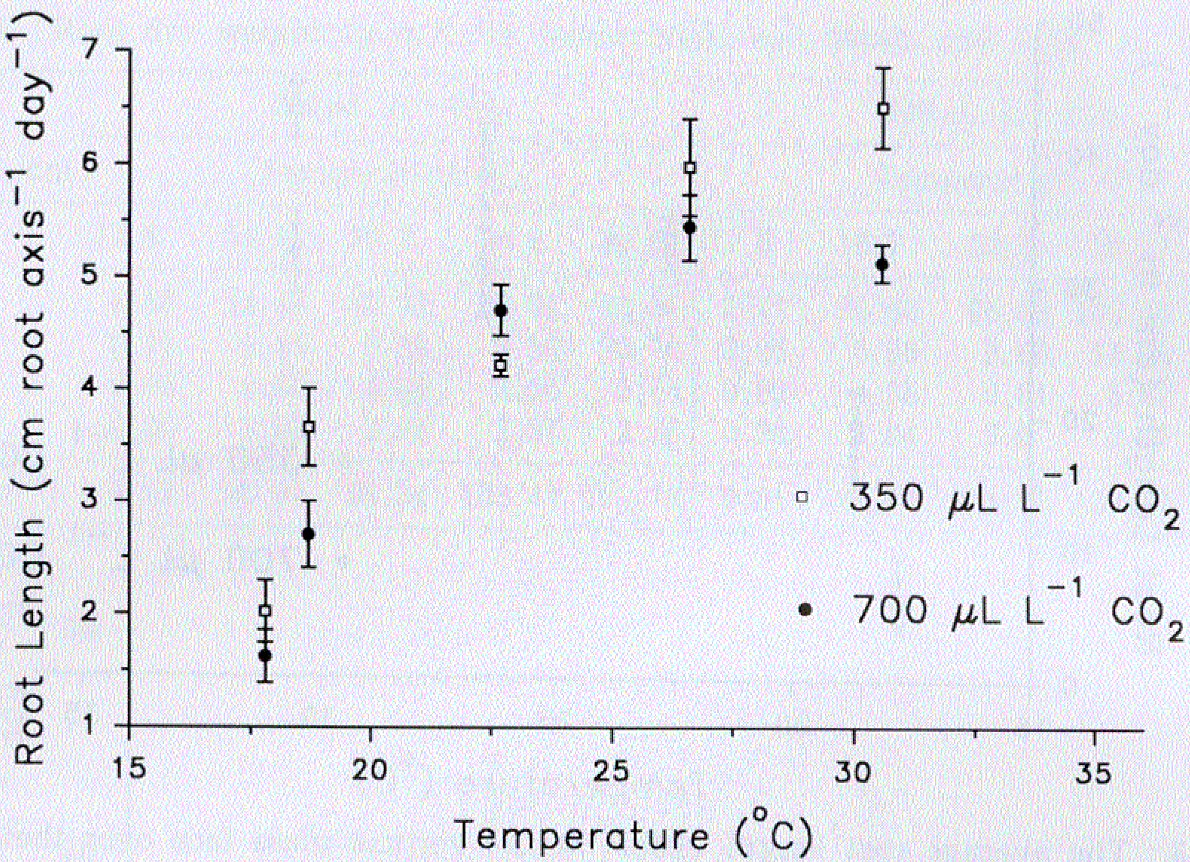

Fig. 4. The average root length per root axis at the vertical soil/glass interface over the season as influenced by [CO_2] and temperature treatments.

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Competition between plants

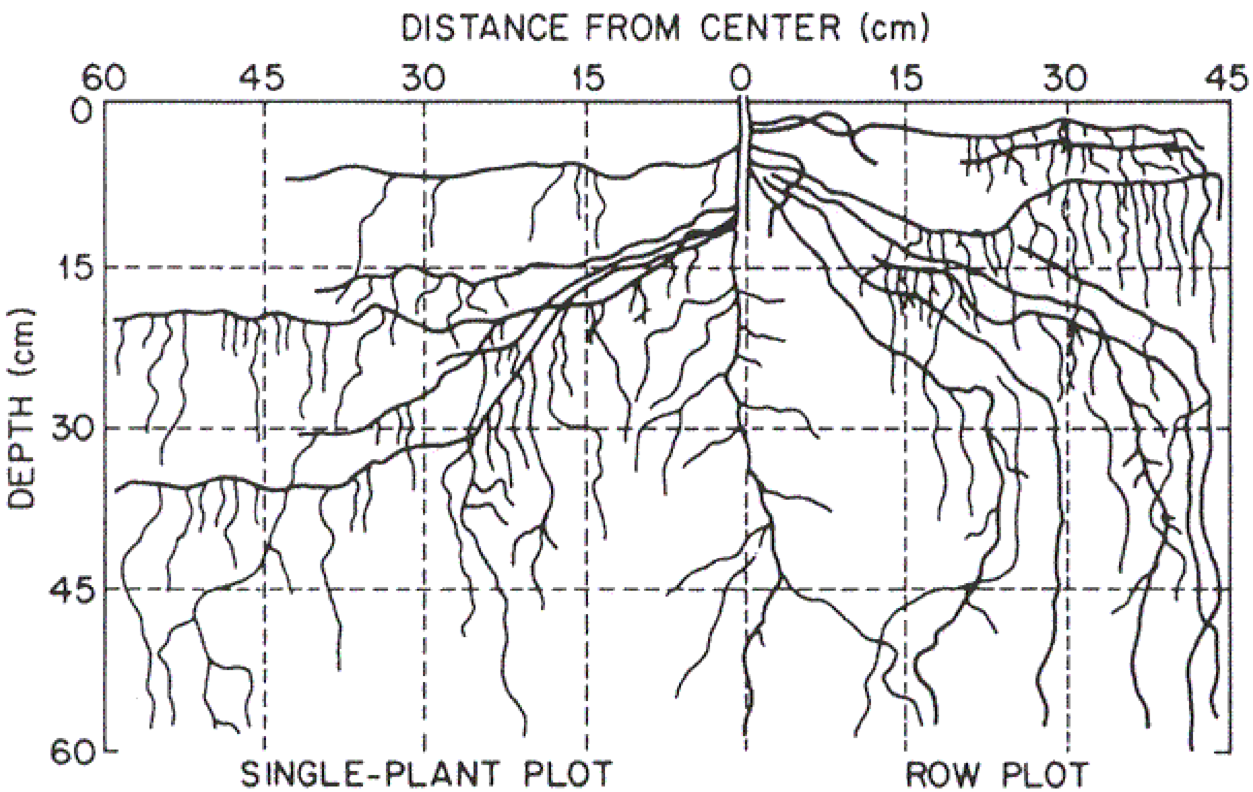

Figure 5.21 Difference in lateral root extension of an isolated soybean root system (left side) and that of a plant growing in a row. From Kramer (1983), after Raper and Barber (1970a).

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Soil compaction and root growth, development and distribution

11 week-old oat plants

Figure 5.16 Effect of a compacted layer of soil on root penetration by 11-week-old oat plants. (Left) Undisturbed soil with dense mass of roots above the compacted layer, but few below it. (Right) Uniform penetration of roots into soil loosened by tillage to a depth of 50 cm. The restriction of root penetration was caused by mechanical resistance, as aeration was not limiting below the compacted layer. From Kramer (1983). Courtesy of H. D. DeRoo, 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.

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Water and Root and Shoot Growth

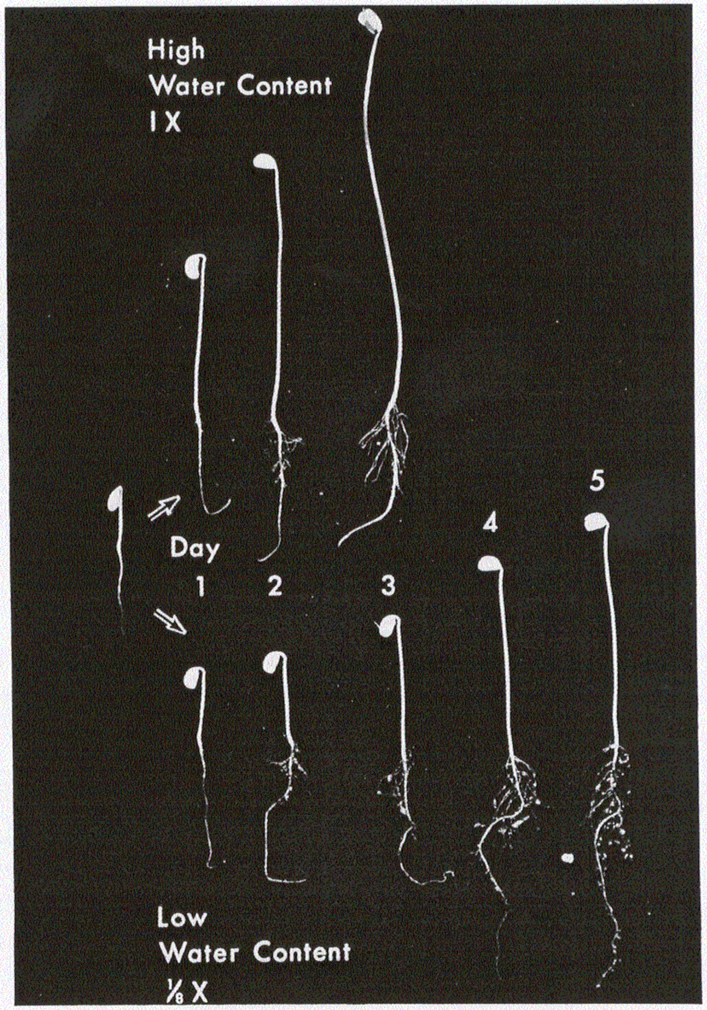

Figure 11.9 Soybean seedlings germinated in the dark and transplanted either to vermiculite containing adequate water (1×) or limited water (1/8×). The 1/8× vermiculite contained one-eighth of the water in the 1× vermiculite and had a water potential of −0.3 MPa compared to −0.01 MPa in the 1× control. Note the marked inhibition of stem (hypocotyl) growth for the first 2 days in 1/8× vermiculite followed by a modest resumption of growth. Roots continued to develop as fast at 1/8× as at 1×.

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Root Growth and Developmental Responses to CO_2

Fig. 1–1. Photographs of 18-d-old soybean plants grown at (a) 350 μmol mol^{-1} and (b) 700 μmol mol^{-1} CO_2. Photographs show the median plant, based on root length, for each treatment (Rogers et al., 1992a).

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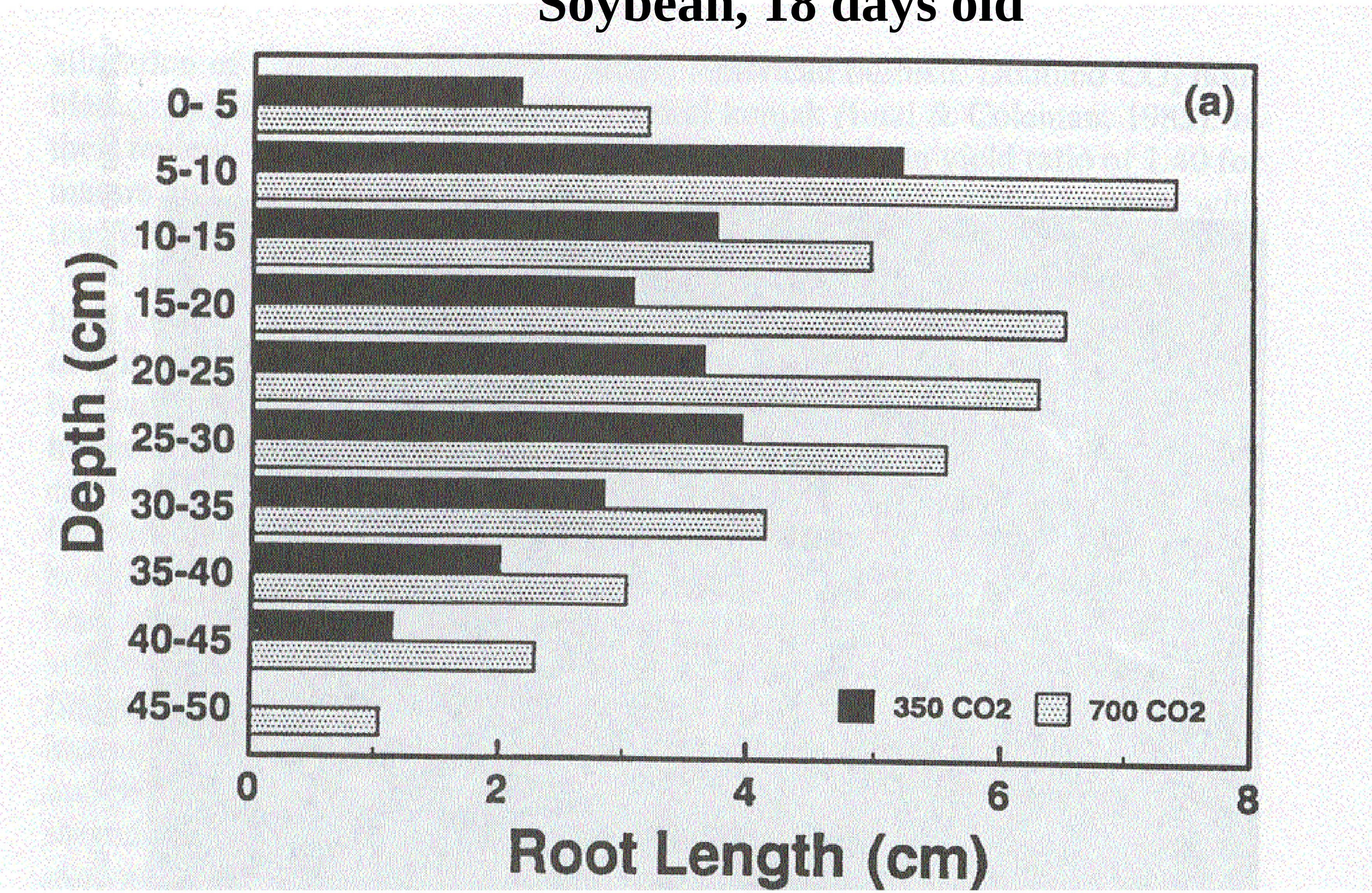
Root Growth and Developmental Responses to CO_2

Soybean, 18 days old



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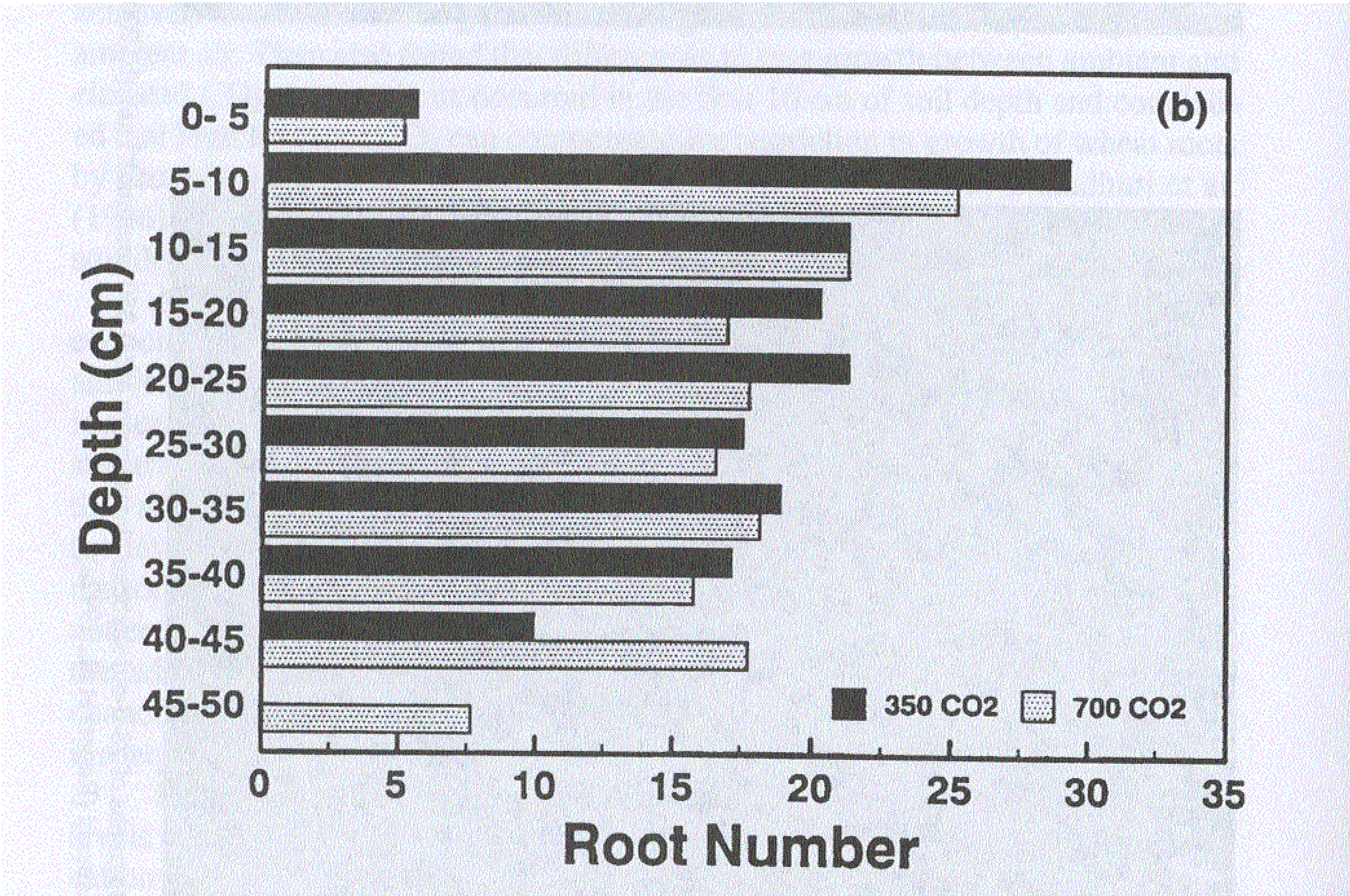
Root Growth and Developmental Responses to CO_2

Soybean, 18 days old



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Root Growth and Developmental – Mass Partitioning - Cotton

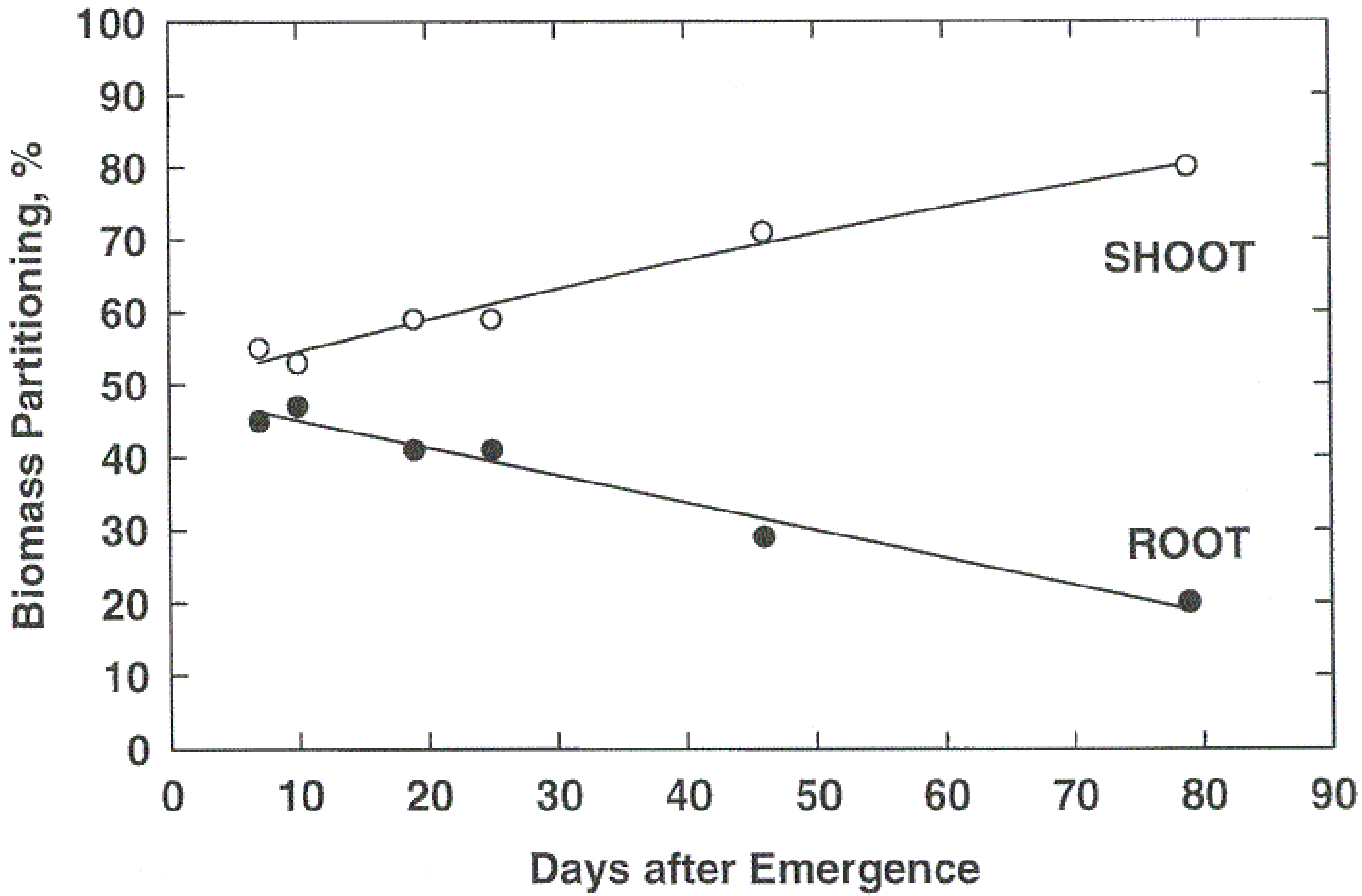

Figure 16 The effect of plant age on biomass partitioning of biomass to roots and aboveground parts (Hodges *et al.*, 1993).

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Root Growth and Developmental – Mass Partitioning - Cotton

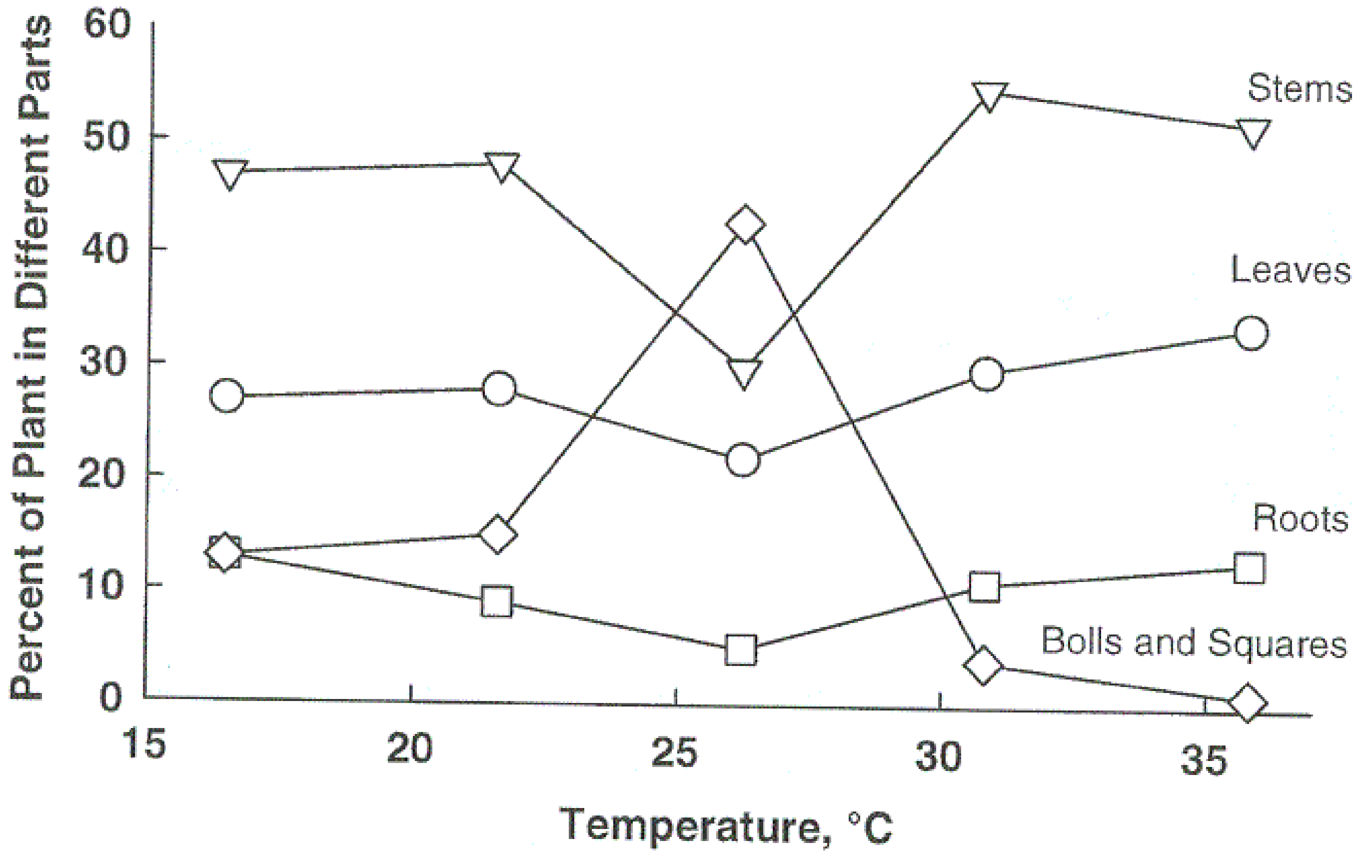

Figure 17 The role of temperature on cotton plant partitioning among different organs (V. R. Reddy *et al*., 1991).

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.