# Mechanical Stress by Soil Aggregates – Response of Maize Seedlings

Bandula Premalal and Bill Deen
Department of Plant Agriculture, University of Guelph, Guelph, ON, Canada
bkarunan@uoguelph.ca

## Introduction

- Soil Structure, the arrangement of aggregates and void spaces play an important role in early plant growth and development by conditioning water and nutrient dynamics and aeration.
- Soil structure also affects root growth and development *per se*[2,7].
- Decreases of shoot growth with increasing aggregate size is not explained entirely by water or nutrient relations[2,6].
- Root generated signaling mechanism in response to other root zone stresses such as soil drying[1,4] and root restriction[5] and also proliferation of roots in response to high nutrient concentrations[3] have been reported.
- Preferential root growth and/or root sensing and signaling mechanisms in relation to aggregate size may exist in maize, but these mechanisms are not clearly understood.

## Objectives

- To assess aboveground response of maize to roots affected by stresses associated with size of aggregates and to identify possible mechanisms involved.

## Materials and Method

- Growth room Conditions – 25°C/20°C day/night temperature and 16hr photoperiod.
- 4 liter plastic pots jointed together (Figure 1b).
- Seeds (Pioneer 37D82) germinated in sterilized sand.
- After emergence the radicle was removed and remaining root system (seminal roots) divided equally into two jointed paper pots (10cm high, 3cm Ø, Figure 1a).
- 4-5 days after root division – transferred to experimental pots (Figure 1b).
- Each side contains either coarse aggregates (C, 2-7mm Ø) or fine aggregates (F, <0.2mm Ø) with nutrient mixture or pure nutrient mixture (H) and achieved combinations of CC, FF, HH, CH, FH, and CF as treatments.
- Shoot and root dry weights (by oven drying at 75 °C, 48 hrs) and root length (by WinRhyzo Pro.) were measured at 18 days after initiation of treatments.

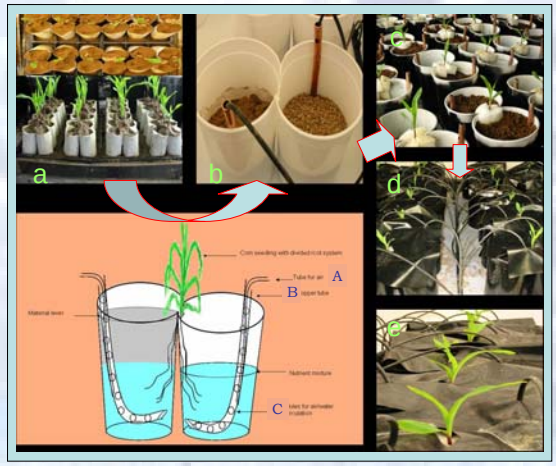


Figure 1. Arrangement of experiment pots. A- copper tube with holes (C), B – rubber tube for aeration and circulation of solution

## Results

- Reduction of shoot growth was observed when part of the root system was exposed to coarse aggregates regardless of the mechanical stress of other side (Figure 2A).
- 27% and 41% lower shoot biomass at 18 days after initiation of treatments were recorded in CF and CH treatments, respectively when compared to no coarse aggregate interference (FF and HH).
- Lower root biomass was observed in coarse aggregate half of pot (C) regardless of the mechanical stress in other side (Figure 2B)

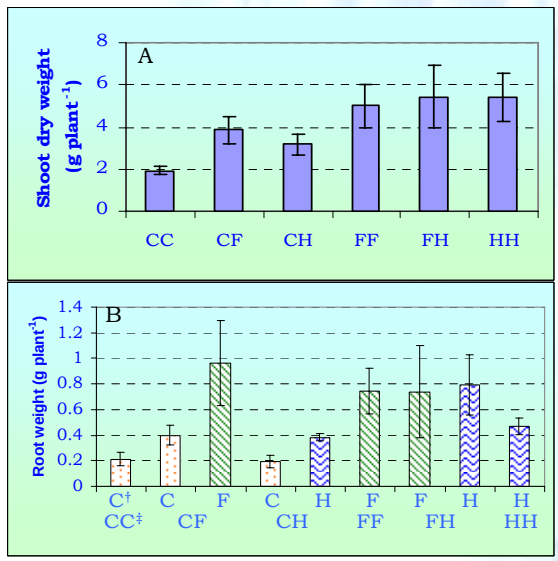


Figure 2. Corn shoot (A) and root (B) biomass measured at 18 days after initiation of treatments. †Material of the ½ root system was grown, ‡treatments

- Mechanical stress of coarse aggregates in CF and CH did not reduce or promote root biomass of the F or H side of the root system which received comparatively lower mechanical stress.
- Lower root lengths were also recorded in coarse aggregates affected side (C) regardless of the other side (F or H).
- F or H ½ of the root system produced significantly higher root lengths compared to the coarse aggregate (C) ½ of CF and CH treatments but were not significantly different from the lengths of ½ of their controls (FF and HH, Figure3).

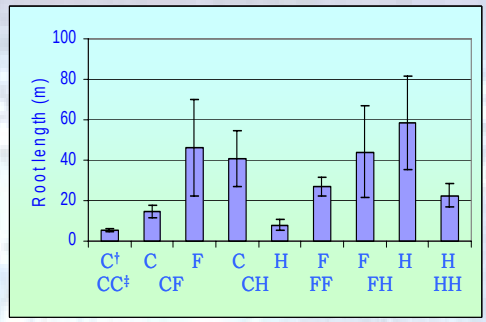


Figure 3. Total root length measured at 18 days after treatment initiation †, ‡ see figure 2

## Conclusions

- Effect of mechanical stress caused by aggregates could not be explained either by water or nutrient absorption difference and may not be chemically regulated.
- Stress due to coarse aggregates may increase the demand for photosynthates to grow around the aggregates. In this process, roots may either respire more or lose more carbon as root exudates. However, the results from this study have not provided clear evidence for or against these ideas. Further exploration using intensive methodologies such as Carbon isotope and xylem sap analysis will be needed in future research works to have a clear understanding.

## References

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