# Nutrient Deficiency Diagnostic Training with Field and Hydroponically Grown Crops

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## Background

The Manitoba Crop Diagnostic School was initiated in 1995 and annually provides training for 350 - 400 field agronomists over a two week period in mid July.

Symptoms of nutrient deficiencies, other than nitrogen (N), have proven difficult to demonstrate on the fertile, high organic matter loam textured soils of the Carman Research Station.

The following techniques have been developed to demonstrate many of the macro and micronutrient deficiencies which may occur in prairie crops.

## Sandboxes for Macronutrient Deficiencies

Four large sand boxes (2.4 m x 2.4m) were built on concrete slabs, lined with landscape fabric and filled with coarse, low organic matter, low fertility sand soil.

*Figure 1. Sand box for demonstrating macronutrient deficiencies.*

A fully fertilized reference box received annual applications of nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) whereas the other three boxes have either P, K or S fertilizer excluded.

Corn, soybeans, sunflowers, canola, wheat, flax and alfalfa were hand-seeded.

Challenges:

1. These raised sand beds must be watered regularly. Sulfates in groundwater masked any S deficiencies until boxes were watered with either rainwater or reverse osmosis (RO) water.
2. The rooting environment in these raised and watered beds is near optimum for root exploration and often crops do not show deficiencies as severe as expected for such low testing soils.

## Hydroponic Beds for Micronutrient Deficiencies

The macronutrient fertilizer control sand box has not exhibited micronutrient deficiencies in any of the seven years of observation. A hydroponic system was built in 2010 to provide observation of deficiency symptoms of copper (Cu), boron (B) and zinc (Zn) in corn, wheat, canola and soybeans. A standard Hoagland solution was prepared for the control with other solutions devoid of either Cu, B or Zn.

Notable features of the hydroponic beds (*Figure 2*):

- Four raised sloping beds of silica sand.
- Seeds were pre-germinated and transplanted.
- The hydroponic nutrient solution was circulated to the raised end of the bed (A) and allowed to drain into blue storage barrels (B).
- Solution was recirculated at intervals of 15 minutes on and 45 minutes off in order to provide replenishment of the rooting zone with oxygen.
- The beds were located outdoors providing as natural a growing environment as possible (e.g. avoiding etiolation and high temperatures).
- A plastic canopy (C) was erected over the beds to reduce nutrient contamination from rainfall and evaporative losses.
- Wind damage of loosely rooted plants was minimized using orange mesh covering the bed (D) and windbreaks (E).
- Solutions were changed every two weeks to rebalance nutrients in the solution. Algae growth on the surface was removed at this time.

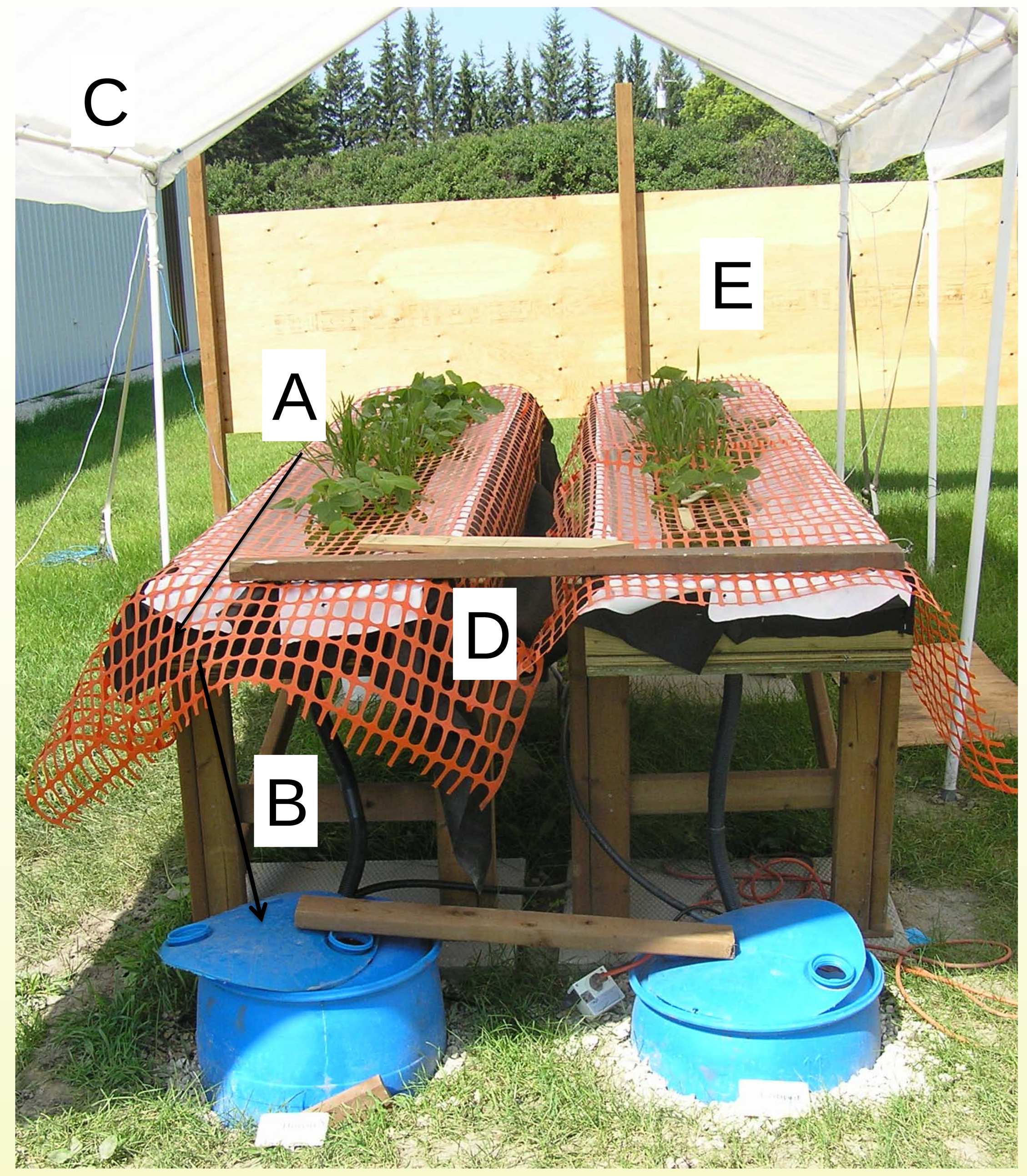


*Figure 2. Two of the hydroponic beds.*

## Results

Deficiency symptoms were observed (*Figure 3*) and documented by participants *(Figure 4).*

Corn Wheat Canola Soybeans

No Copper

No Boron

No Zinc


*Figure 3. Observed symptoms .*

*Figure 4. Diagnostic school participants complete their lesson on deficiency diagnosis.*

Field agronomists (*Figure 4*) rated the value of the lesson 4.4/5 for quality of information learned.

Visual symptoms were considered a starting place for diagnosis to be confirmed with soil and tissue analysis.