

Getting to the Root of Yield Loss in Corn (2)

Pre-Conditioning Corn Crops for Yield Loss

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Dr. Swanton is professor of weed science at the University of Guelph and is internationally recognized for his pioneering research into the critical period of weed control for corn and soybeans.

White Papers on Weed Control is a series of research and agronomic reports to disseminate recent findings and their value for on-farm weed management.

Pre-Conditioned Yield Loss

Why are these weeds causing irreversible yield loss?



Something happens in corn fields that causes irreversible yield loss even before weeds are large enough to compete with the crop for moisture, nutrients and sunlight.

This mystery has not been explained. The solution, however, could equip growers with critical insights into how to control weeds for optimum yields.

Our hypothesis is that corn crops are **pre-conditioned** for yield loss by the presence of early weeds, even where there is no direct competition.

We have initiated a research program at the University of Guelph to test this hypothesis. Initial results are presented and discussed below.

Research is continuing in order to confirm and expand our knowledge of the role of pre-conditioning in modern corn production.

We know...

- early weeds cause irreversible yield losses
- the critical weed-free period starts at the 3rd leaf stage
- yield losses are most severe when weeds emerge close to crop emergence



For optimum yields, the time of a weed's emergence is even more important than the total number of weeds that emerge. This is a key learning from our research into the critical weed-free period in corn.

Weeds that emerge with or shortly after the crop cause the largest yield losses.

Late-emerging weeds cause less yield loss. For instance, redroot pigweed emerging at the crop's 7-leaf stage has been shown to cause no yield loss, while 0.5 pigweeds per square metre caused a 5 per cent yield loss when they emerged before the 4-leaf stage of the corn.

These studies contributed to understanding that the 3- to 8-leaf stage in corn is the critical weed-free period.

We don't know...

- what causes early season yield loss.

Conclusion...

The interaction between weed and crop is much more complex than once thought.



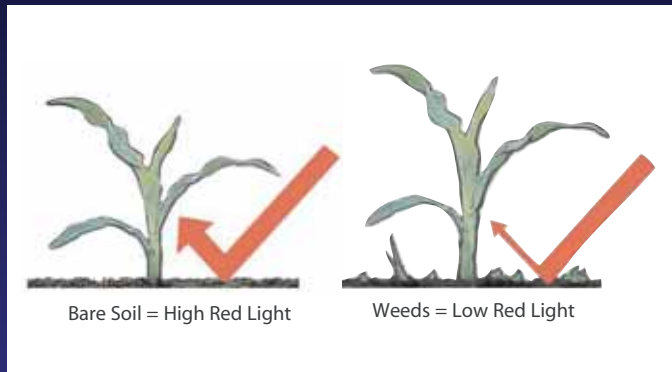
Yield loss in corn has long been attributed to direct competition between weeds and the crop for finite resources including water, nutrients and sunlight.

This approach has made 'common sense', especially since growers know that the application of nutrients and the availability of moisture and sunlight are highly correlated to corn yields.

However, strong evidence calls the competition theory in question, including:

- Irreversible yield losses occur **before** weeds are large enough to compete aggressively
- Yield loss occurs even when early season soils have good moisture levels and growers apply abundant nutrients via fertilizer.

Corn 'Sees' Early Weeds



Many plants are able to detect the presence of potential competitors (i.e. weeds) by subtle changes in the quality of light reflected from the field surface.

Green plants absorb red light in order to provide energy for photosynthesis. Thus, a field with emerged weeds will reflect less red light back to the corn plants.

Phytochromes in plants can detect this change as a shift in the ratio of red to far-red light, and react by producing:

- thinner leaves
- low root-to-top growth ratio
- longer stem internodes
- low leaf to stem dry weight ratio

Collectively, these are termed shade-avoidance characteristics.

Putting Shade Avoidance to the Test

Materials and Methods



Weed free
PPFD = 500 μmol
R/FR = 1.23



Weedy
PPFD = 500 μmol
R/FR = 0.65

Our hypothesis is that shade-avoidance contributes to early, irreversible yield loss in corn by pre-conditioning the crop for reduced efficiency and lower stress tolerance.

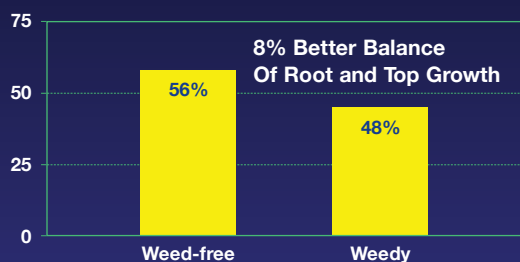
Specifically, shade-avoidance may result in:

- smaller root systems in proportion to top growth, exposing the crop to nutrient and moisture stress, especially during peak periods such as pollination and grain fill
- taller plants with greater leaf surface

For our research, we grew pots of corn in growth chambers surrounded either by bare soil or by sod. The corn was kept physically separated, so there was no direct competition and the only difference between chambers was the quality of reflected light.

Weeds Reduce Root Balance*

Per Cent Root To Top-Growth



*At 9-leaf stage

At the 9-leaf stage, corn plants grown near bare soil had a larger amount of root to support their above-ground growth.

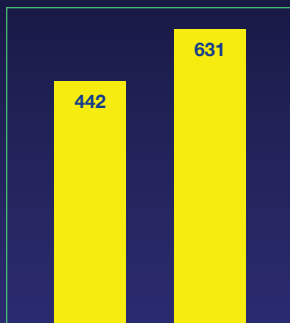
The ratio of root to shoot was 14.3 per cent higher in the bare-soil treatment than it was for corn plants grown near sod.

Corn plants may therefore respond to early weeds by growing taller in order to reduce their risk of becoming shaded out. However, because the plant has a limit to its growth capability, the larger above-ground growth comes at the expense of root growth.

Our results suggest that this imbalanced root growth may pre-condition the crop for yield loss.

Smaller Roots, Bigger Topgrowth*

Leaf Area cm²



Height cm



Weed-free

Weedy

Weed-free

Weedy

*At 9-leaf stage

Corn plants grown near sod were taller and leafier than corn plants grown near bare soil.

When corn plants detected the presence of 'weeds', they grew 6.4 cm's taller by the 9-leaf stage. In addition, they produced 43 per cent more leaf area.

However, this additional top growth may overburden the relatively smaller root system of these plants, especially during stress conditions and at peak times of nutrient and moisture demand.

Pre-Conditioned for Irreversible Yield Loss

- early weeds change the way a corn plant grows for the rest of the year
- smaller root system compared to top growth

These initial results suggest that the presence of early season weeds changes the way that a corn plant grows, leading to an imbalance of roots and top-growth.

This imbalance then pre-conditions the crop for yield loss.

Shade-avoidance may also explain why early yield losses are irreversible. Simply put, the corn plant has limited opportunity to correct the early imbalance caused by the detection of weeds.

Further research is underway to confirm and extend these insights.

Weed Control that Stops Yield Loss

Control weeds early before your crop becomes pre-conditioned for irreversible yield loss.

For corn growers, this research confirms the importance of early season weed control. Crop growth is impacted soon after emergence.

The research also confirms that the need for early season weed control is not reduced in seasons or in fields with excellent fertility and moisture.

Therefore, the message to growers is: control your weeds before your crop becomes pre-conditioned for yield loss.