Effect of Defoliation on Maize Growth and Yield

Key Points
- Maize seedlings can be damaged through a variety of means, affecting crop growth and yield.
- This study, conducted in Hastings and Chertsey, investigated the time of early season total defoliation by cutting plants to ground level at growth stages up to V8 (eight fully emerged leaves).
- Defoliation up to V4 had minimal effect on forage and grain yield. However, maturity appeared to be delayed, affecting grain and forage moisture; the later the defoliation, the greater the impact.
- The impact of defoliation at V6 will depend on whether the crop regrows from the main stem or from tillers. V6 yields were more affected where regrowth was from tillers (Hastings) than main stem (Chertsey).
- Plants cut at V8 did not survive as the growing point of the plant was destroyed by defoliation.
- This simulated damage (defoliation by cutting) does not take into account other impacts associated with defoliation in field situations, such as soil compaction, freezing, shear stress, bruising or other secondary impacts.

Introduction
Maize seedlings can be damaged through a variety of means including vehicular traffic, stock, greasy cutworm, frost, hail, and wind damage. The impact of losing leaves or even most of the plant early in the season is likely to reduce crop regrowth and final yield.

Damage to the growing point of maize can kill the plant. The growing point in a maize plant remains below the soil surface until growth stage V6 (six fully emerged leaves). Up until this time, the crop can suffer above ground damage without killing the crop, although yields may be reduced.

The aim of this study was to determine the effect of timing of early season total defoliation (to simulate early season plant damage) on the regrowth of maize and final yield.

Approach
Two trials were conducted in 2007-08, one at Hastings (Hawke’s Bay) and the other at Chertsey (Canterbury).

The Hastings trial was sown on 15 October 2007 (hybrid 34D7T, population 100K/ha), and fully fertilised and irrigated. The five defoliation treatments involved comparing an uncut control with cutting the plants off at ground level using secateurs at four growth stages:
- V2 – two fully emerged leaves
- V4 – four fully emerged leaves
- V6 – six fully emerged leaves
- V8 – eight fully emerged leaves

Crop regrowth was assessed and a final yield (grain and whole crop biomass) was measured on 12 May 2008.

The Chertsey trial was sown on 4 November 2007 (hybrid 39G12, population 120K/ha), and fully fertilised and irrigated. The four defoliation treatments involved comparing an uncut control with cutting the plants off at ground level at three different growth stages; V3, V5 and V6. Final yields (grain and whole crop biomass) were measured on 11 April 2008.

Results - Hastings
The total amount of biomass removed at the V2 cut was 20 kg DM/ha. Cut plants were regrowing within three days. Three weeks after cutting, the V2 cut plants were around 1.5 leaves behind the uncut plants in terms of crop growth stage.

Plants cut at V4 (80 kg DM/ha) also regrew well after cutting. Ten days after cutting, the V4 cut plants were around 2 leaves behind the uncut plants.

Plants cut at V6 (600 kg DM/ha) regrew mainly from tillers. The main stems of many of the plants were dead (Figure 1). Plants cut at V8 (2400 kg DM/ha) did not recover (completely died). Except for the V8 cut, there was no effect of cutting on plant population.

Figure 1. Maize regrowth as tillers in V6 cut plants at Hastings.
The uncut plants produced the greatest whole crop biomass, but grain yield was the same as the V2 and V4 treatments (Table 1).

The V6 cut plants yielded significantly less whole crop biomass and grain. Compared with the uncut treatment, yield loss for V6 cut plants was 45% for total yield and 60% for grain yield. Both plant and grain moisture were highest for this treatment, suggesting a delay in maturity compared with other treatments. V6 cut plants were visibly shorter and greener than other treatments (Figure 2).

Table 1. Effect of defoliation on maize yield and grain moisture at Hastings.

<table>
<thead>
<tr>
<th></th>
<th>Total Yield</th>
<th>Grain</th>
<th>Grain Moist</th>
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<tr>
<td></td>
<td>T DM/ha</td>
<td>T/ha</td>
<td>%</td>
</tr>
<tr>
<td>Uncut</td>
<td>33.1 a</td>
<td>20.4 a</td>
<td>19.6 a</td>
</tr>
<tr>
<td>V2</td>
<td>27.7 b</td>
<td>20.4 a</td>
<td>20.9 b</td>
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<tr>
<td>V4</td>
<td>25.5 b</td>
<td>18.9 a</td>
<td>22.3 c</td>
</tr>
<tr>
<td>V6</td>
<td>18.2 c</td>
<td>8.2 b</td>
<td>27.2 d</td>
</tr>
<tr>
<td>Sig</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
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<td>LSD_{0.05}</td>
<td>3.9</td>
<td>3.3</td>
<td>1.1</td>
</tr>
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</table>

Values with the same letter are not significantly different at P=0.05.

Figure 2. Plants from V6, V4, V2 and uncut (left to right) at Hastings.

Results - Chertsey
Plants cut at V3, V5 and V6 had a total of 35, 130 and 400 kg DM/ha removed respectively. Plant population was unaffected by cutting at V3 and V5. Around 20% of the V6 cut plants did not recover. Compared with the uncut treatment, yield loss for V6 cut plants was 23% for total yield and 20% for grain yield.

There was no difference in total crop biomass or grain yield between the uncut plants and those cut at V3 and V5 (Table 2). V6 cut plants yielded less total biomass and grain than uncut plants, an effect driven primarily by lower plant population after the cutting treatment. Plant regrowth was from the main stem rather than as tillers. As found in Hastings, defoliation decreased crop dry matter content, indicating a delay in maturity.

Table 1. Effect of defoliation on maize yields and plant dry matter % at Chertsey.

<table>
<thead>
<tr>
<th></th>
<th>Total Yield</th>
<th>Grain</th>
<th>Plant DM %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T DM/ha</td>
<td>T/ha</td>
<td>%</td>
</tr>
<tr>
<td>Uncut</td>
<td>15.4 a</td>
<td>9.3 a</td>
<td>55.5 a</td>
</tr>
<tr>
<td>V3</td>
<td>14.7 a</td>
<td>8.4 ab</td>
<td>49.7 b</td>
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<tr>
<td>V5</td>
<td>14.8 a</td>
<td>9.5 a</td>
<td>45.2 c</td>
</tr>
<tr>
<td>V6</td>
<td>11.8 b</td>
<td>7.4 b</td>
<td>39.3 d</td>
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<tr>
<td>Sig</td>
<td>&lt;0.05</td>
<td>&lt;0.06</td>
<td>&lt;0.001</td>
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<tr>
<td>LSD_{0.05}</td>
<td>2.0</td>
<td>1.3</td>
<td>4.1</td>
</tr>
</tbody>
</table>

Values with the same letter are not significantly different at P=0.05.

Conclusions
Defoliation of crops up to growth stage V4 had minimal effect on maize forage and grain yield. However maturity appeared to be delayed, affecting grain and forage moisture; the later the defoliation, the greater the impact.

The impact of defoliation at V6 will depend on whether the crop regrows from the main stem or from tillers. V6 yields were more affected in Hastings (tiller regrowth) than Chertsey (main stem regrowth). Also the yield potential at Hastings was greater, with uncut maize yielding twice that of Chertsey. Plants cut at V8 did not survive.

Growers should note that this simulated crop damage (defoliation by cutting) does not take into account other impacts associated with defoliation in field situations, such as soil compaction, freezing, shear stress, bruising or other secondary impacts.

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