Bare patch and poor emergence of cereals. 3. Crusting of the soil surface

S C. Chambers

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Bare patch and poor emergence of cereals. 3. Crusting of the soil surface

Cover Page Footnote
Grateful acknowledgment is made to officers of the Wheat and Sheep Division for assistance given with the field work and to Mrs. R. Thurloe for the statistical analysis of results.
In some seasons extensive bare patches occur in cereal crops sown on the heavier wheat belt soils. Experimental results from Beverley indicate that the poor emergence in some of these plantings may be due to crusting of the soil surface. Working the surface with light harrows may destroy the crust and improve emergence.

During the past four years many instances of poor emergence have been reported in cereals, particularly in crops of wheat. Although parasitic fungi are sometimes responsible for seedling mortality, recent investigations indicate that it may be caused by non-parasitic factors such as deep sowing (Chambers, 1961).

Some of the earliest field observations pointed to soil crusting as another non-parasitic cause, because exhausted seedlings were often found beneath the hardened, impenetrable surface of bare areas in crops. Such bare patches were relatively common in the heavier wheat-belt soils and developed when wet conditions at seeding time were followed by several days of warm, dry weather.

To investigate these observations, the following work was done in an area prone to surface crusting at the Avondale Research Station, Beverley.

EXPERIMENTAL

On May 31, 1961, the site was cultivated to a very fine tilth, and 14 days later the experimental plots were hand sown with the wheat variety Gabo.

At the time of seeding, the surface soil was soft and moist, as more than one inch of rain had fallen within the preceding 48 hours.

The experiment was multifactorial in design and contained 40 plots, each with 100 seeds planted in 10 rows of 10, with two inches between seeds. The grain was sown at depths of one and three inches, as depth of sowing was another factor under investigation.

To increase the likelihood of crusting, the moist surfaces of 20 plots were compacted after sowing. At the same time, the surfaces of the remaining 20 control plots were loosened with a hand trowel.

Each seedling was examined as it emerged from the soil and rated as normal or abnormal in accordance with the following system:

**Normal.**—White sheathing leaf (coleoptile) emerges from the soil before the first true green leaf. (Fig. 1.)

**Abnormal.**—Coleoptile fails to appear and first true leaf emerges directly from the soil (Fig. 1.)
Fig. 1.—Diagrammatic representation of:

(A) Normal emergence of wheat seedling with coleoptile or white sheathing leaf (a) emerging from the soil before the appearance of the first true leaf (b).

(B) Abnormal emergence when coleoptile (a) fails to appear and first true leaf (b) emerges direct from soil.
   B (i) the tip of the first leaf emerging from soil.
   B (ii) the tip cannot break through the surface and the leaf arching upwards to emerge.

OBSERVATIONS AND RESULTS

(i) Surface Crusting
The surface was soft and moist when the grain was sown because of the rain which had fallen in the previous 48 hours. However, a hard crusted surface formed within seven days on the 20 plots which had been compacted artificially. During the first 22 days, this surface was softened temporarily by falls of rain on the 13th (48 points) and 18th (33 points) days after seeding.

Although more rain fell after the 22nd day (Table 1), emergence counts showed only relatively slight increases after this date (Table 2.)

(ii) Emergence of Seedlings
Emergence counts were made at 8, 15, 22, 29 and 35 days after seeding (Table 2). The final count at 35 days (Table 3) was analysed [using the transformation arcsin \(\sqrt{\%}\) percentage]. This analysis indicated that the differences for normal emergence and also non-emergence were significant at the 0.01 per cent. level. The values for abnormal emergence were not significantly different.

<table>
<thead>
<tr>
<th>Date</th>
<th>No. of days after seeding</th>
<th>Rainfall (in points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 26</td>
<td>13</td>
<td>48</td>
</tr>
<tr>
<td>June 27</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>July 1</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td>July 4</td>
<td>21</td>
<td>6</td>
</tr>
<tr>
<td>July 7</td>
<td>24</td>
<td>10</td>
</tr>
<tr>
<td>July 8</td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td>July 10</td>
<td>27</td>
<td>6</td>
</tr>
<tr>
<td>July 11</td>
<td>28</td>
<td>11</td>
</tr>
</tbody>
</table>

TABLE 1
Rainfall at Avondale Research Station During the Experimental Period.
Fig. 2.—Distorted seedlings found partially embedded in a crusted soil surface. Note the tendency of shoots to spiral and zig-zag.

**TABLE 2**

Percentage Emergence of Wheat Seedlings in Experimental Plots.

<table>
<thead>
<tr>
<th>Date</th>
<th>No. of days after seeding</th>
<th>Percentage Emergence</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Surface crusted plots</td>
<td>Control plots</td>
</tr>
<tr>
<td>June 21</td>
<td>8</td>
<td>1.3</td>
<td>5.1</td>
</tr>
<tr>
<td>June 28</td>
<td>15</td>
<td>16.6</td>
<td>64.3</td>
</tr>
<tr>
<td>July 5</td>
<td>22</td>
<td>33.1</td>
<td>80.2</td>
</tr>
<tr>
<td>July 13</td>
<td>29</td>
<td>36.4</td>
<td>81.8</td>
</tr>
<tr>
<td>July 15</td>
<td>35</td>
<td>36.8</td>
<td>82.2</td>
</tr>
</tbody>
</table>

Bare patches, where seedlings had failed to emerge were examined after the final count. In many instances, the tips of these seedlings had become embedded in the soil surface as it hardened, thus preventing further upward growth of the shoot. However, with continued growth of the shoot below the crust, the seedlings tended either to spiral or zig-zag against the soil barrier. (Figs. 2 and 3.)

The tips of other seedlings appeared to have reached the crusted surface after it hardened, and consequently these shoots tended to grow parallel to, but immediately below the crust. (Fig. 3.) Such seedlings had become grossly elongated before exhausting the food reserves in the seed.

**TABLE 3**

Final Emergence Count of Wheat Seedlings in Relation to Physical State of Soil Surface.

<table>
<thead>
<tr>
<th>Soil Surface</th>
<th>Percentage Emergence</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
<td>Abnormal</td>
</tr>
<tr>
<td>Loose, Non-crusted</td>
<td>59.0</td>
<td>23.2</td>
</tr>
<tr>
<td>Compact, Crusted</td>
<td>12.6</td>
<td>24.2</td>
</tr>
<tr>
<td>Level of Significance (using transformation arcsin √% )</td>
<td>p&lt;0.01</td>
<td>Not significant</td>
</tr>
</tbody>
</table>

**DISCUSSION**

From the results in Table 3, it is evident that compaction of the moist soil surface with subsequent crusting markedly depressed emergence.
However, the individual effects of these two factors cannot be determined from the results.

Some idea of depression in emergence by soil compaction alone, may be gained from an identical experiment at Merredin, where frequent falls of rain prevented surface crusting. In this instance, the emergence counts at 35 days were 72 per cent. in the compacted plots and 90 per cent. in the control, a difference of 18 per cent. This is considerably less than the difference of 45 per cent. recorded at Avondale (Table 3) where crusting occurred, indicating that surface crusting can be an important cause of poor emergence.

Observations suggest that surface crusting is commonest on the heavier soils, especially when the physical condition has deteriorated as a result of poor soil management.

The process starts when heavy rain falls immediately after sowing and destroys the surface structure. The subsequent occurrence of warm, dry weather hardens the clay fraction of the surface soil and causes a crust to form.

Should such conditions cause extensive crusting and so hinder the emergence of seedlings, it is suggested that the affected areas be worked once with a wide set of light harrows. The harrowing is best done at right angles to the drilling.

This emergency measure will destroy the crust and so enable large numbers of seedlings to emerge satisfactorily.

REFERENCE

ACKNOWLEDGMENTS
Grateful acknowledgment is made to officers of the Wheat and Sheep Division for assistance given with the field work and to Mrs. R. Thurloe for the statistical analysis of results.
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