the white-spined line PI 212233 (P1C), the F2 and backcross progenies segregated 15 black: 1 white and 3:1, respectively (Table 1) instead of the 3:1 and 1:1 ratios expected from assumption of a single gene difference as reported in the literature (3, 4, 5). However, when a different black-spined plant (P1B) from line 9362 was crossed to a different white-spined plant (P1D) from 'Pixie', the F2 and backcross ratios were 15 black: 1 white and 3:1, respectively (Table 1) instead of the 3 :1 and 1:1 ratios expected from assumption of a single gene difference as reported in the literature (3, 4, 5).

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Table 1. Emergence of tomato seedlings.

<table>
<thead>
<tr>
<th>Anticrustant material</th>
<th>Ratio (v/v) anticrustant:soil</th>
<th>% emergence in 14 days(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (soil only)</td>
<td>0:1</td>
<td>20</td>
</tr>
<tr>
<td>Wet coke acid</td>
<td>1:1</td>
<td>20</td>
</tr>
<tr>
<td>Petroleum coke</td>
<td>1:2</td>
<td>25</td>
</tr>
<tr>
<td>Vermiculite</td>
<td>1:2</td>
<td>50</td>
</tr>
<tr>
<td>Quartz sand</td>
<td>1:1</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>1/2:1</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>1:0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>1:0</td>
<td>100</td>
</tr>
</tbody>
</table>

\(^a\)Based on 100 seed (25 seed per replication).

Table 2. The influence of anticrustants on growth of tomato plants in the greenhouse.

<table>
<thead>
<tr>
<th>Anticrustant treatment(^2)</th>
<th>Dry wt (g) 10 plants</th>
<th>No of true leaves/plant</th>
<th>Plant height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (soil only)</td>
<td>1.37 b(^2)</td>
<td>4.6 b</td>
<td>7.7 c</td>
</tr>
<tr>
<td>Quartz sand</td>
<td>2.03 a</td>
<td>5.1 a</td>
<td>10.3 a</td>
</tr>
<tr>
<td>Vermiculite</td>
<td>2.09 a</td>
<td>5.2 a</td>
<td>9.8 ab</td>
</tr>
<tr>
<td>Perlite</td>
<td>2.01 a</td>
<td>5.1 a</td>
<td>9.9 a</td>
</tr>
<tr>
<td>Peat</td>
<td>1.81 a</td>
<td>5.2 a</td>
<td>8.9 b</td>
</tr>
</tbody>
</table>

\(^2\)Test period 28 days from seeding on 'Heinz 1370' tomato in 4-inch pots with 5/8 inches of anticrustant material over seed. Soil was silt loam (30% sand, 52% silt, 18% clay), wet to field capacity, and emergence. According to a study by Duncan and Lutz (4), the incidence of natural emergence was high for soils with large amounts of silt and 2:1 type clay, common in the Midwest.

Methods of overcoming soil crust were first tested under greenhouse studies. Petroleum coke mixed with soil in various proportions was placed at a 1/4 inch depth over tomato seed and the surface was allowed to crust before germination. The coke: soil mixture increased seedling emergence (Table 1), but an application of pure coke, vermiculite, or sand was required for 100% emergence. In another test with a silt loam soil with 2.5% organic matter and poor structure, we found that, even if seedlings emerged through a soil crust, vigor and growth rate were reduced (Table 2). A field study verified the benefits of anticrustant (Table 3). The anticrustant vermiculite (no. 2 grade), Nurseryman compost, Nurseryman laboratory, Grandview, Indiana, and petroleum coke consistently increased the rate of seedling emergence and increased resulting plant height and weight.

On the basis of these studies and those reported by E1s (2), we feel that the use of anticrustants in the seeding of tomato on soils with crusting tendencies is essential to insure a dependable, uniform emergence of vigorous seedlings. In Arizona, silica sand was found to be a suitable anticrustant for lettuce (1).

The seeder. Plant population is regulated by releasing seeds in clumps at the intervals desired. This is accomplished with the use of a seed plate, a clumper, or a punched belt.

Under Indiana conditions suitable populations are obtained by seeding 4 to 7 seeds, in clumps 6 to 9 inches apart. This ensures the establishment of 2 to 4 plants per clump.

The starter fertilizer. Optimum tomato seedling growth has been found to be promoted by the application of 227 mg P per 30 cm (1) of row ft directly on the seed (7). Spraying 1 ml 10-14-8-0 N-P-K (1034-0 oxide form) per 30 cm of row directly on the seed will assure the P necessary for optimum starter effect.

The anticrustant. In the Midwest there is a high probability of an intervening rain between planting (late April) and emergence due to delayed germination as a result of low temperatures. The compacting and dispersing effect of rain drops on the soil produces a crust which interferes with emergence. According to Lemos and Lutz (4), the incidence of natural crust was high for soils with large amounts of silt and 2:1 type clay, common in the Midwest.

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on the IH 185 and John Deere 71 seeders to regulate the seed drop. Punched or machined seed plates will also give a multiple seed drop, but not grouped as tightly as with the clumper.

A tube is located just behind the seed drop to spray liquid 2-3-0 N-P-K (10-30-0 oxide form diluted 1:4 with water) on the seed at 500 ml per 30 m (1 pint per 100 ft) of row. An 8004 T-jet nozzle worked well to direct the spray into the seed furrow. This rate of P fertilizer promotes optimum seedling growth rates on loam or heavier soils. For sandy soils we recommend that the concn of the solution be reduced by half.

The anticrustant delivery tube is placed just ahead of the press wheel. A 3/4 x 2 inch opening for the tip of the tube confines the anticrustant into the seed furrow. The anticrustant hopper is positioned directly over the tube and the positive delivery mechanism of a Gandy insecticide applicator is modified to deliver anticrustant at 4 liter per 25 m (4 quarts in 85 ft) of row.

The press wheel has a concave surface so that the wheel exerts pressure along the side of the row, with a slight pressure towards the seed furrow to firm the soil against the anticrustant and leave a narrow convex ridge. The split press wheel of the John Deere 33 seeder left an ideal type ridge that maintained an anticrustant column over the seed even after a heavy rain.

The seeding system has been tested for the last 2 years at different locations in Indiana on different soil types using defuzzed tomato seed and vermiculite, no. 2 grade. Uniform stands were established under adverse conditions (in one instance a 6 inch rainfall the day after seeding). Our integrated system has eliminated several of the disadvantages previously associated with tomato seeding in the Midwest.

**Literature Cited**