Differential Varietal Responses of Winter Wheat Germination and Early Growth to Controlled Limited Moisture Conditions

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The success of a winter wheat crop is initially dependent on the establishment of good, vigorous fall stands. Soil moisture at planting time in the Western United States is not dependable and is seldom adequate. A definite contribution to the successful production of winter wheat would be the development of varieties or selections that would germinate and produce vigorous stands in soil with limited moisture.

Winter wheat varieties when seeded during a year were observed to differ in their ability to produce stands. Investigation of this response by use of osmotic solutions and controlled moisture in soil verified these field observations. Interpretation of these results indicates that it may be possible to breed and select varieties which will produce better stands than our present adapted varieties.

**REVIEW OF LITERATURE**

The moisture absorption of a seed is related to the absorption forces within the seed which enable it to overcome the adsorption forces of the soil particles. Doneen and MacGillworay concluded that seed germination was proportionately delayed as the initial soil-moisture percentage was decreased. They also observed that the germination percentage for some crops is lowered as the soil moisture is increased above the wilting coefficient, but for some crops the proportion of seed germinated is not influenced as long as the soil moisture is above the wilting coefficient. However, seeds of all crops germinated in a shorter time at high soil moisture than at low soil moisture. Hunter and Erickson found that, when the available soil moisture was below the moisture required for germination of soybean seed, the seeds became covered with mycelia of fungi and were killed at the end of a week without germination taking place. They also observed that in order for seeds to germinate, each crop seed studied had to attain a specific moisture content.

**MATERIAL AND METHODS**

Stand counts in the winter wheat experimental plots, located in Laramie, Archer Substation, and Wheatland, Wyo., were estimated before the first killing frost in the fall of 1953. The varieties, Yogo C.I. 8033 and Cheyenne C.I. 8885, were chosen for laboratory study. Seed of the two varieties used in the experiment were grown at Laramie and Sheridan Substation farms. In order to observe their reaction to conditions of limited moisture, the seeds were germinated in solutions of different osmotic pressures. These solutions were prepared by using d-mannitol, a hexanhydric alcohol, which according to Uhivities is nontoxic to seed. This sugar alcohol is sufficiently soluble to permit the preparation of solutions with osmotic pressures up to 15 atmospheres.

The amount of mannitol and water to provide the different atmospheric tensions were calculated by the following formula:

\[
\text{Osmotic pressure} (P) = \frac{g \cdot R \cdot T}{m \cdot V}
\]

\[
\text{Grams mannitol} (g) = \frac{P \cdot V \cdot m}{R \cdot T}
\]

where
- \(V\) = volume in liters
- \(m\) = molecular weight of mannitol
- \(R\) = 0.08205 liter atmospheres per degree per mole
- \(T\) = absolute temperature

Based on the preceding formula, solutions of mannitol were mixed in intervals of 0.5 atmosphere from 6.3 to 11.5 atmospheres. The control consisted of distilled water, representing 0 atmospheres. Fifteen ml. of the appropriate solution were added to each dish after sterilization.

A layer of washed white sand was placed to a depth of about 4 ml. in each petri dish. Five layers of filter paper were placed in each dish, two to cover the seeds and three over the sand. The dishes were then sterilized in an oven for 2 hours at 190°C in order to reduce growth of bacteria and mold.

The seeds were sorted, and only seeds which appeared sound were used. They were treated with Ceresan to eliminate mold which would be present on the seed.

The osmotic solution experiments were conducted in an insulated cabinet, inside a high humidity walk-in germinator which is held at 20° plus or minus 2°C. Pans of water were placed in the cabinet to reduce evaporation from the petri dishes. The moisture which was evaporated from these dishes for the 9-day period was calculated at 1.56% by weight. Selected seed of both varieties had a 99% germination when tested in the Wyoming State Seed Laboratory. The petri dishes were divided into quarters in each of which five seeds were placed. Two dishes which contained the total of 40 seeds represented a treatment for each variety and location. At intervals of 3, 5, 7, and 9 days the dishes were removed from the cabinet and the epicotyl (coleoptile and plumule) of each seedling was measured. Each seed according

Table 1. — Rating scale to determine growth score for the measurement of the length of the epicotyl of germinating seedlings.

<table>
<thead>
<tr>
<th>Growth score</th>
<th>Length of epicotyl—Centimeters</th>
<th>Growth score</th>
<th>Length of epicotyl—Centimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0—0.2</td>
<td>0.0—0.2</td>
<td>9.0—11.0</td>
<td>2.2—2.9</td>
</tr>
<tr>
<td>0.2—0.4</td>
<td>0.4—0.6</td>
<td>10.0—12.0</td>
<td>2.8—3.4</td>
</tr>
<tr>
<td>0.4—0.6</td>
<td>0.6—0.8</td>
<td>11.0—13.0</td>
<td>3.4—4.0</td>
</tr>
<tr>
<td>0.6—0.8</td>
<td>0.8—1.0</td>
<td>12.0—14.0</td>
<td>4.0—4.8</td>
</tr>
<tr>
<td>1.0—1.4</td>
<td>1.4—1.8</td>
<td>13.0—15.0</td>
<td>4.8—5.6</td>
</tr>
<tr>
<td>1.4—1.8</td>
<td>1.8—2.2</td>
<td>14.0—16.0</td>
<td>5.6—6.4</td>
</tr>
<tr>
<td>1.8—2.2</td>
<td>2.2—2.9</td>
<td></td>
<td>6.4—7.2</td>
</tr>
</tbody>
</table>

\footnote{1} Contribution from the Department of Agronomy, Wyoming Agr. Exp. Sta., Laramie, Wyo. Published with approval of the Director as Journal Paper No. 52. Rec. for publication June 17, 1954.

\footnote{2} Graduate student in Agronomy and assistant agronomist. Part of a thesis submitted by Helmerick in partial fulfillment of the requirements for the M.S. degree.

\footnote{3} Doneen, L. D., and John H. MacGillworay. Germination (emergence) of vegetable seeds as affected by different soil moisture conditions. Plant Physiol. 18:524—529. 1943.


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