The Relationship Between Heat Unit Accumulation and the Planting and Harvesting of Canning Peas

Yale H. Katz

While there are many factors that govern and affect the quality of canning peas during growth, the stage of maturity when harvested is possibly the most important (7). The grading of raw peas by a direct mechanical means of measuring tenderness (since tenderness is one index of raw pea quality) is accomplished by use of the tenderometer (6). This is an instrument which measures the force necessary to shear the peas through a standardized grid, this force being inversely proportional to the tenderness of the pea. There is a very high correlation between tenderometer readings of raw peas and the percentage of alcohol insoluble solids in canned peas (6,8) and between tenderometer readings and the starch content of peas.3

Tenderometer values of peas growing at or near maturity may increase 15–30 units in one day, so that an advance or delay in the time of harvesting of as little as one day is of considerable importance to both the grower and canner. Peas which are planted several days apart may be ready for harvesting at nearly the same time. This bunching causes an uneven flow of peas to the canner at harvest-time. Staggering the seeding schedule with different varieties over a period of days does not entirely mitigate this problem.

Boswell (1) stated that "temperature is the most potent climatic factor affecting the yield and development of the pea." In a study of the effect of a certain quantum of heat upon the growth of a plant, it is necessary to fix a base temperature, or, as Kincer (4) terms it, a "zero of vital temperature point," above which growth occurs. For peas, this base temperature is taken to be 40°F (1,5). Two indices for the measurement of the total heat requirements of plants have been used, namely, the direct summation index, and the exponential index.

The direct summation index is based upon the accumulation of the daily mean temperatures above the base temperature for the period of the plant's growth, and is expressed in terms of heat units. Thus, for example, a day with a mean temperature of 67°F will have an accumulation of 67–40 = 27 heat units. This method assumes that the rate of growth is directly proportional to the increase in temperature, (harmful high temperatures included) whereas, at least within moderate ranges of temperature, the functional relationship is of the form:

$$
\text{rate of growth} = \log_{10} \text{temperature increment}
$$

The exponential index is based on the assumption that plant growth rates follow the rule of Arrhenius, doubling with each increase in temperature 18°F. It is derived from the sum total of temperature efficiencies, where the daily mean temperature is obtained by the formula:

$$
(\text{t-40})\text{u} = 2^{18},
$$

or in a more workable form, \( \log \text{u} = \frac{(\text{t-40})}{18} \). Accordingly, the temperature efficiency of 2°F mean temperature is 1.41, and for a mean temperature is 58°F is 2.00, etc. Hence, a rate of plants is considered to be nonlinear in temperature. A criticism of this index is that temperatures that are too high for optimum growth are ascribed efficiencies greatly out of proportion real worth.

Caldwell and co-workers (2) concluded that length of time of planting and consequent rate of accumulation will be of considerable interest to canners, packers, freezeers, and dehydrators.

This paper presents data on the effect of heat summations upon the degree of maturity of canning peas, in the vicinity of Columbus, Wis., for the years 1942 to 1944. Over this period, the average acreage was 2,129 acres.

MATERIALS AND METHODS

The data used in this study consisted of the planting and harvesting dates and tenderometer readings for Alaskan fields, grown under the direction of the Columbus company (now Stokely Bros., Inc.) Columbus, Wis., 1942 to 1944, inclusive.

Since neither field temperature nor Columbus temperature data existed, it was necessary to use temperature data from Wis., which is located 30 miles south and west. It is realized that the temperature data used are not comparable to those experienced by the crop. Mean daily temperatures for a normal year, for both methods.

Figs. 1 and 2 show the accumulation of heat throughout July for the 3-year period along with the tenderometer values of peas growing at or near maturity. The number of individual records used is as given below:

<table>
<thead>
<tr>
<th>Year</th>
<th>Acreage</th>
<th>Records</th>
</tr>
</thead>
<tbody>
<tr>
<td>1942</td>
<td>2,129</td>
<td>17,195</td>
</tr>
<tr>
<td>1943</td>
<td>2,129</td>
<td>19,139</td>
</tr>
<tr>
<td>1944</td>
<td>2,129</td>
<td>19,139</td>
</tr>
</tbody>
</table>

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1 Contribution from the Department of Agronomy, Wisconsin Agricultural Experiment Station, Madison, Wis. Approved for publication by the Director—Condensed from a thesis submitted to the Graduate School of University of Wisconsin in partial fulfillment of requirements for the degree of Master of Science. Paper was published February, 1952.

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