FORECASTING THE MATURITY DATE OF SNAP BEANS

Alex J. Kish
National Oceanic and Atmospheric Administration
National Weather Service
Clemson, South Carolina 29631

Aviation meteorologists' main concern is the safety of the aircraft and passengers from take-off to landing. They forecast ceilings and visibilities, weather enroute and at destination. Agricultural meteorologists' principal interest is the crops a farmer plants from the day of planting to harvest. They forecast soil temperatures, frosts and freezes, the weather during the growing season and at harvest. They also forecast, for certain crops, the date of maturity. One crop which maturity date can be forecast is the snap bean.

Why forecast the date of maturity of snap beans? Snap beans must be harvested at a specific stage of maturity to obtain the highest quality. Most varieties become tough and fibrous if left on the plants beyond this point. To predict accurately the maturity date of a particular variety is of importance to farm managers and cannery supervisors. The method most often used is the total heat-units required to mature a crop.

Heat-units can be either growing-degree days or growing-degree hours. A degree day is a measure of departure (°F or °C) of the mean daily temperature above a base temperature. A degree hour is the departure (in °F or °C) of the hourly temperature above a base temperature. The base temperature used for snap beans is 10°C (50°F).

Field experiments were conducted at Clemson University to study the accuracy of the heat-unit system in predicting the maturity of snap beans. The growing-degree day method was found to be unreliable (Table 1) in predicting the maturity for three plantings of Harvester and Tendercrop and five plantings of Blue Lake 274 varieties of snap beans. To predict snap bean maturity accurately, accumulated heat-units should not vary greatly between plantings. It appears that other meteorological elements beside temperature affect snap bean maturity.

Two major components of the environment that contribute to the variation of the number of calendar days to snap bean maturity are temperature and moisture. The available soil moisture for each of the plantings varied greatly. Because of the unreliability of the heat-unit method, it was decided to integrate the available soil moisture parameter into the degree-day method. The formula that gave the smallest coefficient of variation was one using the daily heat-unit multiplied by a ratio of the daily available soil moisture to a constant soil moisture value. Whenever the available soil moisture equaled or exceeded the constant, the ratio of 1 was used. This relationship is expressed as:

$$SMGDD = GDD(x/c) \text{ when } x < c \qquad (1)$$
$$SMGDD = GDD \text{ when } x \geq c$$

Where:

SMGDD = soil moisture growing-degree day units
x = daily available soil moisture (%)
c = constant soil moisture (%)
GDD = growing-degree day units

The accumulation of the daily SMGDD from planting to maturity for snap beans is expressed as:

$$SMGDD_S = \sum_{p}^{m} GDD_{50}(x/c) \qquad (2)$$

Where:

$SMGDD_S$ = sum of soil moisture growing-degree day units
p = date of planting
m = date of maturity
GDD_{50} = growing-degree day heat units base 50
x = daily available soil moisture (%)
c = constant available soil moisture for snap beans

Literature does not reveal the available soil moisture level at which the snap bean begins to suffer a reduction in growth and develop-

Table 1. A comparison of growing-degree days and soil moisture-growing degree days required to mature "Harvester", "Tendercrop" and "Blue Lake 274" snap beans. (Clemson, S. C., 1966, 1975, 1976).

Planting Date	Tendercrop		Harvester		Blue Lake 274	
	GDD[1]	SMGDD[2]	GDD	SMGDD	GDD	SMGDD
April 18	1009	938	997	935		
April 30					1101	1009
May 5	1080	933	1015	903		
May 6					1055	1018
May 14					1269	1034
May 20	1228	939	1197	920	1123	1034
June 4					1325	1037
Mean	1106	937	1070	919	1175	1026
AAD[3]	219	6	200	32	270	28
CV[4]	10.1	0.3	10.3	1.7	9.9	1.1

[1] Growing-degree days (base 50).

[2] Soil-moisture growing degree days.

[3] Average absolute deviation.

[4] Coefficient of varability.

ment. Determination of this level was done experimentally. It was found that optimum available soil moisture level to be used as the constant soil moisture value in the formula was in the 57 to 59% range.

Equation 2, with 58% as the constant, was used to calculage SMGDD units required for maturity. GDD and SMGDD maturity data for the three varieties, the average absolute deviation, and the coefficient of variability are presented in Table 1. A comparison of GDD with the new SMGDD method shows that the latter was superior to the usual heat-unit method in predicting snap bean maturity. Further research comparing GDD with SMGDD for other varieties in various locations is indicated to confirm the validity of the proposed method.