THE GRAVITY OF SPECIFIC GRAVITIES (THE 1998 SEASON)

by
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Abstract:

The specific gravities of potatoes from the Columbia Basin and the Pacific Northwest were some of the lowest seen for many years. Extended periods of high temperatures during the 1998 season was much to blame. We have installed a potato growth simulation model on the PAWS network for growers to use for monitoring the types of weather conditions that may result in poor quality potatoes. The model, its interpretation and use will be explained.

The specific gravity of potato tubers is an important quality characteristic that indicates how well the tuber will process into frozen French fries. It is of significant enough value to warrant additional incentive payments to growers who can produce potatoes with high specific gravity values. Although it is of monetary value to growers, few understand what factors affect this characteristic of the raw product. In previous research studies, we have determined that the number one reason for the variation in specific gravity between years is the weather conditions during the growing season.

What is specific gravity?

Specific gravity is a measure of the amount of starch in the tuber and can be determined by several methods. Most processors use the weight in air/weight in water method but the older hydrometer method or more laborious method of salt brine solution separation can also be used. The methods all provide a reasonable estimate of the amount of starch in the tuber. This measurement is however, only an estimate and the actual amount of starch present can only be determined by much more time consuming and expensive measures.

What affects specific gravity?

Since starch is the primary component being measured by the specific gravity determination and the starch content is what determines finished product recoveries and quality in processing, the factors that affect starch formation are important to understand. I have reviewed the subject of factors influencing specific gravity on other occasions (Dean 1995, Dean 1998). Many of these factors and other information about specific gravity of potatoes can be found in the WSU extension Bulletin "Specific Gravity of Potatoes by Dean and Thornton.

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Weather affects specific gravity.

We have just experienced another of the weather events called "El Nino" and its aftermath "La Nina" in the 1998 season. The national weather service announced that worldwide the average temperature for 1998 was the highest ever recorded. Many significant weather events occurred in 1998 that will make it one of remembrance for many people.

In order to understand how the weather affected the 1998 crop, we must first understand a few basic facts about potato growth. Potatoes grow very slowly below 50F but increase in their rate of growth linearly between 50F and 80F. The rate of photosynthesis, the process producing all the carbohydrates and eventually starch, is not affected much by temperatures below 78F but is affected significantly above 78F. Its rate decreases rapidly when temperatures exceed 80F and approach zero at 110F. In fact the effect of temperature on total carbohydrate content may be much greater if respiration, transpiration and other processes are considered.

The 1998 gravities:

The specific gravity of the Washington potato crop was one of the two lowest on record since I began studying this phenomenon in 1978 (figure 1). The data for figure one were obtained from Columbia Basin potato processors and is representative of the industry. The lowest recorded specific gravities were reported in 1977 (1.075) followed by the current year 1998 (1.077). In general, Washington producers are improving the specific gravities of their crops at the same time that they have increased yields. This alone dispels one of the old adages that high yields will result in poor gravities. What is it that causes the variation in gravities we see in the crop from year to year and is there anything we can do about it?

How did the 1998 weather affect potato specific gravities?

We have developed a computer model to predict the effect of weather (primarily air temperature) on potato growth for the Columbia Basin (Dean 1980). This model has been modified slightly and is being made available for general use at this time on the Public Agricultural Weather System (PAWS) operated by Washington State University. Information about this service can be obtained on the WSU web site or by phoning the PAWS office at the IAREC (509)-786-9367. The output of this model may help understand the effect of weather on the specific gravity of potatoes.

The weather is less severe in the north part of the Columbia Basin in areas such as Quincy. The output of our computer model shows that the crop got an earlier start at planting in 1996 than 1998 but was soon surpassed by the warmer spring conditions of 1998 (figure 2). The two years paralleled one another for the time period that is important for foliage growth between May 1 and July 1. This indicates that the crop may have been slightly earlier in 1998, but that the two years were not very different until after the first week of July. There were two apparent stress periods in July during 1996 followed by a period of steady growth potential for the remainder of the season. In contrast, there was a period of mild stress during mid July in 1998 followed by a more severe stress and then a period of renewed favorable growth for the remainder of the season. These stress periods may appear small, but may be significant depending on what stage of growth the potato is in at the time they occur.

The weather in Othello for the same two years was similar with the exception that the period of stress may have been longer but not as large as in Quincy (figure 3). When we observe the model output for the weather in the south Basin at the Paterson Station, a much more dramatic picture emerges. The spring weather is very favorable for growth as is indicated by the extreme slope of the lines for both years from the first of May until the first of July (figure 4). The potential for growth levels off and then decreases sharply in the high temperature period of mid July to mid August. The difference in this set of graphs seems to be in the duration and level of apparent stress in August and early September. The weather returned to favorable conditions by the end of August in 1996, but not until the middle of September in 1998.

If we compare the model outputs for potential growth during two years of relatively good gravities (1993 and 1995) with two years of relatively poor gravities (1991 and 1998) we may see additional trends at the Paterson site. The specific gravities of the 1993 and 1995 crops were 1.085. The growth potentials for these two years at the Paterson site were favorable for almost the entire season (figure 5). The specific gravities for the 1991 and 1998 crops were 1.080 and 1.077 respectively. The growth potential graphs indicate a long period of significant stress for both years that was not relieved until after the first of September. The general condition of the crop going into this time period and its condition after the stress would of course greatly affect the final yield and quality of the crop.

It is not my intent to state that the crop in any given year is going to turn out good or poor by this model. Rather it is my hope that if these correlations are true, we may learn specific management techniques that can be used to reduce the effect of adverse weather on our potato crop. I would like to suggest the following as some possibilities.

1) Adjust fertilizer levels (nitrogen) to approximate the need based on the prospect for continued good growth temperatures during the July and August time periods. When unfavorable periods occur, reduce the amount of nitrogen applied to avoid causing the plant to return to a juvenile (foliage) stage of growth at the expense of the stored carbohydrates in the tubers.

2) Avoid situations that will supply the crop with large amounts of nitrogen late in the season (high organic matter residues).

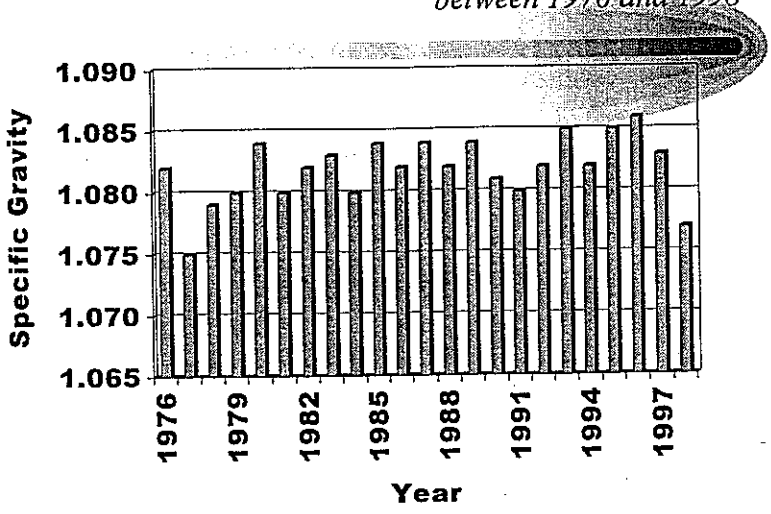
3) Maintain soil moisture levels at optimum at all times. Too high of soil moisture levels will aggravate the problem perhaps as much as low soil moisture levels.

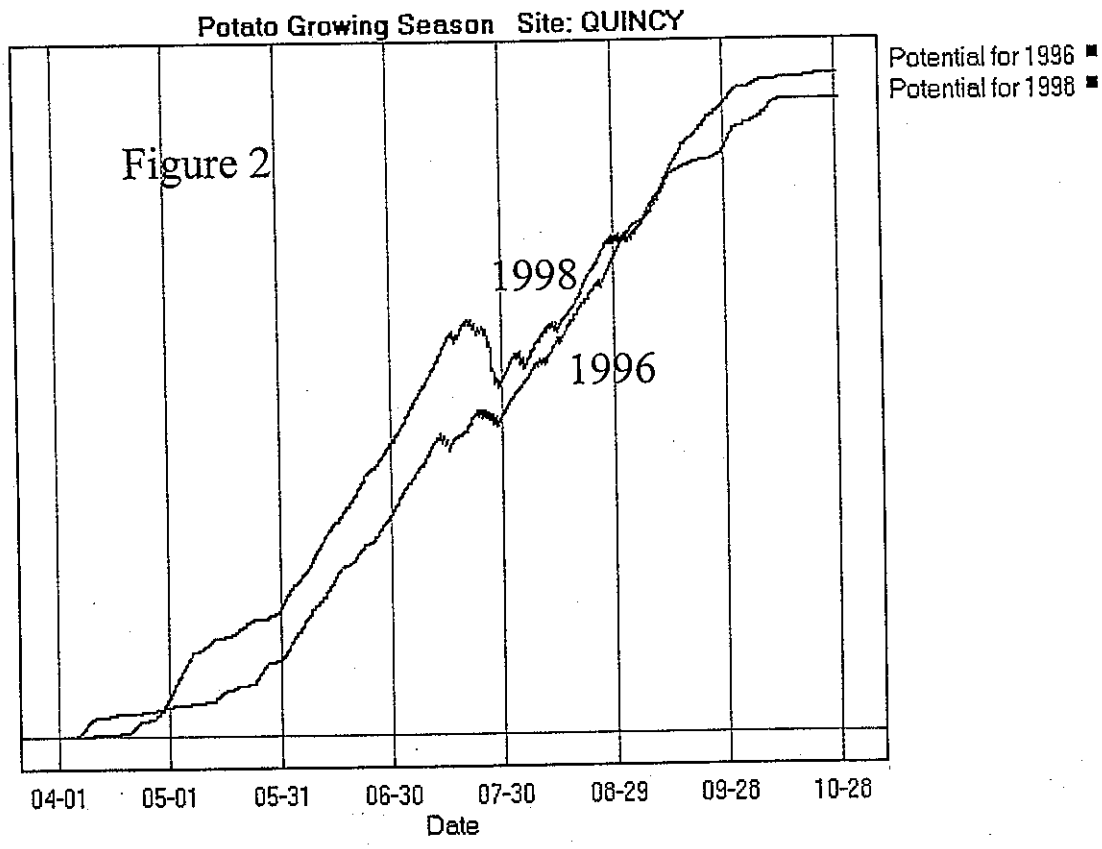
4) Consider growth-regulating sprays such as Malic Hydrazide as a means to control foliage growth and protect the specific gravities achieved early in the season.

Remember that it is not enough to just do something, you must do the right thing at the right time to get the right effect.

Figure 1

Specific gravity of potatoes grown in Washington State between 1976 and 1998





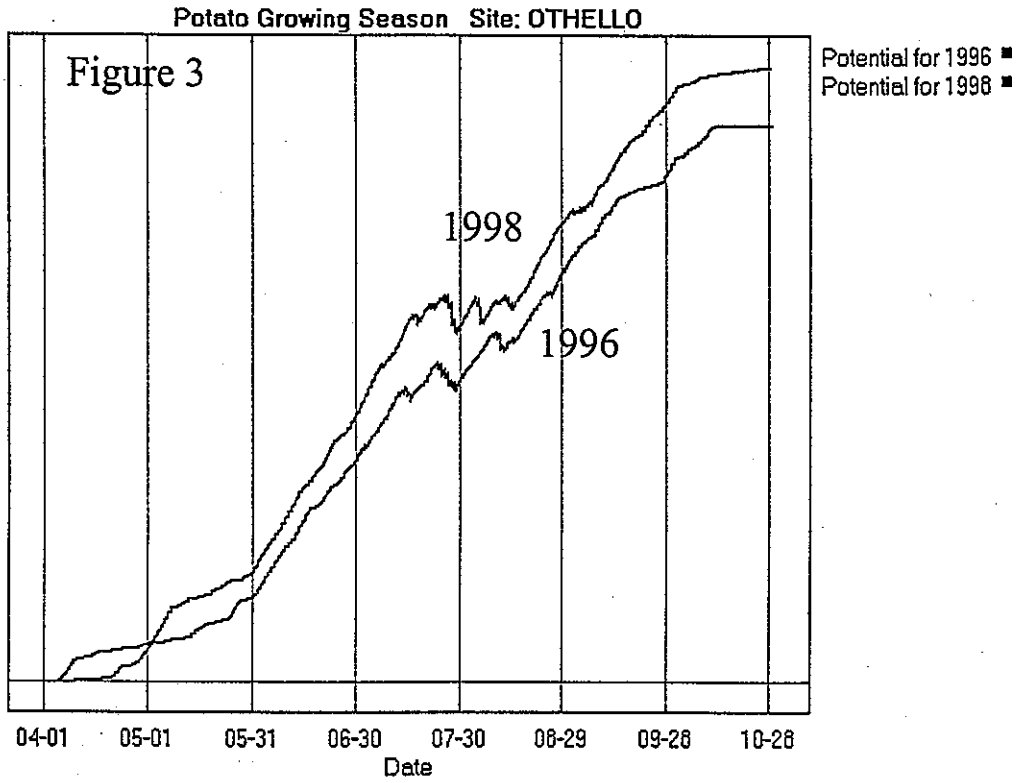


Figure 3

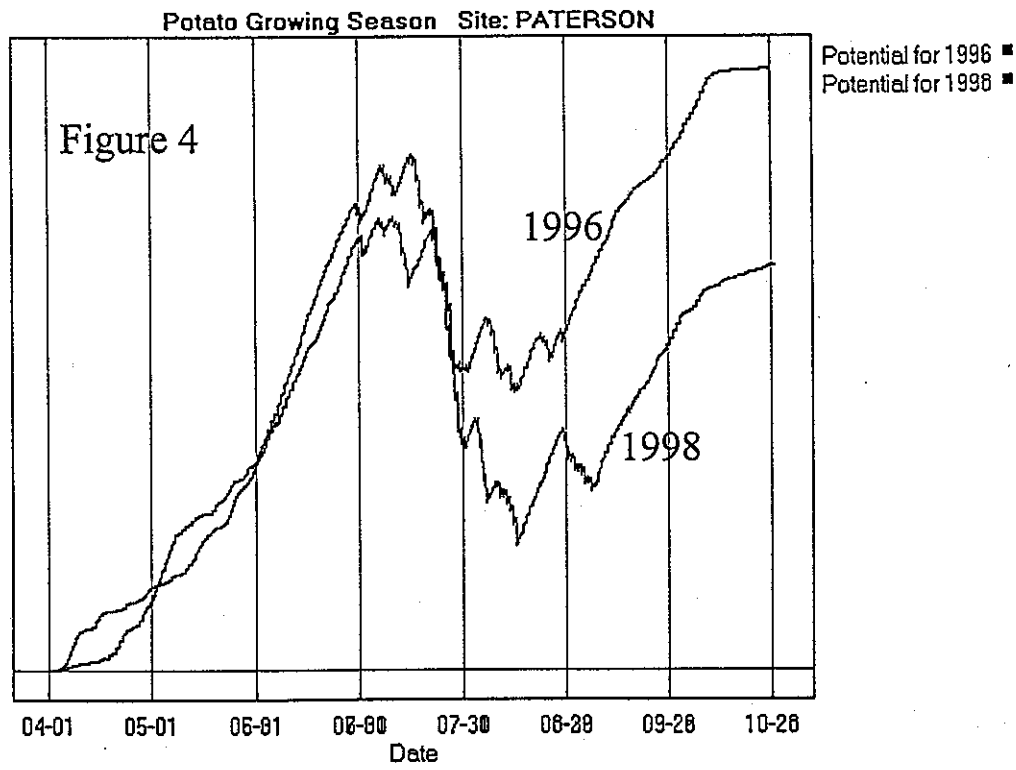
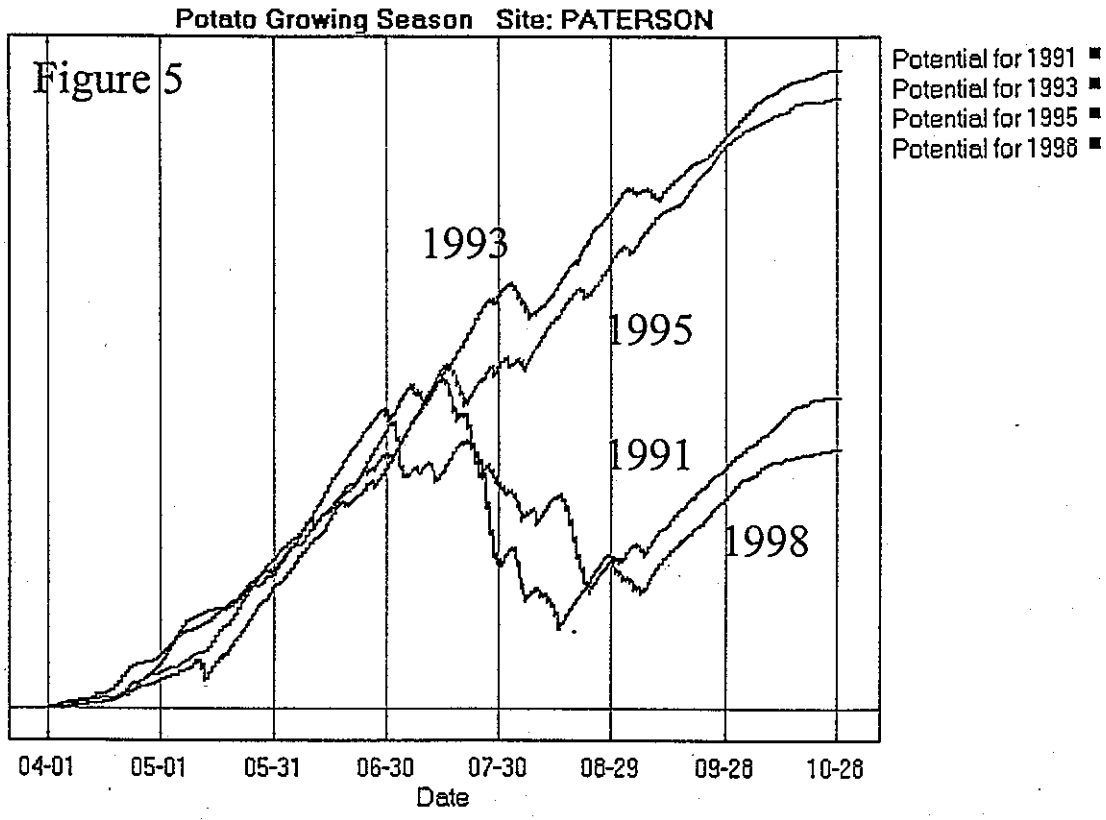


Figure 4


Potato Growing Season Site: PATERSON
Figure 5
Potential for 1991
Potential for 1993
Potential for 1995
Potential for 1998
1993
1995
1991
1998
04-01
05-01
05-31
06-30
07-30
08-29
09-28
10-28
Date