HIGH TEMPERATURE - HOW IT INFLUENCES POTATO YIELD AND QUALITY

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Temperature is one of the most important factors influencing potato plant growth, tuber yield and quality. Both air and soil temperatures are important in determining yield, specific gravity, and incidence of malformations and sugar ends. Low specific gravity is one of the main problems that was experienced by the Northwest potato industry during 1990.

There are two questions that should be asked. First, can the high temperatures experienced during the 1990 growing season account for all the reports of low yield and quality? Secondly, are there other factors, besides high temperatures, that could have contributed to the reduction in yield and quality experienced in 1990?

To answer the first question, it is important to look at the plant processes that are directly affected by high temperatures. Up to 90% of the dry matter in tubers comes from carbon dioxide taken up during the process of photosynthesis. This carbon is utilized for plant growth, and also in respiration that produces energy to keep the plant alive. Photosynthesis and respiration are very sensitive to temperature. Photosynthesis decreases rapidly at temperatures above 75 to 80°F, while respiration increases. This can result in a reduction in the amount of dry matter for growth, and ultimately reduced yield. Under field conditions, however, there is always a portion of the day (early morning and late afternoon) during which photosynthesis is high. The "Mid-day depression" of photosynthesis occurs once temperature increases above the optimum range.

Tuber yield and specific gravity is reduced under high temperatures not only due to reduced carbon uptake, but also because vine growth is promoted at the expense of tuber growth. High temperatures favor the production of stems and leaves. Although more leaves are produced, they are smaller, and not as effective at intercepting light for photosynthesis.

There also is evidence that the rate of transport of carbohydrates to tubers, and incorporation of sugars into starch in tubers is reduced at high temperature. This can result in lower specific gravity.

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The above relationships between temperature and plant processes involved in yield are the reason that many people are quick to blame heat stress for all the problems experienced in 1990. Greenhouse experiments conducted at Aberdeen, Idaho indicate that it takes a very long period of both high air and soil temperatures to severely reduce yield and gravity (Table 1). Five weeks of 100°F day temperatures and 82°F night temperatures, combined with 86°F soil temperatures were required to reduce dry matter production by 38%. Specific gravity was reduced by 45% under these same conditions.

Were temperatures in 1990 high enough to account for severe losses in yield and quality? Temperature records for Othello indicate that in August maximum daytime temperatures were often around 100°F, but night time temperatures were generally around 60°F (Figure 1). Historic records of monthly mean maximum temperatures show that 1990 values were generally 2 to 3°F above the values in 1988 or 1989 (Figure 2). Minimum monthly temperatures were only slightly above normal (Figure 3). This indicates that while high temperatures in 1990 may have contributed to the overall lower average yield and specific gravity, temperature cannot be the only factor involved.

High temperatures are often associated with other stresses, particularly water stress. Crop water use increases greatly at high temperatures, resulting in rapid depletion of soil water content. The combination of heat and water stress together can cause a greater reduction in yield and quality than either factor alone. Irrigation management practices are important because they can reduce water stress, but also because soil temperature can be reduced by light frequent applications.

High temperature may also interact with nitrogen nutrition. Both high temperatures and high nitrogen availability can result in excessive vine growth, and delayed tuber initiation. It is likely therefore, that high nitrogen could aggravate problems associated with high temperatures.

SUMMARY

High temperatures can result in lower yield and specific gravity, but other stresses associated with high temperature may be just as important under field conditions. Although high temperatures cannot be avoided, some of the accompanying stress can be minimized by management practices that include:

1. Apply irrigations based on crop water use and soil water holding capacity.

2. Take advantage of cooling effect of leaf shading by maintaining full canopy cover.

3. Avoid excessive nitrogen applications that promote rapid vine growth.

4. Plant varieties that are less sensitive than Russet Burbank to environmental stresses.

Table 1. Effect of day/night air temperature and soil temperature on total dry matter production and % tuber dry matter of Russet Burbank.

Day/Night Air Temperature (°F)	Soil Temperature (°F)	Total Plant Dry Weight (g)	Tuber Dry Matter Content (%)
77/54	61	152	24.3 (1.101)*
	86	136	18.6 (1.075)
100/82	61	117	20.6 (1.084)
	86	94	13.4 (1.050)

*Estimated specific gravity value corresponding to the % tuber dry matter.

Figure 1. Maximum, minimum and average daily temperature at Othello, Washington during August 1990.

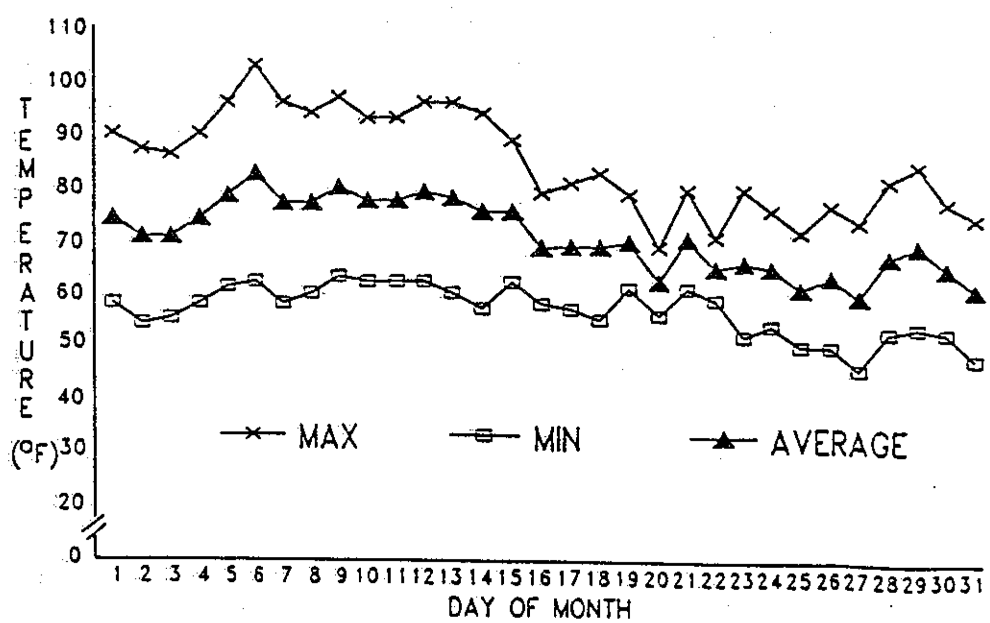

Figure 2. Mean monthly maximum temperature at Othello, Washington during 1988, 1989 and 1990.

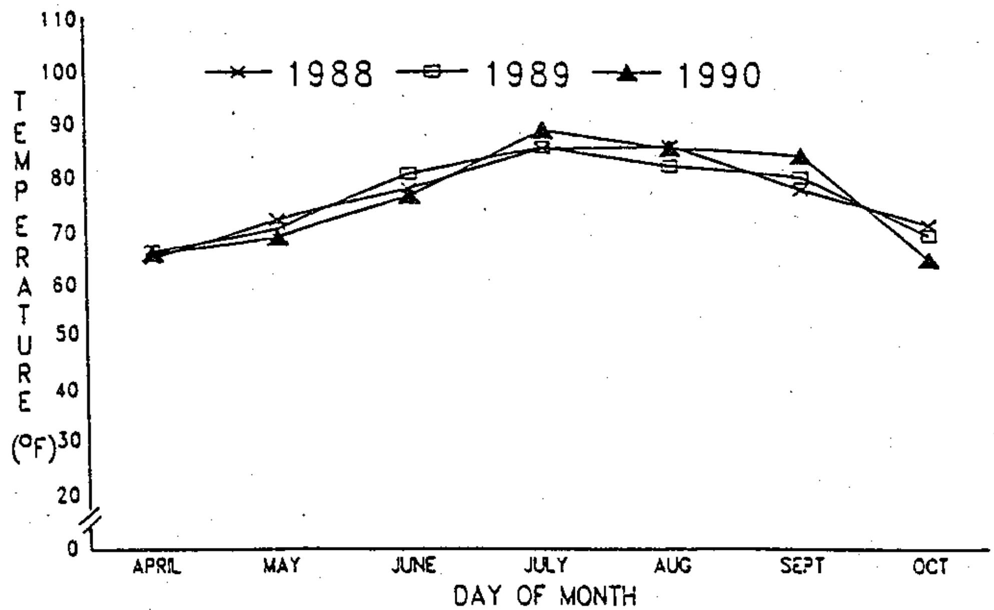

Figure 3. Mean monthly minimum temperature at Othello, Washington during 1988, 1989 and 1990.