Research Note on Effects of Diurnal Temperature Extremes on Cotton Yields at the University of Arizona Maricopa Agricultural Center

D. C. Warren[1] and R. S. Rauschkolb[2]

Abstract

An examination of the weather record for the University of Arizona Maricopa Agricultural Center revealed that short staple cotton yields were negatively affected by cool summers. Cool summers are here defined as June through August months with many days having cooler than average max temperatures for those months. No correlation to yield was found for nighttime temperature; nor was there a detectable effect of higher than average temperature affecting yields.

Introduction

Weather records have been recorded at the University of Arizona Maricopa Agricultural Center since 1987 by the AZMET team headed by Dr. Paul Brown[3]. Since cotton yields vary dramatically from one year to the next, we wished to test the effects that temperature extremes had on field grown cotton.

On average, temperatures have remained fairly constant during cotton growing seasons the last 9 years. The average high temperature calculated for the summer months is about 40°C. The average nighttime low temperature is about 22°C during the same period (Figure 1).

Without much change in the average temperatures from year to year, differences in cotton yields cannot be explained on the basis of temperature averages. Therefore, we chose a method of comparing cotton yields versus temperature extrema in order to detect temperature related effects on cotton yields.

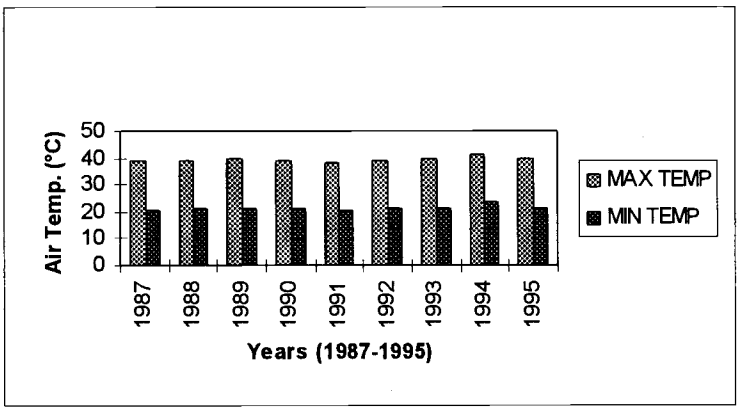

Figure 1. Mean daily max and min air temperatures averaged for June-August months within a given year.

[1] Computer Specialist, University of Arizona Maricopa Agricultural Center, Maricopa, AZ 85239
[2] Resident Director, University of Arizona Maricopa Agricultural Center, Maricopa, AZ 85239
[3] Extension Specialist, Dept. of Soil & Water Science, University of Arizona, Tucson, AZ 85721

Results

If temperature extremes play a role in cotton yields, they must be represented by some other method besides averaging. Thus, in Figures 2 and 3, temperature extremes are represented discretely as individual data points for each day. The criteria for plotting temperature extremes were: if a daytime temperature was above or below 1 standard deviation of the 9-year average summertime high temperature, then the datum was plotted (Figure 2). Likewise, if a nighttime low temperature occurred that was above or below 1 standard deviation of the 9-year average summertime low temperature, the datum was plotted (Figure 3).

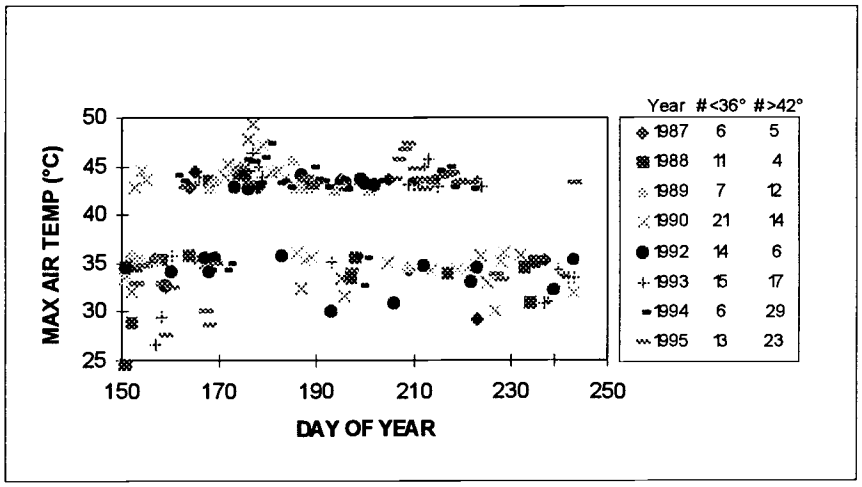

Figure 2. Daily air temperature maxima outside of 1 Standard Deviation of mean max air temperatures from a 9-year record for June-August months. The columns beside Year in legend to the right of scattergram denote number of occurrences of extremes in a given year.

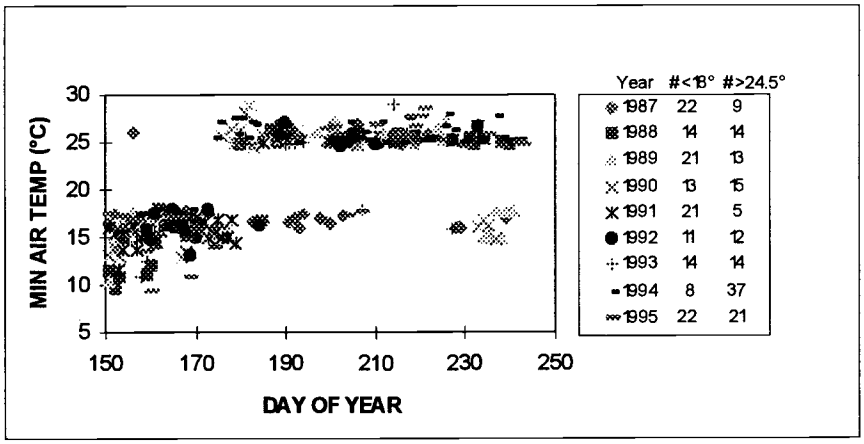

Figure 3. Daily air temperature minima outside of 1 Standard Deviation of mean min air temperatures from a 9-year record for June-August months. The columns beside Year in legend to the right of scattergram denote number of occurrences of extremes in a given year.

The different yields recorded on upland, short staple varieties, varied from a high of 3.46 bales/acre in 1987, down to a low of 2.56 in 1995. Although many factors besides weather play a role in defining the quantity of cotton produced, the University of Arizona Maricopa Agricultural Center minimizes the year-to-year effects on

yield associated with inconsistent cultural practices by maintaining a highly regulated system of management (Patrick Murphree, pers. comm)[4].

From totaling the number of extremes within a given year and correlating those totals against annual yields, it is possible to make some meaningful comparisons. The correlation of the number of cool days in a given year versus yields gave the only significant correlation; a value of -0.72 with 6df, $\alpha<.05$. When correlating the number of cool nights, hot nights, or hot days against yields, no significant results emerged (Fig. 4).

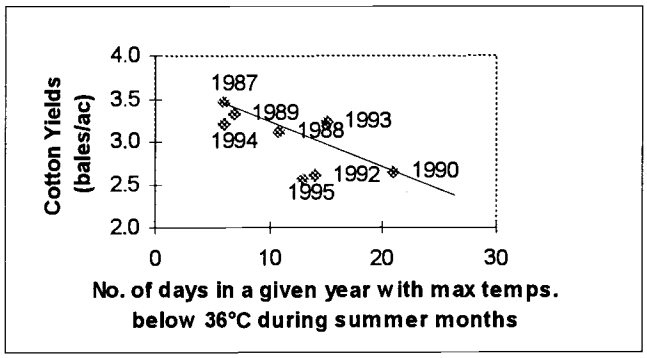

Figure 4. Correlation between cotton yields and the number of relatively cool days during summer months in a given year.

Conclusions

These data are principally given to satisfy curiosity concerning effects of temperature extremes on cotton yields. The study is not offered as being scientifically rigorous, but merely an attempt at deseminating in a useful fashion the historic weather data accumulated at the University of Arizona Maricopa Agricultural Center, and offering some insights into how temperature extremes may in some part be affecting cotton yields.

In conclusion, there is no magic formula that arises from our analysis which gives threshhold information on make or break temperature regimes with respect to cotton yields. In fact, our senses might tell us that the worst yields would be in those years where the weather is unusually hot. But as these data show, the only correlation between temperature extremes and yields occur when a high number of relatively cool days during the growing season depress yields as opposed to high heat extremes which showed no significant effect . Thus, once again, our results confirm what is already known about cotton: you're more likely to get a good yield with an uncomfortably warm summer than you are with a cool summer.

[4] Demonstration Farm Superintendent, University of Arizona Maricopa Agricultural Center, Maricopa, AZ 85239