Seed Yields Decline at Higher Average Temperatures

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Abstracted by ECHO staff from the article "Rising Temperatures and Plant Productivity," published in the August 2006 issue of Agricultural Research magazine.

What happens to seed yield if a crop is planted in a warmer climate or if global warming causes temperatures to rise? Increased carbon dioxide levels may encourage some plants to grow larger and increase crop yields, but elevated temperatures could leave some seed crops sterile according to L. Hartwell Allen, Jr., a soil scientist in the Agricultural Research Service's Chemistry Research Unit in Gainesville, Florida.

"Increased temperatures affect reproductive processes more than they affect photosynthesis and vegetative growth. A plant may still grow to its typical size even if its seed development fails."

Researchers in Florida and at the International Rice Research Institute measured heat's effect on yields of rice, grain sorghum, kidney beans, soybeans, and peanuts grown at four maximum/minimum daily temperature cycles.

"Each crop was found to have its own optimal mean daily temperature (OMDT) for seed yield. As temperatures rose, yields decreased, dropping to zero at about 18°F (10°C) above each crop's specific OMDT." Seed productivity generally decreased by about 6 percent for every 1°F (0.55°C) above a given plant's OMDT. Current summer temperatures in the southern United States are 2-4°F (1.1-2.2 °C) higher than optimum for most grain crops.

"Compared to rice and grain sorghum, which yield best at an OMDT of 77°F (25 °C), kidney beans were more sensitive to heat, while soybeans and peanuts were less so. Pollination failure was the chief cause of yield declines at higher temperatures. The number of pollen grains per flower and the percent of viable pollen declined as temperature increased, as did the number and size of seeds per pod.

"Allen found that fewer soybeans were produced at aboveoptimal temperatures, and individual beans grew less. Peanut yields fell because the number of viable pollen spores and percentage of flowers setting seeds declined, eventually reaching zero.

"For all the crops studied, even when pollination was successful, shortened seed-filling time and higher respiration rates at moderate temperature increases also contributed to yield declines.

Allen says that using traditional breeding to develop crops with built-in heat tolerance may offer the best hope for helping plants—and growers—cope with rising temperatures [Ed: or for places where temperatures are already above optimum].

“We’re trying to identify cultivars that yield well in very hot environments,” he says. “If heat tolerance could be incorporated into all productive crop varieties, it would lessen the agricultural impact of climate change.

“Also, adjusting the time of day when pollen is shed by a plant could improve its viability. Varieties that shed pollen earlier in the day, when temperatures are cooler, would be more likely to flourish.”

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