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Heat tolerance found in sweet potato cultivars could protect food security from the effects of climate change

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Food security is a growing concern as crop yields are threatened by increasing climatic variability — periods of excessively hot weather, or heatwaves, specifically. This study examines the crop diversity of the sweet potato (*Ipomoea batatas*) to understand which genetic variants flourish in response to climatic stress and to identify the crop traits that aid this success.

Climate change is one of the foremost environmental risks faced by communities around the world. As temperatures rise, important crops are under threat. Growing conditions for the sweet potato, for instance, face increases of 1 to 6 °C by 2070 — which could negatively impact many cultivars (a variety of a plant developed from a natural species and maintained through cultivation) of this crucial food crop (the fifth most important in the world).

Sweet potatoes are more resistant to climate stress than many crops. There are over 6 171 varieties of sweet potato, originating from 62 countries, in the gene bank of Peru's International Potato Centre (CIP). In addition to its hardiness, the sweet potato has many other sustainable characteristics: it can help stabilise erosion-prone soils, is highly nutritious and is easy to grow. These characteristics support several of the United Nations' 17 Sustainable Development Goals; the EU is committed to these goals, with agricultural sustainability and climate resilience forming an intrinsic part of the roadmap for the European Green Deal[1].

This study explores how the genetic diversity of crops can be used as a tool for adapting to climatic extremes and continuing to grow high-yielding crops within a changing climate.

A field in Peru was planted with 1 973 sweet potato varieties from 50 countries to screen for heat tolerance (sourced from the CIP collection). The experimental plots were exposed to two temperature conditions: non-heat stress (12.3 to 31.7 °C) and heat stress (17.3 to 36.9 °C). Heat stress plots showed a mean warming of 5.5 °C for air and 4.5 °C for soil when compared with the non-heat stress plots, and experienced extreme heat events of over 35 °C for 14 days (mean duration of event: 1.8 hours). These temperatures exceed the optimum growing conditions for sweet

Heat tolerance found in sweet potato cultivars could protect food security from the effects of climate change (continued)

potato. The effect of the heat stress on the plants was calculated by measuring root and foliage yield 120 days after planting.

The researchers also used a model to estimate the importance of three environmental variables — altitude, temperature and precipitation at the location of origin — and nine morphological and physiological traits known to affect the heat tolerance of plants on sweet potato root yield. The canopy (or above-ground portion of the plant) temperature of the whole experimental plot was measured using high-precision airborne thermography.

The heat-tolerance field experiment identified 132 heat-tolerant sweet potato varieties (6.7% of the 1 973 investigated). The data analysis found canopy temperature depression (the difference between air and leaf temperature), chlorophyll content (green pigment found in plants) and sweet potato flesh colour to all be predictors of heat tolerance. Orange-fleshed potatoes tended to tolerate heat stress better than other varieties, for instance.

Each studied continent (the Americas, Africa and Asia) contains strains of sweet potato that are heat tolerant. For example, in areas of the Americas where heat stress is predicted to be strongest, at 4 to 5 °C, seven cultivars of sweet potato are highly heat tolerant and able to achieve stable yields despite heat stress. A further 15 American cultivars of sweet potato would manage to retain 50% of their yield (as measured in stress-free conditions).

These results highlight the role of within-species crop biodiversity in protecting the productivity and resilience of agricultural systems in the face of climate-related heat stress. Mass field testing, as performed in this study, can identify heat tolerance traits for local farmers to consider in their crop breeding and selection — an important part of ensuring food security under climate change.

The researchers acknowledge a number of caveats to their findings, including that heatwaves with similar air temperatures may have different impacts on crop yield and plant traits (depending on the optimum temperatures for local varieties of sweet potato, and local conditions such as wind speed). They also call for more data on how the combination of heatwaves and severe drought may affect sweet potato yields.

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1. European Green Deal 2019.