A mathematical description of evaporative cooling potential for perishables storage in India

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Abstract

Post-harvest losses of fruit and vegetables in India, estimated to be around 30 %, can cause major economic disaster for smallholder farmers. A significant part of these losses occur due to lack of appropriate cold storage facilities, high temperatures, and low RH of ambient air especially during summer months. The high capital required and lack of uninterrupted power supply makes it difficult for farmers to build cold stores and existing cold storages are not distributed equitably and do not have sufficient capacity to serve India's 100 million smallholder farmers. One cooling option is the relatively inexpensive evaporatively cooled (EC) storage, which was designed to enable farmers to avert distress sale and get a fair price for produce. An EC storage, termed the Pusa EC room, was built using novel construction materials including fabric walls and insulative blocks and evaluated year-round over a period of 5 years (2017–2021) using respiratory and senescence responses of amaranth (*Amaranthus* spp.) to storage temperatures. Wetting of the fabric walls yielded cooling of the structure interior during the daytime, but not at nighttime. As a result of lowered temperatures, storage life was predicted to be nearly doubled relative to storage at ambient temperatures during the warm and dry spring and summer weeks, however it was not improved appreciably when the ambient temperature declined and RH increased during late summer, fall, and winter. The estimated daily reduction in respired CO_2 for the leafy amaranth, used here as a model plant, was governed by a simple mathematical expression using wet bulb depression of temperature relative to ambient. The predictive equation can be applied to any plant material for which the metabolic response to temperature is defined and permits convenient estimation of the benefits of evaporative cooling, potentially anywhere on the globe. This relationship was used for predicting storage-life improvement for many cities of major climate

zones in India using data retrieved from website https://en.climate-data.org. EC room benefits were projected to be highest for warmer, drier climates, as would be expected; however, regional climate classifications were not always found to be a good guide for siting EC rooms due to local and microclimate variability.