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Chilling injury of large cardamom (*Amomum subulatum* Roxb.) in high altitudes of Sikkim and Darjeeling, India

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Abstract

Manifestations of cold temperature damage on large cardamom (*Amomum subulatum* Roxb.) was monitored at Pangthang (2160 m MSL), East Sikkim during the winter seasons (October–March) of 2006–10. Damage to plant tissues, mainly leaves, occurred during prolonged cold wave conditions (below 6°C) that prevailed during December–February. Tiny pin prick like water soaked lesions appeared on the lamina, coalescing to form a large patch that died and turned pale brownish and served as infection court for fungal pathogens. Extreme frosting on leaves was more common in exposed areas without shade trees.

Keywords: extreme frosting, fungal pathogens, low temperature damage, winter

Large cardamom (*Amomum subulatum* Roxb.) (Zingiberaceae) is indigenous to moist, deciduous and evergreen forests of sub-Himalayan tracts and is the main cash crop cultivated in Sikkim and Darjeeling hills of West Bengal, India. The crop is commonly grown on sloped land or terraces made on steep hills. The large cardamom growing tract along the hill gradient is often divided into lower (< 1000 m MSL), mid (1000-1500 m MSL) and high (> 1500 m MSL) altitudes. The microclimate of these altitudes greatly influences crop health, physiology and production. Large cardamom is affected by various biotic and abiotic stresses at all altitudes and these factors are mainly responsible for poor plant health and production in certain regions. In this paper, we describe the chilling injury affecting large cardamom during winter at high altitudes of this region.

Observations on the effect of cold temperature to large cardamom was recorded at Indian Cardamom Research Institute Research Farm at Pangthang (2160 m MSL), East Sikkim during the winter seasons (October–March) of 2006–07, 2007–08, 2008–09 and 2009–10. The cultivars under observation were Sawney and Varlangey (8–10 years old). Visual changes on the plant tissues were noted. The weather data from the Research Farm Observatory was used for interpreting its effect on the plant. Random

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field expeditions were also undertaken to high (Gumbadara, Kalimpong, Darjeeling; Ravangala, South Sikkim; Pelling, West Sikkim) mid (Assam Lingzey, East Sikkim) and lower (Dzongu, North Sikkim; Rongli, East Sikkim) altitudes for monitoring the effect of low temperature on the crop. The affected tissues were collected and checked for the occurrence of secondary colonizers by following standard tissue plating method on potato dextrose agar.

Damage to plant tissues, mainly leaves, occurred during prolonged cold wave conditions (below 6°C) that prevailed during December–February (Fig. 1a & b). These conditions were beyond the agro-climatic requirements of the crop (Kashyapi 2004; Gupta & Das 2006). When the cold wave occurred, tiny, pin-prick like water soaked lesions appeared on the leaf lamina which enlarged and coalesced to form a large patch and later died turning pale brownish in colour (Fig. 2a). Severe cold at night and mild frosting followed by clear sunny day sometimes resulted in mild yellowing and scorching of leaves which hastened up the process of browning. Frost bands, consisting of discolored, corky tissue in a band or large area of the leaf surface were often produced after a late frost (Fig. 2b). Random field expeditions and monitoring showed that chilling injury did not occur at mid or low altitudes where comparatively higher temperature prevailed (12°C and above). In addition to direct damage caused by low temperature, the dead tissues also served as infection court for fungal pathogens such as *Colletotrichum gloeosporioides* (Penz.) Sacc., *Pestalotiopsis versicolor* (Speg.) Steyaert and *Alternaria dianthi* F. Stevens & J. G. Hall. The first two are important pathogens of the crop causing blight and leaf streak, respectively and

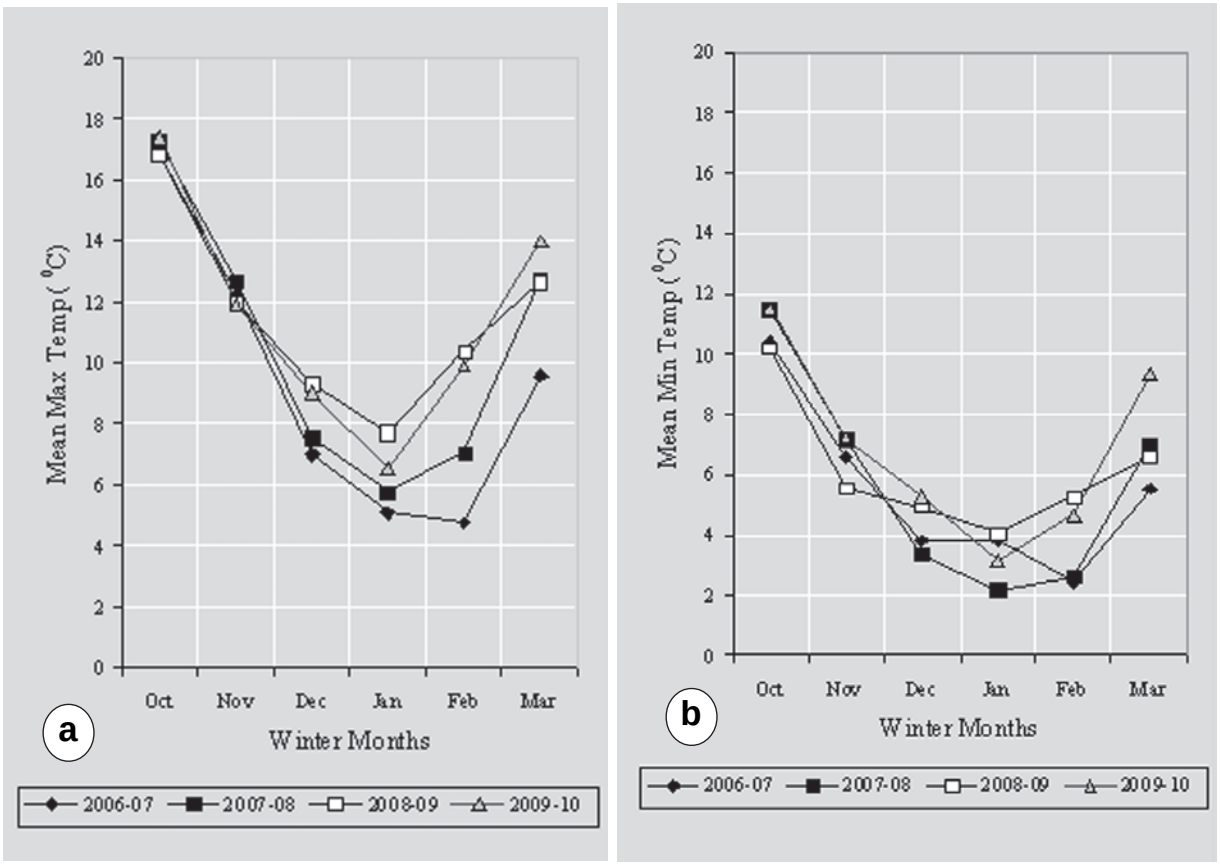

Fig. 1 Temperature (°C) recorded during the winter season of the study period
a. Monthly mean maximum temperature; b. Monthly mean minimum temperature

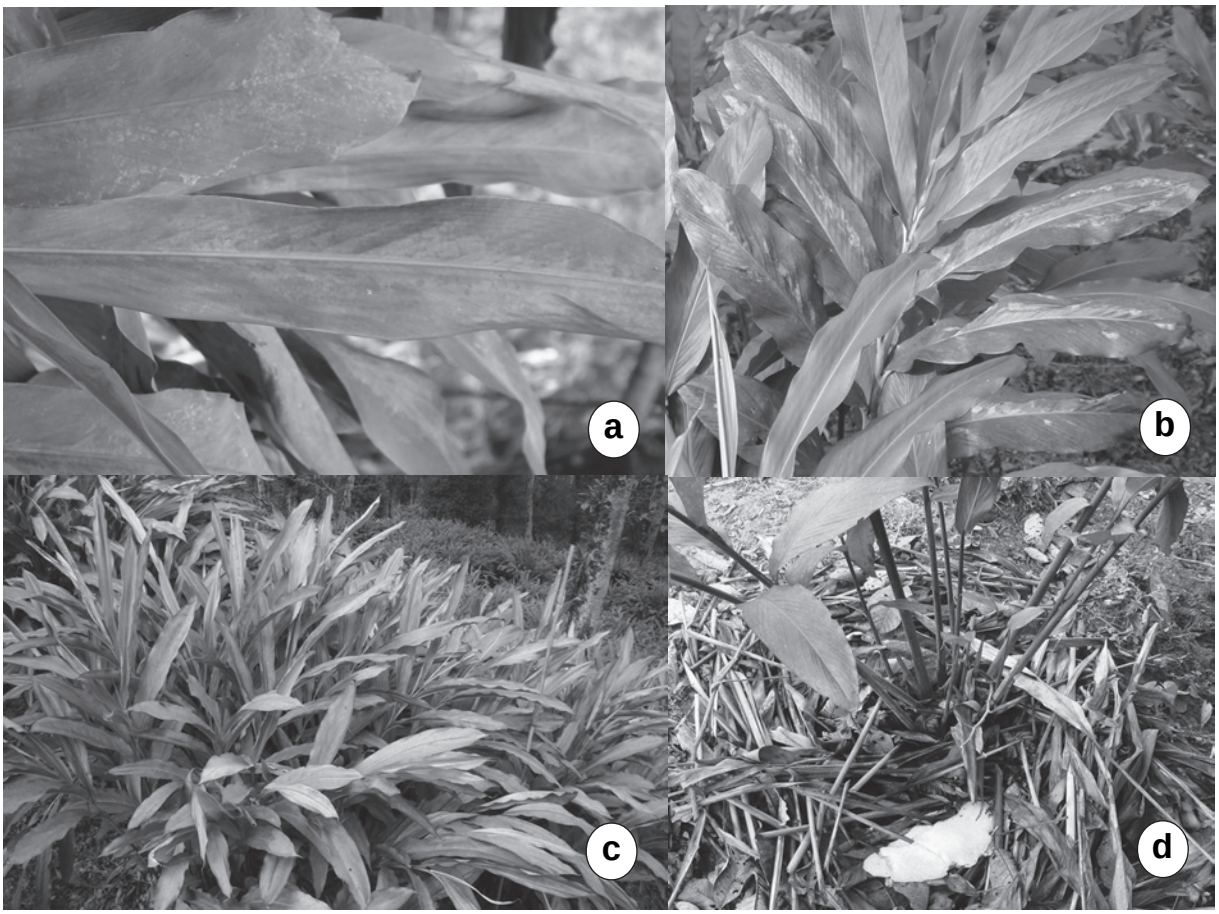

Fig. 2 Chilling injury of large cardamom.
(a) Foliar browning formed by coalesce of pin pricked areas; (b) 'Band' like appearance of injury on leaves; (c) Severe browning (burnt up appearance) of leaves in exposed area; (d) Ice formation at plant base

A. dianthi is a minor pathogen (Saju *et al*. 2010; Saju & Deka 2011; Srivastava & Verma 1989). Towards the end of the winter season, fungal colonization on the tissue could be seen as black dots. Cold damage was more severe on leaves in the exposed areas without shade trees (Fig. 2c). Ice formations were also common at night and when it happened around the plant base, it led to drying of the clump after the winter (Fig. 2d). Chilling injury was comparatively less in protected areas with agro-shade net and under trees having spread out canopies. In general, low temperature injures plants primarily by inducing ice formation between or within the cell walls (Agrios 2006). In order to avoid the risk, agro-shade net cover was being used as protection over genetic resources collection during winter and spring in government farms. Other than large cardamom, few *Zingiberaceous* plants also showed the chilling injury symptoms in the vicinity of the study area. It is inferred that sensitivity to low temperature is probably due to the origin and domestication of the crop at mid or lower altitudes where cold wave conditions did not occur. Chilling injury is a production constraint in many horticultural crops of tropical and subtropical origin (Lyons 1973; Couey 1982; Morris 1982).

During the onset of spring and summer rains in April–May the dried plant parts starts decaying and these symptoms could be mistaken for disease in an advanced stage. Chilling injury of large cardamom is a regular phenomenon year after year that has not been documented so far.

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