the needle surface increased with decreasing wavelengths which is consistent with Rayleigh-type scattering (Day *et al.*, 1992).

High short-wavelength reflection with lesser reflection in the longer visible wavelengths permits specific screening of UV without reducing the availability of visible light for photosynthesis. A 25% reduction of UV radiation by reflection as demonstrated in *P. pungens*, however, would screen the UV rather inefficiently and appears unimportant compared to the highly efficient UV-screening capacity of many conifer needles (Day *et al.*, 1992; Fischbach *et al.*, 1999). Similarly, data from other species suggests that high UV reflection in glaucous leaves is relatively insignificant in UV screening. Glaucous leaves of *Echeveria* sp. reflected 20% of UV radiation (Robberecht *et al.*, 1980), and UV reflectance of 25 and 35% was determined for glaucous leaves of two *Eucalyptus* species (Holmes and Keiller, 2002). In leaves of *Triticum turgidum*, reflectance in the visible range increased with the amount of epicuticular wax but always remained below 30% at 400 nm which was the shortest wavelength used in this study (Johnson *et al.*, 1983). *Sorghum bicolor* leaves, with a dense filamentous wax surface, also reflected 25% of UV-B radiation (Grant *et al.*, 2003).

On the other hand, powdery epicuticular waxes on leaves of the succulent rosette-plant *Dudleya brittonii* provided appreciable protection against UV but also against visible radiation with reported reflectances of 80% in the UV and 60–70% in the visible range (Mulroy, 1979). Wax removal reduced reflectance to that of naturally occurring, non-glaucous leaves of *D. brittonii*. *Kalanchoe pumila*, like *D. brittonii*, is a Crassulaceae species and also has the powdery wax surface associated with relatively high reflectance values. Young leaves reflected 40% of blue radiation between 400 and 500 nm but only 5% after removal of epicuticular waxes (Eller and Willi, 1977). Reflection of visible radiation by developed leaves of *Cotyledon orbiculata*, also a Crassulaceae, was 60% and was reduced to 10% following wax removal (Barker *et al.*, 1997). Wax layers which reflect visible radiation efficiently, however, do not always exhibit high UV reflectance. In *K. pumila*, reflectance dropped from 33% at 500 nm to below 10% in the UV-B (Holmes and Keiller, 2002). The physical basis for the different reflectance characteristics is unresolved. In any case, high reflection of UV or of visible radiation by waxes forms a long-lasting shield against photo-stress which might confer advantages to plants growing under continuous excessive light intensities.

On the lower side of leaves of some species, epicuticular waxes have remarkably high reflectance of visible radiation (cf. Feldhake, 2002). It has been proposed that the lower surface of such leaves minimises loss of non-absorbed radiation by reflecting it back to the mesophyll (Smith *et al.*, 1997); fluorescence and fibre optics measurements, however, indicate that intensities of non-absorbed radiation at the lower mesophyll border are relatively small (Cui *et al.*, 1991; Bornman *et al.*, 1991; Vogelmann and Evans, 2002) so that back reflection would rescue little light. Indeed, when the lower epidermis was removed from leaves of four herbaceous species, only minor effects on leaf absorbance spectra in the visible range were observed (Lin and Ehleringer, 1983).