5 Noninvasive Quantification of Foliar Pigments
Principles and Implementation

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5.1 INTRODUCTION

Pigments are central to the functioning of photosynthetic apparatus and hence for all vital functions of plants. Green chlorophylls (Chl), represented by Chl a and b, the primary photosynthetic pigments, absorb light energy and eventually convert it into chemical energy in the form of electron flow [1–3]. Yellow-to-orange carotenoids (Car) are the accessory pigments that augment Chl in light absorption and serve the indispensable function of protection of the photosynthetic apparatus from photooxidative damage, mostly via elimination of reactive oxygen species and thermal dissipation of excessively absorbed light energy via operation of the xanthophyll cycle [1,4,5]. Foliar Car are usually represented by carotenoids, mostly β-carotene, and xanthophylls—lutein, zeaxanthin, violaxanthin, antheraxanthin, and neoxanthin [6]. The retention of carotenoids in the progress of chlorophyll breakdown has been suggested as a mechanism of photoprotection during leaf senescence [7,8]. Changes in leaf carotenoid content and its proportion to chlorophyll are widely used for diagnosing the physiological state of plants during development, senescence, acclimation, and adaptation to different environments and stresses [9].

Another widespread pigment group, flavonoids include red-colored anthocyanins (AnCs) and pale-yellow flavonols (Flv) important for optical shielding of plant tissues in the green and UV-to-blue regions of the spectrum, respectively [10–12]. In leaves, they localize in vacuoles of epidermal cells or those just below the adaxial epidermis, but occasionally also in the cells of abaxial epidermis, palisade, and spongy mesophyll [13]. The induction of AnC biosynthesis occurs as a result of deficiencies in nitrogen and phosphorus, wounding, pathogen infection, desiccation, low temperature, UV irradiation, and so on, so it is generally accepted that AnCs fulfill important physiological functions by being involved in adaptation to numerous stresses and environmental strain reduction [14–16]. Some lines of evidence suggest that the protective effects of anthocyanins