CHAPTER 1
INTRODUCTION

Bud necrosis (BN) of grapevines is a physiological disorder of the compound axillary buds of grapevines (Bains et al., 1981; Bindra and Chohan, 1975; Dry and Coombe, 1994; Hopping, 1977; Lavee, 1987; Lavee et al., 1981; Morrison and Iodi, 1990; Naito et al., 1986; Perez and Kliewer, 1990; Wolf and Warren, 1995). The disorder usually affects the primary buds, but occasionally the secondary buds will also abort. Primary buds produce the fruiting shoots for the following season. When primary buds abort, the secondary buds undergo further development and produce the following year's fruiting shoots. Shoots that develop from secondary buds typically have smaller and fewer fruit clusters. Therefore, the crop yield of secondary shoots is lower than that of primary shoots.

BN has been associated with high rates of shoot growth and large cane diameter (Dry and Coombe, 1994; Lavee, 1987; Lavee et al., 1981; Wolf and Warren, 1995), excessive irrigation (Bindra and Chohan, 1975; Perez, 1991), low carbohydrate levels in bud tissues (Naito et al., 1987), shading of buds (Perez and Kliewer, 1990; Wolf and Warren, 1995), and high gibberellin-like activity in buds (Lavee, 1987; Ziv et al., 1981). Excessive irrigation and high gibberellin-like activity may increase shoot vigor, which under certain conditions, may result in localized carbohydrate deprivation in sink organs or tissues. Shading has also been reported to reduce the rate of whole vine photosynthesis leading to carbohydrate deprivation (Cartechini and Palliotti, 1995). There are conflicting reports regarding the effect of shoot thinning on BN. Shoot thinning increased BN in 'Shiraz' in Australia (Dry and Coombe, 1994) and decreased BN in another cultivar, 'Thompson Seedless' in Chile (Perez and Kliewer, 1990). It was suggested that shoot thinning might have resulted in an increased vigor in the remaining shoots because under situations of severe stress the carbon reserves are mobilized into the remaining shoots (Koblet et al., 1993). However, shoot thinning also improves the light penetration within the vine canopy and may, under certain conditions (Perez and Kliewer, 1990), decrease BN incidence. Thus, the literature on BN remains equivocal as to possible causes.

As shoot vigor and shade have been reported to cause BN, it was hypothesized in this study that carbohydrate and/or mineral nutrient deprivation in the axillary buds is responsible for the occurrence of BN. As shoot growth starts in spring, the growing shoot tip is the dominant sink until fruit set and fruit ripening, after which fruit clusters become very strong sinks (Edson et al., 1995; Motomura, 1990). Under stress situations, carbon reserves are translocated to the growing shoot tips and developing fruit clusters at the expense of the other plant parts such as the axillary buds (Koblet et al., 1993). Therefore, to characterize and study the role of carbohydrate and mineral nutrient deprivation in BN incidence, a series of experiments were conducted from 1993 to 1996 with 'Riesling'. 'Riesling' is very important in Virginia and is affected by BN in every vineyard examined (Wolf and Warren, 1995).

One objective of this project was to characterize the anatomical developments of BN in ‘Riesling’ (BN-prone) vines, with respect to temporal patterns of development and comparison to a BN-insensitive cultivar, ‘Chardonnay’. A second objective was to explore the possible role of localized mineral nutrient or carbohydrate deprivation in BN incidence in ‘Riesling’ grape buds. Localized carbohydrate deprivation was attempted by artificial shading. Changes in carbohydrate levels in bud tissues of ‘Riesling’ vines were also attempted by shoot tip removal. Starch accumulation patterns in buds of a range of cultivars (‘Riesling’, ‘Viognier’, ‘Syrah’, and ‘Chardonnay’) expressing differential BN-sensitivity was also examined.

Chapter 2 reviews the existing literature on BN in grapevines. Causal factors associated with grapevine BN in different cultivars from different parts of the world are compared and contrasted.

Chapter 3 describes anatomical observations in the onset and development of BN in ‘Riesling’ (BN-prone) and ‘Chardonnay’ (BN-insensitive) grapevines. Anatomical studies were done using both light and scanning electron microscopy.

Chapter 4 describes the possible role of localized carbohydrate and mineral nutrient deprivation in BN incidence in ‘Riesling’ and ‘Chardonnay’ grapevines. Localized carbohydrate deprivation in bud, leaf, and stem tissues was attempted by artificial shading and shoot-tipping. Carbohydrates were analyzed by High Performance Liquid Chromatography (HPLC). ‘Riesling’ and ‘Chardonnay’ vines were surveyed for levels of mineral nutrients and carbohydrates in bud, leaf, and stem tissues. A visual starch assessment was made of buds of four cultivars showing differential BN sensitivity.

Chapter 5 summarizes the results of anatomical observations in BN onset and development, experiments with shade and shoot-tipping, and mineral nutrient and carbohydrate surveys of ‘Riesling’ vines in Virginia.

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