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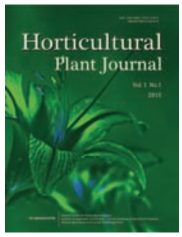

Preliminary Study of the Characteristics of Several Glossy Cabbage (*Brassica oleracea* var. *capitata* L.) Mutants

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Abstract

To determine the characteristics and potential practical applications of glossy cabbage (*Brassica oleracea* var. *capitata* L.) mutants, five different glossy mutants were studied. The amount of epicuticular wax covering the mutant leaves was only approximately 30% that of the wild-type (WT) leaves. The wax crystals of WT plants were columnar and linear, while they were granular and rod-shaped in the mutants. Additionally, in WT cabbage, the primary wax components were alkanes, alcohols, fatty acids, ketones, and aldehydes. There was a significant decrease in the abundance of alkanes and ketones in the wax of the mutants. The glossy-green trait of the mutants may be the result of an inhibited alkane-forming pathway. Higher rates of chlorophyll leaching and water loss demonstrate that the mutant leaves were more permeable and sensitive to drought stress than the WT leaves. Growth curve results indicated that the growth rate of *mutant-1* and *mutant-3* was slower than that of the corresponding WT cabbage, resulting in shorter plants. However, the growth rate of *mutant-2* was not influenced by the lack of coating wax. An investigation of the agronomic traits and heterosis of the glossy cabbage mutants indicated that all five mutants had glossy-green leaves, which was a favorable characteristic. The F_1 plants derived from crosses involving *mutant-2* exhibited obvious heterosis, suggesting the observed glossy-green trait is controlled by a dominant gene. Therefore, *mutant-2* may be useful as a source of genetic material for future cabbage breeding experiments.

Keywords: cabbage; glossy mutant; agronomic trait; microstructure; wax component

1. Introduction

The outer cabbage leaves are coated with an epicuticular wax layer, which is very important as the first line of defense against externa1 factors. Color of wild-type (WT) cabbage leaves are green, gray green, or blue green, but wax-deficient mutants appear glossy-green because of the lack of wax. The glossy cabbage mutant has some favorable characteristics over WT cabbage such as a crispier texture and a greater abundance of sugar, vitamin C, and dry matter (Chu and Wang, 1993; Li et al., 2012; Liu et al., 2014).

Plant cuticular wax production involves a series of complex processes, including the biosynthesis of various wax components, transportation of products, and regulation of the signal involved in wax biosynthesis. Cuticular wax is composed mainly of very long chain fatty acids (VLCFAs) and

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their derivatives, including alkanes, primary and secondary alcohols, aldehydes, ketones, and alkyl esters (Samuels et al., 2008; Buschhaus & Jetter, 2011). The steps involved in cuticular wax biosynthesis are as follows: (1) synthesis of C16/C18 fatty acids in plastids, (2) extension of the C16/C18 fatty acids to form VLCFAs, (3) and differentiation of the VLCFAs into wax components via the alcohol- and alkane-forming pathways. Primary alcohols and alkyl esters are produced in the alcohol forming pathway and aldehydes, alkanes, secondary alcohols, and ketones are generated in the alkane-forming pathway (Bernard & Joubès, 2013).

Previous studies regarding the glossy cabbage mutant have usually focused on only one mutant. In this study, several glossy cabbage mutants collected from different regions and at different growth stages were analyzed. Differences in wax structure and content between the mutants and WT cabbage were investigated using scanning electron microscopy (SEM) and gas chromatography mass spectrometry (GC-MS). Examining cuticle permeability, growth, and agronomic characteristics enabled the characterization of the effects of wax deficiency on cabbage physiology. The observed heterosis associated with one of the mutants (i.e., *mutant-2*), whose wax-less trait was controlled by a dominant gene, may have practical implications for future attempts at breeding glossy cabbage cultivars.

2. Materials and methods

2.1. Material

This study was completed between July 2013 and December 2014 on the Beijing Nankou Farm at the Institute of Vegetables and Flowers of the Chinese Academy of Agricultural Sciences. Experimental materials included five glossy cabbage (*Brassica oleracea* var. *capitata* L.) mutants and three WT cabbage cultivars (Table 1, Fig. 1). Comparisons of heterosis were completed with the following crosses: *mutant-2* × 13Q-201, *mutant-2* × 13Q-208, *mutant-2* × 13Q-352, and *mutant-2* × 13Q-508. The waxy parents, 13Q-201, 13Q-208, 13Q-352, and 13Q-508, were inbred lines.

Table 1 Glossy cabbage mutants and wild-type cabbage

Material No.	Material name	Inheritance of glossy trait
mutant-1	21-3you	Single recessive
WT-1	21-3	
mutant-2	10Q-385you	Single dominant
WT-2	10Q-385	
mutant-3	10Q-961	Single recessive
WT-3	10Q-962	
mutant-4	11Q-Ld1	Single recessive
mutant-5	10Q-960	Double recessive

Fig. 1 Five glossy cabbage mutants, three wild-type cabbage plants, a hybrid parent (13Q-208), and an F_1 plant