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Adoption of table grape cultivars: An attribute preference study on Chinese grape growers

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ABSTRACT

Cultivars are a main agricultural material in the table grape production chain. China has the largest number of table grape growers in the world, but their cultivar-adoption preferences are largely unknown. We aimed to fill this gap. A questionnaire study, in-depth interview and photograph test were carried out with 1045 table grape growers in the main growing regions of China, and results were validated by table grape cultivar research publications. Results revealed good yield, high disease resistance, high berry sugar content (19–20°Brix), large berry size, compact cluster and strong transport/storage potential as the top criteria in Chinese grape growers' cultivar adoption. Deep red to dark purple colour was preferred to light-colour selections; round to oval shape and strong Muscat flavour were welcomed. Seedlessness was a low-weighted attribute. Chinese grape growers are highly willing to adopt new table grape cultivars. In addition to featured consumption attributes, they emphasize production attributes and risk-control management in their adoption decision-making. Our results provide first information on table grape cultivar adoption in China. The outlined multi-trait adoption indexes could be useful to international and domestic table grape breeders and nurseries at both strategic and tactical levels.

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1. Introduction

Grape is a crop of major economic importance. Worldwide, around 20 million tons of table grapes were produced in 2014. China ranks as the largest table grape producer with its 9 million tons harvest for that year (USDA Foreign Agricultural Service, 2015). There are an estimated 2.9 million farmers growing table grapes on 540 thousand hectares, and on average, around 200 million new vines are planted by growers every year (Chairman of Chinese Grape Growers' Association, personal communication).

Grape growers are direct consumers of table grape cultivars. Growers have an integral and pivotal dual role in the sustainability of the globalized table grape-production chain, as primary consumers of cultivars and other agricultural materials such as fertilizers, pesticides and farm machinery, and as suppliers of a grape commodity. In this unique role, which differs from that of the final consumers who purchase agricultural products by mainly evaluating consumption attributes, growers will consider production

attributes as key factors in their cultivar-adoption decision-making (Jaeger et al., 2011; Robertsnkrumah and Badrie, 2005). The separation between consumption and production decisions has been well acknowledged in fruit crops (Edmeades, 2003).

Grape growers may have markedly different cultivar-selection criteria than breeders or nurseries. Previous research on crops in both developed and developing countries has demonstrated that farmers use a different and more complicated set of biological and economic criteria than breeders in cultivar evaluation; their choice is also strongly influenced by other factors in the agricultural supply chain, such as agrichemical and extension services (Haugerud and Collinson, 1990; Sperling et al., 1993; Mulatu and Zelleke, 2002; Vanloqueren and Baret, 2008; Macholdt and Honermeier, 2016).

A good number of public and private breeding programmes are run in major table grape countries/regions by universities, research institutes, companies and individual breeders (Wei et al., 2002; Reisch et al., 2012; Correa et al., 2016; Masahiko and Akihiko, 2016). Grape breeding is a costly and time-consuming process (Karaagac et al., 2012), in which nurseries are also heavily invested, facing strong competition (Golino, 2000). Against this background, an understanding of farmers' cultivar-adoption choices could increase the efficiency of breeding programmes and nurseries, their

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likelihood of producing cultivars that are acceptable to farmers, and the adoption of new breeding lines (Joshi and Witcombe, 1996).

In the present study, we administered a questionnaire and a grape-cluster photo preference test to 1045 table grape growers in major growing regions in China to determine the key attributes of the most preferred/desired table grape cultivars in China. Furthermore, Chinese publications on table grape cultivars from 2013 to 2015 were collected and the characteristics of the most popular cultivars were carefully abstracted to provide a reference to validate the growers' answers. It was found that Chinese table grape growers have a strong willingness to adopt new cultivars; they use a set of production and consumption attribute parameters in their cultivar adoption decision-making and risk control. Our results can be used to refine table grape breeding goals and improve the efficiency of marketing new cultivars, facilitate the production of market-tailored grapevine materials by nurseries, and add in-depth knowledge of Chinese table grape cultivars consumers' cultivar-adoption preferences in the world table grape industry.

2. Materials and methods

2.1. Survey by questionnaire

The survey was carried out by face-to-face interviews in the main table grape-growing regions of China. So that the present survey results would be comparable with our previous consumer preference investigation, the questionnaire used by Zhou et al. (2015) was adopted with modifications to gain viticultural performance-related information. In brief, growers' basic and background information was collected. For all preference tests, a 9-point Likert-type scale was used, with 1 representing 'dislike/strongly disagree' and 9 'like/strongly agree'. The collected data were input into Excel (Microsoft) spread sheets, and categorised under the different provinces and regions for overall statistics and regional data statistics, respectively. To measure and rank the relative importance of 13 attributes of table grape cultivars, a best–worst choice test was carried out and analysed as in previous publications (Finn and Louviere, 1992; Marley and Louviere, 2005; Zhou et al., 2015).

2.2. Photo preference test for grape extrinsic attributes

Twelve photographs of grape clusters, including nine of representative table grape selections and three of major/popular growing cultivars, i.e., Red Globe, Shine Muscat and Summer Black, were used in the preference test. None of the photographs indicated cultivar, selection name or breeder information. The growers were shown the 12 photographs in a rotating colour sequence, and were asked to score their preferences on six extrinsic attributes after having seen every photograph. The respondents were briefly asked if they had any additional comments, requirements or suggestions pertaining to extrinsic attributes of table grape cultivars.

2.3. Data analysis

Separate statistical analyses were carried out for each survey question. The average, variance, distribution and correlation were calculated using all valid questionnaires. Principal component analysis (PCA) was carried out using SPSS software to elucidate the main attributes affecting growers' preferences; the process and algorithm were the same as in Zhou et al. (2015). Aside from the overall data analysis, to further determine whether any one growing region had different preferences for the table grape attributes of interest, answers to specific questions were statistically analysed at the province level.

2.4. Attributes of successful table grape cultivars: validation by literature statistics

To validate the results from the investigation of growers, a statistical analysis of the literature was performed. Using 'table grape' as the key word, Chinese scientific journals from 2013 to 2015 were searched and articles were downloaded from the China Knowledge Resource Integrated Database (www.cnki.net). These were then manually screened and sorted. Table grape cultivars studied in qualified reports were listed on Excel sheets and information on extrinsic and intrinsic attributes of the cultivars was extracted and calculated.

3. Results and discussion

3.1. General information from the respondents

China grows table grapes in all of its provinces, at latitudes covering about 20°–45°N, and longitudes covering about 75°–130°E, with altitude differences of more than 3000 m. Growers vary considerably in terms of their environmental conditions, viticulture requirements, targeted markets and other factors that could have a key influence on their adoption of table grape cultivars. We carried out interviews in the 16 top table grape-growing provinces in China (Fig. 1), according to the provincial grape acreage data published by the Chinese Agriculture Year Book.

Basic information on the 1045 grape growers who completed the questionnaire survey and grape photo preference test is summarized in Table 1. The majority of the respondents were 30–50 years of age, predominantly male, with almost half having a junior high school education or below, while 20% and 25%, respectively, were senior high school and college/university graduates. Though most of the respondents were self-employed small growers with vineyards of less than 1 ha, 155 and 255 respondents worked in grape companies and cooperatives, respectively, together making up 39.24% of the respondents. The results were in good agreement with the trend of increasing business scale and popularity of the agro-company-derived business model in the last few years. Furthermore, 41 respondents worked in over 100-ha production units and around 50% of the respondents used various protected cultivation facilities (greenhouse, high tunnel and so on) in their vineyards.

The top cultivars grown by the respondents were Kyoho, Red Globe, Summer Black and Thompson Seedless, while 47 cultivars in total were named when the respondents were asked to list one to three major ones in their vineyards; 332 and 270 respondents answered that only one or two cultivars, respectively, are grown in their vineyard, while the others had three or more cultivars. It is worth noting that a high proportion of the named cultivars were hybrids, such as Kyoho, Summer Black, Crystal (Niagara), Red Fuji and Shine Muscat; this can be explained by natural selection in a continental climate, where most of the annual precipitation occurs in the grape-growing season. Though seeded grapes were dominant, major grown seedless cultivars were Summer Black, Thompson Seedless, Flame Seedless, Crimson Seedless, Centennial Seedless, Fantasy Seedless and Mars. The major aromatic cultivars grown in the respondents' vineyards included Muscat Hamburg, Shine Muscat, Kyoho and other *vinifera-labrusca* hybrids. The two major finger berry cultivars—Manicure Finger and Gold Finger—grown in the respondents' vineyards are both *vinifera-labrusca* hybrids.

3.2. Preferences for extrinsic attributes

Grape growers' degree of preference for the eight indicated grape skin colours is shown in Fig. 2. Favourite colour was listed