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Evaluation of agronomic traits in Chinese wild grapes and screening superior accessions for use in a breeding program

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Summary

This study was conducted to evaluate 15 agronomic traits in 67 accessions of 13 Chinese wild *Vitis* species. The results have been used to screen superior accessions for grape breeding in the future. Chinese wild *Vitis* had high diversity in economic traits among the species, such as bud-burst date, blooming date, berry ripening date, bunch weights, berry weights, berry soluble solid contents, berry acid contents, and vine production. Bunch weights of 56 Chinese wild accessions and berry weights of 12 Chinese species (except *V. davidii*) were much smaller than those of the two European cultivars. In our 25-year of evaluation on disease resistance and economic qualities in this Chinese germplasm, we suggest that *V. quinquangularis*, *V. amurensis*, *V. yeshanensis*, *V. romanetii*, and certain accessions in *V. liubanensis* be the first potential materials chosen for breeding.

K e y w o r d s : China, grapes, disease resistance, berry qualities, breeding.

Introduction

The high morphological and genetic diversity of *V. vinifera* and the ease with which it is asexually propagated gave rise to an estimated number of more than 10,000 cultivars all over the world (ALLEWELDT and POSSINGHAM 1988). Most production cultivars are derived from *V. vinifera*, because of its high berry qualities (HE 1994, 1999 a and b, WANG *et al*. 1998). But *V. vinifera* is highly susceptible to fungal diseases, which causes heavy losses in grape production (BROWN *et al*. 1999 a, b and c, HE 1999 a). Grape breeders are making efforts to use germplasm to improve resistance of cultivars of *V. vinifera* and to breed new resistant cultivars for grape growers (ALLEWELDT and POSSINGHAM 1988, BROWN *et al*. 1999 b). A primary consideration for grape breeders is choosing germplasm exhibiting high resistance and high berry qualities for breeding new cultivars adaptable to the localities and acceptable by the growers (ALLEWELDT and POSSINGHAM 1988). Therefore, evaluating the germplasm and selecting the superior accessions from the germplasm are of primary importance for breeding programs (SPRANGUE 1980, ALLEWELDT and POSSINGHAM 1988, BROWN *et al.* 1999 b).

The *Vitis* genus contains more than 70 species naturally occurring in three geographical regions: 1) South Europe and Asia Minor, 2) East Asia, and 3) North and Central America (ALLEWELDT and POSSINGHAM 1988, HE 1994 and 1999 a). *Vitis* species having their origin in the Americas have been used for disease resistance breeding against the fungal diseases *Uncinula necator* and *Plasmopara viticola* which attack vines of *V. vinifera* grapes. Germplasm from the Americas commonly used for breeding include *V. labrusca, V. riparia, V. rupestris, V. aestivalis, V. cinerea, V. berlandieri,* and *V. champini* (ALLEWELDT and POSSINGHAM 1988).

As part of the diverse East Asia *Vitis* gene pool, China alone has more than 35 *Vitis* species occurring naturally, providing a wealth of undercharacterized genetic diversity (HE 1999, WANG *et al*. 1998). Chinese wild *Vitis* have extremely high resistance to *Elsinoë ampelina* (de Barry) Shear and *Glomerella cingulata* (Ston.) Spauld et Schrenk (WANG *et al.* 1998), and high resistance to *Uncinula necator* (Schw.) Burr. (WANG and HE 1997). This germplasm can be easily crossed with *V. vinifera* (HE 1999 a). Currently, the scope and depth of the utilization of Chinese wild *Vitis* germplasm is significantly less than that of species originating in North America (HE 1999 a and b). However, the desirable resistance genes in Chinese wild *Vitis* have attracted more grape breeders' attention recently (WANG *et al*. 1998). This study was conducted to evaluate Chinese wild germplasm and to screen superior materials from this germplasm with expectation that this research will lead to more informed use of Chinese wild grapes in breeding in the future.

Material and Methods

P l a n t m a t e r i a l s : Germplasm was obtained from the grape germplasm repository at the Northwest A&F University, Yangling, Shaanxi Province, China. The cuttings of wild grapes were collected in the fall of the years from 1979 to 1984 by the University grape research group led by Prof. PUCHAO HE. All wild grapes were grafted on a European grape 'Cabernet Blanc'. Three to five plants of each wild accession (original plants were five for each accession, but few plants died later) and five plants of two control cultivars were planted in the same location at the University repository.

E v a l u a t i o n o f f i f t e e n a g r o n o m i c t r a i t s : Three grape phenological dates were chosen for this study, surveying the plants every third day from early spring to late fall of each year, including: 1) bud-burst date of the vines, when 5 % of the winter buds of the overall

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vine burst out and exhibited a purple, velvet ball-like appearance, 2) blooming date, when 5 % of the flowers began blooming, and 3) berry-ripening date, when the content of the sugar in berries no longer increases while acidity does not decrease in the evaluated berries (He 1994). The data of phenological dates of Chinese wild grapes and two control European cultivars were collected every year from 1994 to 2003.

When berries were fully ripened, 15 bunches of each accession were arbitrarily harvested to investigate 12 items (He 1994), including: 1) cluster architecture (CD), categorized into 5 groups by putting the bunches on the tables to examine the change of bunch shapes afterwards. The grapes are extremely loose (EL), berries in the bunches were very loose allowing the cluster to flatten; loose (L), shapes of bunches significantly changed; middle (M), shapes of bunches had a little change; compact (C), shapes of bunches did not change and berries in the bunches lightly contacted each other; extremely compact (EC), berries in bunches contacted tightly with each other and the berry shape changed much by compacting each other, 2) bunch average weight (BuW), computed by weighing 15 arbitrarily chosen bunches to calculate their average value, 3) bunch rachis average weight (RW), calculated by weighing the rachis after the berries in the bunch above were removed, 4) berry colors (BC), grouped into 3 types, black (B), white (W), and red (R), 5) berry average weight (BeW), found by weighing 100 arbitrarily chosen berries to calculate their average value, 6) berry skin thickness (ST), categorized into 4 groups, thin (TN), the berry skin thickness was similar to that of 'Thompson Seedless'; middle (M), the berry skin thickness was similar to that of 'Muscat Hamburg'; thick (TK), the berry skin thickness was similar to that of 'Kyoho'; extremely thick (ETK), is thicker than that of 'Kyoho', 7) average seed number per berry (SN), calculated by counting seeds in 100 arbitrarily chosen berries to calculate its average, 8) percentage of berry juice (JP), calculated by the percentage of the weight of berry juice to the weight of berry, the weight of berry juice was determined by averagely measuring the weight of remains subtracted from the weight of 100 berries after the juice was squeezed completely from the berries, 9) soluble solid contents in berries (SC), measured by detecting the juice above using the Hand Saccharinmeter, 10) acidic acid contents in berries (AC), measured using the method of acidic-basic titration, the concentration was calculated as gram of tartaric acid per liter of fresh berry juice, 11) average vine production (VP), measured by harvesting and weighing all the berries (including the samples used above) on the vines of a accession to calculate an average of a vine of the accession, and 12) vine overall vigor (VV), calculated by overall vine size as measured by summer and winter pruning weight. This item was categorized into 5 groups - extremely vigorous (EV), the vine vigor was stronger than that of 'Kyoho'; vigorous (V), the vine vigor was similar to that of 'Kyoho'; middle (M), the vine vigor was similar to that of 'Muscat Hamburg'; weak (W), the vine vigor was similar to that of 'Zaojinxiang', a cultivar bred by Prof. He in 1974; extremely weak (EW), the vine vigor was weaker than that of 'Zaojinxiang'.

Data of the 12 items above were collected every year from 1994 to 2003. The average values of each item were used to evaluate the quality of the germplasm.

Results and Discussion

Phenological dates of Chinese wild grapes: Three phenological dates, the bud-burst date, the blooming date, and the berry-ripening date, in Chinese wild *Vitis* germplasm varied greatly among the species, ranging, in Yangling, from early March to late April, from mid-April to early June, and from mid-July to mid-September, respectively. Most Chinese *Vitis* species undergo budburst one month earlier than *V. vinifera.* Of 13 Chinese species, the bud-burst date of *V. amurensis, V. romanetii,V. bashanica,* and *V. adstricta* was among the earliest, in early March. *V. davidii var. cyanocaarpa* was the latest, being late April. *V. amurensis, V. romanetii,* and *V. adstricta* bloomed early, in mid-April. *V. quinquangularis*, and *V. davidii var. cyanocarpa* bloomed very late, in early June. Most Chinese species ripened their fruits earlier than the two European grape cultivars. But *V. quinquangularis*, *V. davidii*, and *V. davidii var. cyanocarpa* ripened very late, in middle September.

Fruit qualities in Chinese wild grapes: Berries of Chinese *Vitis* germplasm exhibit 3 berry colors, black, red, and white with most species being black. In *V. quinquangularis*, there are two berry colors, black and white. Berries of *V. davidii* are red or dark red.

Bunches of all Chinese *Vitis* species were much maller than those of the two control cultivars of *V. vinifera*. The bunch average weight of most species was less than 60 g. Bunches of *V. davidii* were relatively large, averaging 91.1 g. Bunches of *V. bashanica*, and *V. piasezkii* were relatively small, 33.9 g and 32.3 g, respectively. Except *V. davidii,* berries of other Chinese *Vitis* species were also smaller than those of the two *V. vinifera* cultivars. Of all wild species, soluble solid contents in *V. quinquangularis* berries are the highest, ranging from 17.0 to 18.7. While soluble solid contents (SSC) in berries of most Chinese species were lower than those in the control cultivars, their acidic contents were higher than those in the control cultivars. Berry juice contents of most Chinese species were similar to those of the two *V. vinifera* cultivars. Berry skin of most wild species was thick. Most Chinese wild grapes contain 2-3 seeds per berry. Vines of most wild species grow vigorously in natural conditions (Table).

Screening superior accessions for use in a breeding program: Given the importance of berry quality in breeding, grape breeders utilize germplasm containing high quality in berries to endeavor to breed new cultivars and to improve the resistance in the current major cultivars derived from *V. vinifera* (Alleweldt and Possingham 1988). After our 25-year of evaluation of resistance and berry qualities in Chinese wild grapes, we concluded that 'Helongjiang', 'Huaxian-47' (*V. amurensis*); '83-4-96', 'Weinan-3', 'Shangnan-24', '83-4-49' (*V. quinquangularis*), 'Pingli-2', 'Baihe-22', 'Jiangxi-2', 'Pingli-7' (*V. romanetii*); 'Liuba-8', 'Yanshan-2' (*V. yeshanensis*) are

T a b l e

Agronomic traits of accessions of Chinese *Vitis* under natural conditions in Yangling (1994-2003)

	BB[f] dd/mm	BD[g] dd/m	RD[h] dd/m	CD[i]	BuW[j] (g)	RW[k] (g)	BC[l]	BeW[m] (g)	ST[n]	SN[o]	JP[p] (%)	SC[q] (%)	AC[r] (g/l)	VP[s] (kg)	VI[t]
V. amurensis Rupr.															
Shuangyou-H[w]	8/3-14/3	19/4-27/4	2/8-8/8	C	80.0	3.2	B	1.35	TK	3.14	76.7	17.0	18.3	7.2	V
Tonghua No.3-♀[x]	5/3-12/3	22/4-26/4	5/8-13/8	C	59.6	3.3	B	1.40	TK	2.60	70.5	15.0	25.6	5.0	V
Zuoshan No.1-♀	6/3-11/3	23/4-27/4	4/8-10/8	C	52.4	4.8	B	1.23	TK	2.97	65.6	16.0	22.6	4.8	V
Zuoshan No.2-♀	8/3-14/3	23/4-27/4	1/8-8/8	C	53.5	3.5	B	1.48	TK	2.45	63.2	15.5	23.8	4.7	V
Zuoshan 75097-♀	5/3-12/3	20/4-25/4	1/8-8/8	C	51.5	3.8	B	1.36	TK	3.18	69.8	15.0	23.4	4.7	V
Zuoshan74-1-326-♀	5/3-12/3	20/4-25/4	1/8-7/8	C	56.7	3.9	B	1.30	TK	3.66	68.7	16.2	18.9	4.9	V
Heilongjiang-♂[y]	5/3-12/3	18/4-23/4	—	—	—	—	—	—	—	—	—	—	—	—	V
Taishan-11-♀	6/3-12/3	18/4-23/4	4/8-10/8	C	49.2	3.4	B	1.45	TK	3.02	66.0	16.2	21.5	4.8	V
Huaxian-47-♀	6/3-12/3	23/4-28/4	2/8-10/8	C	45.3	3.2	B	1.37	TK	3.12	65.7	16.4	23.4	4.6	V
V. quinquangularis Rehd															
Nanzheng-1	30/3-6/4	10/6-14/6	4/9-12/9	C	58.6	3.8	B	0.90	TK	2.44	65.7	17.3	21.75	4.4	V
83-4-96-♂	29/3-6/4	7/6-11/6	—	—	—	—	—	—	—	—	—	—	—	—	V
83-4-96-♀	28/3-5/4	7/6-11/6	5/9-12/9	C	63.9	4.5	B	0.90	TK	2.09	65.4	18.7	26.4	4.4	EV
Danfeng-2-♀	1/4-7/4	9/6-13/6	4/9-10/9	C	52.5	3.5	W	0.85	TK	2.45	67.8	17.4	23.6	4.1	V
83-4-49-♀	28/3-5/4	7/6-11/6	4/9-10/9	C	65.7	4.2	B	0.95	TK	2.26	63.2	18.6	24.3	4.5	V
83-4-94-♂	28/3-5/4	7/6-11/6	—	—	—	—	—	—	—	—	—	—	—	—	V
83-4-94-♀	28/3-5/4	7/6-11/6	5/9-12/9	C	64.3	4.4	W	1.06	TK	2.25	85.9	18.2	25.6	4.5	EV
83-4-67-♀	29/3-6/4	7/6-11/6	4/9-10/9	C	50.7	4.2	B	0.84	TK	2.24	64.1	18.4	27.7	4.5	EV
Shangnan-24-H	28/3-5/4	9/6-13/6	4/9-10/9	M	58.5	3.8	W	0.86	TK	2.52	69.6	17.0	25.1	4.5	EV
Taishan-12-♀	29/3-6/4	8/6-12/6	5/9-12/9	C	50.9	3.6	B	0.72	TK	2.06	65.1	18.5	26.6	4.1	EV
Weinan-3-♀	2/4-8/4	9/6-13/6	10/9-15/9	M	58.6	3.5	B	0.82	TK	2.86	67.9	18.3	25.8	5.2	EV
V. romanetii Roman															
Pingli-2-♀	7/3-14/3	20/4-24/4	26/7-2/8	C	60.8	6.9	B	1.18	TK	3.04	69.7	15.4	18.2	4.4	V
Jiangxi-1-♀	7/3-14/3	19/4-23/4	31/7-5/8	C	65.6	6.6	B	1.20	TK	2.88	71.0	18.9	21.3	4.4	EV
Jiangxi-2-♂	8/3-15/3	20/4-24/4	—	—	—	—	—	—	—	—	—	—	—	—	V
Jiangxi-2-♀	8/3-15/3	20/4-24/4	2/8-7/8	L	37.6	6.5	B	0.97	TK	2.64	66.9	15.4	22.3	2.2	V
Baihe-22-♀	9/3-16/3	18/4-22/4	7/8-12/8	M	51.2	8.5	B	1.14	TK	2.58	64.8	15.5	20.2	3.2	V
Liuba-1-♀	9/3-16/3	25/4-29/4	4/8-11/8	M	32.1	6.5	B	1.03	TK	2.61	63.2	14.5	22.6	3.8	V
Pingli-7-♀	7/3-14/3	25/4-29/4	5/8-10/8	M	82.7	7.6	B	1.14	TK	2.42	67.7	17.1	18.6	3.8	EV
V. adstricta Hance.															
Anlin-1-♂	5/3-12/3	26/4-30/4	—	—	—	—	—	—	—	—	—	—	—	—	V
Anlin-2-♀	5/3-12/3	26/4-30/4	31/7-6/8	C	25.7	2.8	B	0.66	M	3.10	66.7	14.8	10.83	3.5	V
Taishan-1-♂	6/3-12/3	25/4-30/4	—	—	—	—	—	—	—	—	—	—	—	—	V
Taishan-2-♀	5/3-12/3	25/4-30/4	31/7-6/8	C	30.1	2.9	B	0.61	M	2.74	72.9	14.2	11.2	3.8	V

Table, continued

	BB[f] dd/mm	BD[g] dd/m	RD[h] dd/m	CD[i]	BuW[j] (g)	RW[k] (g)	BC[l]	BeW[m] (g)	ST[n]	SN[o]	JP[p] (%)	SC[q] (%)	AC[r] (g/l)	VP[s] (kg)	VI[t]
V. piasezkii Maxim															
Liuba-6-♀	12/3-18-3	25/4-29/4	6/8-10/8	EL	31.0	3.9	B	1.03	TK	1.54	68.8	16.1	19.2	2.6	M
Liuba-7-♀	12/3-18-3	24/4-28/4	8/8-12/8	EL	27.0	3.6	B	0.95	TK	1.74	60.8	16.9	23.6	2.7	V
Liuba-8-♀	12/3-18-3	24/4-28/4	7/8-11/8	EL	31.7	3.8	B	1.03	TK	1.80	71.2	15.4	19.9	2.6	M
Liuba-9-♀	12/3-18-3	25/4-29/4	30/7-5/8	EL	37.5	3.5	B	0.93	TK	1.94	60.7	17.0	25.5	1.2	V
Nanzheng-2-♀	14/3-21/3	21/4-25/4	8/8-14/8	L	32.5	3.4	B	1.05	TK	1.67	62.3	18.2	22.6	2.8	V
Huaxian-1-♀	16/3-22/3	24/4-28/4	9/8-15/8	L	30.8	3.4	B	0.95	TK	1.80	65.0	18.0	23.5	2.9	V
Baishui-40-♀	15/3-21/3	23/4-27/4	6/8-10/8	EL	34.3	3.6	B	1.02	TK	1.74	65.6	17.9	23.1	3.3	V
Meixian-6-♀	18/3-24/3	19/4-23/4	3/8-8/8	L	37.1	3.7	B	1.07	TK	1.53	64.3	16.5	20.7	3.4	V
Gansu-91-♀	16/3-24/3	24/4-28/4	80/8-12/8	EL	28.7	3.6	B	0.90	TK	1.46	61.7	16.1	20.9	2.7	V
V. pseudoreticulata W. T. Wang															
Huan-1-♀	5/4-12/4	3/6-8/6	29/8-4/9	M	44.8	2.2	B	0.72	TN	2.06	64.8	16.0	17.4	3.5	V
Baihe-35-1-♀	30/3-6/4	2/6-6/6	26/8-30/8	C	45.6	2.3	B	0.87	TN	2.41	68.7	16.3	19.6	3.5	V
Baihe-35-2-♂	1/4-7/4	31/5-4/6	—	—	—	—	—	—	—	—	—	—	—	—	V
Guangxi-1-♀	28/3-5/4	31/5-4/6	23/8-28/8	C	48.0	2.2	B	0.87	TN	2.72	68.9	17.0	16.3	3.7	EV
Guangxi-2-♂	1/4-7/4	3/6-7/6	—	—	—	—	—	—	—	—	—	—	—	—	V
Baihe-13-♀	30/3-6/4	30/5-3/6	28/8-5/9	C	54.8	1.8	B	0.73	TN	1.92	65.5	15.8	16.3	4.1	EV
Baihe-13-1-♀	29/3-5-4	2/6-6/6	25/8-29/8	M	42.9	2.0	B	0.86	TN	2.38	68.3	14.5	18.4	3.4	V
Shangnan-1-♀	29/3-5-4	3/5-7/6	27/8-4/9	M	40.5	1.8	B	0.86	TN	1.97	68.9	17.2	19.7	3.3	V
Shangnan-2-♂	30/3-6/4	30/5-3/6	—	—	—	—	—	—	—	—	—	—	—	—	V
V. davidii (Roman.) Foe.															
Tangwei-H	26/3-5/4	10/5-13/5	28/8-3/9	M	110.0	6.5	R	3.01	ETK	3.30	71.8	15.3	7.8	7.5	V
Fujian-4-♀	28/3-4/4	11/5-14/5	2/9-8/9	M	98.4	6.9	R	3.02	ETK	3.02	70.8	15.5	9.3	5.0	M
Lueyang-4-♀	25/3-1/4	4/5-9/5	3/9-7/9	L	85.9	6.6	R	2.87	ETK	1.88	72.8	14.5	9.5	5.0	M
Ningqiang-6-♀	26/3-2/4	6/5-10/5	3/9-7/9	M	77.5	5.6	R	3.12	ETK	3.26	71.4	14.6	11.6	5.2	M
Xuefeng-♀	28/3-4/4	8/5-11/5	2/9-8/9	M	79.0	6.7	R	3.28	ETK	3.22	75.6	14.5	10.7	4.8	M
Jinan-1-♀	26/3-3/4	10/5-15/5	4/9-12/9	M	95.6	4.5	R	1.90	ETK	3.62	77.2	13.6	9.5	3.8	M
V. hankockii Hance.															
Lingye-♀	26/3-2/4	30/4-3/5	5/8-10/8	L	41.6	2.7	B	0.88	TK	1.78	68.6	16.2	20.1	3.0	M
Jiangxi-3-♂	27/3-3/4	26/4-30/4	—	—	—	—	—	—	—	—	—	—	—	—	M
V. davidii var. cyanocarpa (Gagn.) Sarg															
Zhenba-3-♀	18/4-24/4	2/6-8/6	10/9-159/9	L	45.8	3.2	B	1.45	TK	1.26	71.33	15.4	21.3	0.8	EW
Lan'ao-5-♀	22/4-28/4	1/3-7/6	8/9-14/9	L	52.6	3.7	B	1.67	TK	1.45	69.5	16.2	22.6	0.9	W
V. liubanensis L.X. Niu															
Liuba-10-♀	27/3-5/4	19/5-23/5	7/8-13/8	C	38.2	3.2	B	1.15	TN	2.47	75.4	16.8	19.3	3.8	V
Lan'ao-2-♀	25/3-31/3	14/5-18/5	7/8-13/8	C	43.1	3.6	B	1.03	TN	2.68	79.8	17.2	18.9	4.0	V
V. qinlingensis P. C. He															
Pingli-5-♀	22/3-26/3	4/5-8/5	26/8-1/9	L	44.3	3.3	B	1.17	TK	1.57	64.2	16.4	22.3	0.9	W
Lueyang-4-♀	20/3-24/3	5/5-9/5	25/8-31/8	L	42.5	3.1	B	1.22	TK	1.63	65.3	17.1	21.5	0.9	W

Table, continued

	BB^f dd/mm	BD^g dd/m	RD^h dd/m	CD^i	BuW^j (g)	RW^k (g)	BC^l	BeW^m (g)	ST^n	SN^o	JP^p (%)	SC^q (%)	AC^r (g/l)	VP^s (kg)	VI^t
					V. bashanica P. C. He										
Baihe-41-♀	8/3-14/3	8/5-13/5	25/7-31/7	C	32.4	1.8	B	0.97	TK	2.23	68.4	17.2	1.91	3.4	V
Baihe-42-♀	8/3-14/3	8/5-13/5	26/7-1/8	C	35.3	2.1	B	1.04	TK	2.36	71.3	17.4	19.4	3.5	V
					V. yeshanensis J. X. Chen										
Yanshan-1-♀	12/3-17/3	15/5-20/5	28/7-5/8		34.9	2.1	B	0.58	TK	3.16	66.9	18.2	18.0	3.8	V
Yanshan-2-♂	12/3-17/3	5/5-9/5	—	—	—	—	—	—	—	—	—	—	—	—	V
					V. vinifera L. (CK^b)										
Cabernet Sauvignon	6/4-12/4	22/5-30/5	24/8-3/9	M	162.7	12.7	B	1.83	M	1.54	71.3	17.8	7.3	9.7	V
Chardonnay	3/4-9/9	23/5-28/5	8/9-15/9	EC	210.7	8.2	W	1.95	M	1.63	69.5	18.7	6.8	12.6	M

^f BB=the bud-burst date of the vines; ^g BD= the blooming date; ^h RD=the berry ripening date; ^i CD=Berry compact degree of bunches; ^j BuW=Bunch average weights; ^k RW=Bunch rachisaverage weights; ^l BC=Berry colors; ^m BeW=Berry average weights; ^n ST=Berry skin thickness; ^o SN= seed average numbers per berry; ^p JP=Berry juice percentage; ^q SC=Soluble solid contents in berries; ^r AC=acidic contents in berries; ^s VP=Vine average production; ^t VI=Vine overall vigor; ^u SI=Susceptibility indices; ^v RL=Resistance level, HR=highly resistant; R=resistant; S=susceptible; HS=highly susceptible; ^w H, ^x ♀, and ^y ♂: codes for 'hermaphrodite', 'female', and 'male' accessions respectively.

superior for grape breeding, especially for boitic resistance breeding. Certain accessions in *V. liubanensis*, such as 'Liuba-8', and 'Liuba-9' are alternatives for disease resistance breeding. Although *V. davidii* had large bunches and big berries, its use should be restricted in breeding, due to its 'fleshy' berries, which are strongly inherited in F_1 hybrids and F_1 back crosses (He 1999 a).

We found Chinese wild *Vitis* species had stronger inheritance in their interspecific F_1 progenies than *V. vinifera* regarding disease resistance, berry tannin contents, SSC and acidic contents in berries (He 1999 a, Luo and He 2004, Li and He 2004). This heredity characteristic in Chinese wild grapes should be considered when choosing them for breeding.

V. amurensis has been proved to have the strongest winter hardiness among the *Vitis* species (He 1994 and 1999 a; Alleweldt and Possingham 1988). However, buds of this species burst out early (Table). Hardiness in vines of this species will decline sharply after budburst. Therefore, vines of this species are easily attacked by late-frost in the spring. This should also be considered when utilizing this germplasm in a breeding program to breed cultivars for regions where late-frosts occur in the spring.

There are three kinds of sexual flowers in Chinese wild grapes, male, female, and hermaphrodite. Most types of Chinese grapes are male or female. Only a few of hermaphrodite types were found in species of *V. quinquangularis*, *V. amurensis*, and *V. davidii* (Table). A mentioned fact is that grape pollination can be affected by the weather conditions, especially by the surrounding temperature (He 1994 and 1999 a). Some Chinese species bloom very early, in the middle spring when the average temperature is 15-20 °C. Female plants are much more numerous than male plants at the repository of the University. Even worse, the blooming dates of most female plants do not match those of the males, the former usually 4 to 5 days later than the latter (Table), indicating the early blooming Chinese grapes, such as *V. amurensis, V. romanetii, V. adstricta*, *V. piasezkii*, and *V. hankockii* may pollinate poorly for most years at the repository, further indicating grape bunches and production per vine of these species would be larger and more than the data we obtained in the Table if pollination of these grapes had been better.

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