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# Relatedness of resistance to anthracnose and to white rot in Chinese wild grapes

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## Summary

**Resistance to anthracnose and to white rot in 56 accessions of 13 Chinese wild *Vitis* species, *V. amurensis*, *V. quinquangularis*, *V. romanetii*, *V. adstricta*, *V. pseudoreticulata*, *V. piazezkii*, *V. davidii*, *V. davidii* var. *cyanocarpa*, *V. liubanensis*, *V. qinlingensis*, *V. bashanica*, *V. yeshanensis* and *V. hankockii* was evaluated under natural conditions in 1996-1998. All 56 accessions and the 13 species showed resistance to anthracnose. All nine accessions of *V. quinquangularis*, and one accession each of *V. romanetii*, *V. adstricta* and *V. pseudoreticulata* exhibited susceptibility to white rot; the remaining 44 accessions (78.57 %) and the other 9 species presented resistant to grape white rot. Two *V. vinifera* cultivars ('Cabernet Sauvignon' and 'Chardonnay') were susceptible to anthracnose and highly susceptible to white rot. The r-value of susceptibility indices between anthracnose and white rot in the 56 accessions is insignificant. In Chinese wild grapes, the mechanisms for producing resistance to both diseases would be very different, but inheritance of resistance to these two diseases in a certain cross is somewhat related by molecular data.**

K e y w o r d s : Wild germplasm, Chinese grapes, disease resistance, anthracnose, white rot.

## Introduction

Grape anthracnose (*Elsinoë ampelina* (de Bary) Shear.) and white rot (*Coniothyrium diplodilla* (Speg.) Sacc.) are two of the main fungal diseases in China (HE 1999). These two diseases are also found in most grape growing regions of the world (JOVANOVIC and SIDOR 1987, MAGAREY *et al.* 1993). Most grape production of China comes from *V. vinifera* cultivars, but *V. vinifera* is highly susceptible to these two diseases (JOVANOVIC and SIDOR 1987, MAGAREY *et al.* 1993). Influenced by the East Asia Monsoon Climate, the raining season is nearly simultaneous with the growing period of the grape berries in the main production areas of China (HE 1999). This climatic event may explain for the epidemic proportion of these two diseases in these areas, causing an annual loss of grape production of 18.5 % from anthracnose and 16.3 % from white rot (HE 1999). Among about 70 *Vitis* species in the world, more than 35 species have their origin in China (HE 1999). Chinese wild *Vitis* has proved to be a precious resource containing high resistance to fungal diseases (HE 1999). Additionally, these species are in general easily crossed with *V. vinifera*, producing hybrids with berries free of the undesirable 'foxy' flavor compounds (ALLEWELDT and POSSINGHAM 1988), making this germplasm more attractive to grape breeders (WANG *et al.* 1995). This study was conducted to evaluate resistance to both diseases and to analyze the relationships between them in Chinese wild grapes, with an expectation that this research will lead to more informed development of this germplasm for use in disease resistance breeding.

## Material and Methods

Plant material was obtained from the grape germplasm repository at the Northwest A&F University, Yangling, Shaanxi, China. In Yangling, the rainy season occurs from May to October with annual rainfall approximately 830 mm. Under natural conditions, both grape anthracnose and white rot peak from mid-July to early August. For this reason, disease resistance evaluation was performed at the end of July when the disease symptoms were fully developed. 200 berries in 10-15 bunches of each accession or cultivar were chosen randomly to evaluate disease resistance. The symptoms observed on berries were scored from 0 to 7 (Grade 0 = no symptoms, 1 = 0.1-5.0 %, 2 = 5.1-15.0 %, 3 = 15.1-30.0 %, 4 = 30.1- 45.0 %, 5 = 45.1-65.0 %, 6 = 65.1-85.0 %, 7 = 85.1-100.0 %), based on the estimated percentage of lesion over the entire berry surface, then the score was converted into a susceptibility index (SI). The resistance level of each accession was rated into five categories based on its SI value (HE 1994). Susceptibility data for the two diseases was collected every year from 1996-1998. The average SI values of three years' data were used to evaluate resistance in the germplasm. Correlation coefficients of susceptibility indices between anthracnose and white rot for accessions of Chinese *Vitis* were calculated to analyze the relationship of resistance to these two diseases (SNEDECOR and COCHRAN 1989).

## Results and Discussion

Among the 56 accessions of the 13 Chinese wild *Vitis* species, all 56 accessions and the 13 species, *V. amurensis*, *V. quinquangularis*, *V. romanetii*, *V. adstricta*, *V. pseudoreticulata*, *V. piazezkii*, *V. davidii*, *V. davidii var. cyanocarpa*, *V. liubanensis*, *V. qinlingensis*, *V. bashanica*, *V.*

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*yeshanensis*, and *V. hankockii*, showed resistance to grape anthracnose. Nine accessions (Nanzhang-1, 83-4-96, Danfeng-2, 83-4-49, 84-4-94, 83-4-67, Shangnan-24, Taishan-1, and Weinan-3) of *V. quinquangularis*, one accession (Jiangxi-2) of *V. romanetii*, one accession (Taishan-2) of *V. adstricta*, and one accession (Hunan-1) of *V. pseudoreticulata* were classified susceptible to white rot, while the remaing 44 (78.57 %) accessions and 9 species, *V. amurensis*, *V. piazezkii*, *V. davidii*, *V. davidii var. cyanocarpa*, *V. liubanensis*, *V. qinlingensis*, *V. bashanica*, *V. yeshanensis*, and *V. hankockii*, were classified as resistant to grape white rot. Two cultivars ('Cabernet Sauvignon' and 'Chardonnay') of *V. vinifera* were susceptible to anthracnose and highly susceptible to white rot (Tab. 1). Overall, Chinese wild *Vitis* had extremely high resistance to anthracnose and high resistance to white rot.

An analysis of correlation coefficients (*r*) of average susceptibility indices between anthracnose and white rot for accessions of 6 of the 13 Chinese *Vitis* species selected, and for 56 total accessions of Chinese *Vitis* revealed a significant correlation in just one species (*V. pseudoreticulata*), while the *r*-values of the other five species and all 56 accessions are insignificant (Tab. 2). The resistance to both fungal diseases in Chinese wild grapes had less relatedness in Chinese wild grapes, though the two diseases can attack the grape berries simultaneously and their symptoms on berries peak at the same time during the season. This further indicates that the mechanisms for producing the resistance to both diseases would be very different in Chinese wild grapes.

In former research, we found that major genes controlling the resistance inheritance to these two diseases

Table 1

Susceptibilty indices and level of resistance rating to anthracnose and white rot for accessions of Chinese *Vitis* under natural conditions in 1996-1998

| Accessions or cutivars | Diseases resistance rating | | | | Accessions or cutivars | Diseases resistance rating | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Anthracnose | | White rot | | | Anthracnose | | White rot | |
| | SI[a] | RL[b] | SI | RL | | SI | RL | SI | RL |
| *V. amurensis* Rupr. | | | | | *V. piazezkii* Maxim. | | | | |
| Shuangyou | 8.51 | R | 1.54 | HR | Liuba-6 | 16.53 | R | 8.26 | R |
| Tonghua No.3 | 15.42 | R | 4.53 | HR | Liuba-7 | 12.76 | R | 12.43 | R |
| Zuoshan No.1 | 18.63 | R | 2.67 | HR | Liuba-8 | 15.58 | R | 10.62 | R |
| Zuoshan No.2 | 17.51 | R | 3.55 | HR | Liuba-9 | 18.31 | R | 3.25 | HR |
| Zuoshan 75097 | 16.22 | R | 1.88 | HR | Nanzheng-2 | 12.41 | R | 20.51 | R |
| Zuoshan74-1-326 | 12.83 | R | 4.53 | HR | Huaxian-1 | 19.54 | R | 8.71 | R |
| Taishan-11 | 14.67 | R | 6.78 | R | Baishui-40 | 18.76 | R | 15.41 | R |
| Huaxian-47 | 4.8 | HR | 3.21 | HR | Meixian-6 | 19.31 | R | 2.87 | HR |
| *V. quinquangularis* Rehd. | | | | | Gansu-91 | 15.62 | R | 24.32 | R |
| Nanzheng-1 | 9.53 | R | 33.41 | S | *V. davidii* (Roman.) Foe | | | | |
| 83-4-96 | 7.66 | R | 32.68 | S | Tangwei | 19.32 | R | 5.43 | R |
| Danfeng-2 | 9.54 | R | 48.67 | S | Fujian-4 | 16.27 | R | 2.31 | HR |
| 83-4-49 | 12.17 | R | 32.21 | S | Lueyang-4 | 12.36 | R | 1.53 | HR |
| 83-4-94 | 16.88 | R | 43.25 | S | Ningqiang-6 | 23.61 | R | 3.21 | HR |
| 83-4-67 | 11.41 | R | 36.45 | S | Xuefeng | 10.27 | R | 2.21 | HR |
| Shangnan-24 | 6.51 | R | 52.37 | HS | Jinan-1 | 15.23 | R | 1.67 | HR |
| Taishan-12 | 16.73 | R | 36.25 | S | *V. davidii var. cyanocarpa* (Gagn.) Sarg | | | | |
| Weinan-3 | 14.69 | R | 65.43 | HS | Zhenba-3 | 15.22 | R | 0.00 | HR |
| *V. romanetii* Roman | | | | | Lan'ao-5 | 16.24 | R | 2.32 | HR |
| Pingli-2 | 18.56 | R | 10.51 | R | *V. liubanensis* L.X. Niu | | | | |
| Jiangxi-1 | 8.45 | R | 2.45 | HR | Liuba-10 | 8.32 | R | 12.37 | R |
| Jiangxi-2 | 10.51 | R | 32.54 | S | Lan'ao-2 | 23.87 | R | 16.54 | R |
| Baihe-22 | 16.44 | R | 10.43 | R | *V. qinlingensis* P. C. He | | | | |
| Liuba-1 | 8.43 | R | 4.36 | HR | Pingli-5 | 9.33 | R | 3.32 | HR |
| Pingli-7 | 4.84 | HR | 3.67 | HR | Lueyang-4 | 10.21 | R | 4.27 | HR |
| *V. adstricta* Hance. | | | | | *V. bashanica* P. C. He | | | | |
| Anlin-2 | 14.32 | R | 8.67 | R | Baihe-41 | 8.72 | R | 20.16 | R |
| Taishan-2 | 13.27 | R | 25.61 | S | Baihe-42 | 4.53 | R | 12.33 | R |
| *V. pseudoreticulata* W. T. Wang | | | | | *V. yeshanensis* J. X. Chen | | | | |
| Huan-1 | 18.53 | R | 28.53 | S | Yanshan-1 | 6.45 | R | 6.51 | R |
| Baihe-35-1 | 12.41 | R | 10.41 | R | *V. hankockii* Hance. | | | | |
| Guangxi-1 | 12.62 | R | 16.21 | R | Lingye | 8.45 | R | 8.71 | R |
| Baihe-13 | 16.28 | R | 22.17 | R | *V. vinifera* L. (CK[c]) | | | | |
| Baihe-13-1 | 9.87 | R | 17.48 | R | Cabernet Sauvignon | 42.16 | S | 45.27 | S |
| Shangnan-1 | 12.65 | R | 20.54 | R | Chardonnay | 58.67 | HS | 75.32 | HS |

SI = Susceptibility indices; RL = Resistance level, HR = highly resistant (SI = 0.1-5.0); R = resistant (SI = 5.1-25.0); S = susceptible (SI = 25.1-50.0); HS = highly susceptible (SI = 50.1-100.0); CK = control.

Table 2

Correlation coefficients of average susceptibility indices between anthracnose and white rot for accessions of Chinese *Vitis*

| | *V. amurensis* | *V. quinquangularis* | *V. romanetii* | *V. piazezkii* | *V. pseudoreticulata* | *V. davidii* | Total |
|---|---|---|---|---|---|---|---|
| df | 7 | 8 | 5 | 8 | 5 | 5 | 55 |
| *r* | 0.159 | 0.096 | 0.227 | -0.575 | 0.761* | 0.593 | -0.113 |
| $r_{0.05}$ | 0.666 | 0.632 | 0.754 | 0.632 | 0.754 | 0.754 | 0.273 |
| $r_{0.01}$ | 0.798 | 0.765 | 0.874 | 0.765 | 0.874 | 0.874 | 0.354 |

were mapped on different linkage groups using molecular markers. We also inferred that the major gene controlling the resistance inheritance to one disease may play a role controlling the resistance inheritance to another disease. Therefore, the inheritance of resistance to these different diseases is somewhat related in Chinese wild grapes, indicating that multiple resistance to different diseases in Chinese wild grapes can pass down to a handful of the $F_1$ individuals in certain crosses (Wang and He 1998). This observation has held true according to our 25-year breeding research work. Notwithstanding the positive effects of moving multiple disease resistance into a more domesticated background the choice of which germplasm to use as the donor of resistance should also consider berry quality as an important determining factor (Wan *et al.* 2007).

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## References

Alleweldt, G.; Possingham, J. V.; 1988: Progress in grapevine breeding. Theor. Appl. Genet. **75**, 669-673.

He, P. C.; 1994: Viticulture. China Agriculture Press, Beijing, China.

He, P. C.; 1999: Viticulture. China Agriculture Press, Beijing, China.

Jovanovic, M.; Sidor, M.; 1987: Some characteristics of the development of *Phomopsis viticola* epiphytes, carrier of white rot, on the variety Italian Riesling [grapevines]. Savremena Poljoprivreda (Yugoslavia) **35**, 463-467.

Magarey, R. D.; Coffey, B. E.; Emmett, R. W.; 1993: Anthracnose of grapevines, a review. Plant Protection Quarterly (Australia) **8**, 106-110.

Snedecor, G. W.; Cochran, W. G.; 1989: Statistical Methods. Iowa State University Press, Ames, Iowa.

Wan, Y.; Schwaninger, H.; He, P.; Wang, Y.; 2007: Comparison of resistance to powdery mildew and downy mildew in Chinese wild grapes. Vitis **46**, 132-136.

Wang, Y. J.; He, P. C.; 1998: Inheritance of resistance to anthracnose a F1 interspecific cross between Chinese wild grapes and European grapes. Fruit-Tree Sci. **15**, 1-5 (in Chinese).

Wang,Y. J.; Liu, Y. L.; He, P. C.; Chen, J.; Lamikanra, O.; Lu, J.; 1995: Evaluation of foliar resistance to *Uncinula necator* in Chinese wild *Vitis* species. Vitis **34**, 159-164.

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