Vitis **48** (1), 57–58 (2009)

Research Note

Susceptibility of Chinese grapes to grape phylloxera

Y. P. Du, H. Zhai, Q. H. Sun and Z. S. Wang

Science and Engineering, Shandong Agricultural University, State Key Laboratory of Crop Biology, Tai'an, Shandong, China

K e y w o r d s : Chinese native grapes, hybrids, phylloxera, susceptibility.

Introduction: Grape phylloxera, *Daktulosphaira vitifolia* (Fitch) (Homoptera, Phylloxeridae). evolved in America, then spread to Europe, devastating viticulture there. Phylloxera rampantly reemerged in Jiading, Shanghai in 2005 and other regions, including Huaihua, Hunan province; Xi'an, Shaanxi province; Xingcheng, Liaoning province all in 2006 and 2007. The phylloxera damage to the grape industry in China is becoming similar to the damage this insect caused in late 19th century Europe.

China is one of the centers of origin of the genus *Vitis* and has about 37 species (He 2001). Many of these native grapes are grown domestically and also used for breeding. Information of resistance of only a few eastern Chinese species to grape phylloxera was available from Boubals (1966) and Galet (1988).

The aim of this research is to evaluate resistance of Chinese native and wild grapes to Chinese strains of grape phylloxera using the method of Granett *et al.* (1987). Granett's classification was based on potential doubling time. Boubals' (1966) classification of susceptibility and resistance was based on observations of tuberosities and nodosities on whole plants. Plants forming few nodosities and no or few tuberosities were resistant, those forming lots of tuberosities were susceptible. The laboratory bioassays were convenient and easily visible. Results were in agreement with those of field experiment (King *et al.* 1982). This work has significance to success of viticulture in China.

Material and Methods: M a t e r i a l : Roots for bioassay experiments were obtained from Zhengzhou National Institute vineyard in 2007. Grape cultivars tested including: (1) SO4 (*V. rupestris* × *V. riparia*) as a negative control; (2) *V. vinifera* 'Cabernet Sauvignon' as a positive control; (3) *V. quinquangularis* Rehd; (4) *V. yeshanensis* J. X. Chen; (5) *V. pseudoreticulata* W. T. Wang; (6) *V. flexuosa* Thunb; (7) *V. heyneana Roem. et Schult* subsp. *ficifolia* Bge. C. L. Li; (8) *V. suosuo* grape; (9) *V. davidii* Roman Foex; (10) *V. amurensis* Rupr; (11) Beihong (*V. amurensis-V. vinifera*); (12) 'Beimei' (*V. amurensis* 'Muscat hambourg'); (13), *V. amurensis* var. 'Gongniang'; (14) 'Beichun' (*V. amurensis* 'Muscat hambourg'); (15) Beta (*V. riparia; V. labrusca; V. vinifera*) (USDA-ARS); (16) 'Huajia No. 8' (*V. pseudoreticu lata*. × 'Carignane'). grape phylloxera used in the experiment were collected from 'Kyoho' grapes ('Campbell Early' (4x) × 'Centennial') in Baqiao, Shaanxi, and reared in the laboratory on 'Kyoho' (Granett *et al.* 1987).

M e t h o d s : Ten phylloxera eggs (2- to 3-d after eggs were laid) were placed on excised grape roots of each strain as described by Granett *et al.* (1987).

Data collected included day (x) of each egg laid, daily number of eggs per female (m_x) collected on 2- to 3-d schedule, and survivorship (l_x, daily proportion of original individuals surviving to the next age class) to and during the adult stage. The life table parameters were determined: Intrinsic rate of increase, r_m: $\sum e^{-rm \times x} l_x m_x = 1$; Doubling time (DT): $\ln(2)/r_m$; (Meyer *et al.* 1986).

Linear correlation analyses SPASS were used and one-way analysis of variance (ANOVA) to compare differences in survival, development, fecundity, life-table parameters, tuberosities %, percentage of starting eggs that become adults.

Results and Discussion: S u r v i v o r s h i p : Over the course of the bioassays phylloxera survival declined (Tab. 1). The negative control, SO4 along with *V. quinquangularis* had the lowest survival on each of the measurement days. The positive control, 'Cabernet Sauvignon' had a relatively high survival with the remaining cultivars having similarly high survival rates.

R e s u l t s o f b i o a s s a y s o f d i f f e r e n t s p e c i e s : As indicated in Tab. 2, Phylloxera on SO4 could not form any tuberosities; The percentage of tuber-

T a b l e 1

Mean percent survival for phylloxera on grape cultivars at selected times of the bioassay

Resources tested	Survivorship (%)				
	9 d	17 d	23 d	29 d	39 d
1 SO4	41a	12c	7c	1c	0c
2 Cabernet Sauvignon	58b	56a	56a	54ab	32a
3 *V. quinquangularis*	40a	32c	27b	22c	0c
4 *V. yeshanensis J.X.Chen*	59b	49b	48a	45b	43a
5 *V. pseudoreticu lata*	59b	51b	43a	39b	25a
6 *V. flexuosa*	60b	60a	53a	37b	29a
7 *V. heyneana*	73b	64a	60a	55ab	31a
8 *V.* suosuo grape	74b	73a	70a	60a	33a
9 *V. davidii*	78b	70a	65a	52ab	35a
10 *V. amurensis*.	71b	49b	47a	45b	35a
11 Beihong	59b	46b	45a	42b	30a
12 Beimei	61b	59a	52a	42b	28a
13 *V. amurensis* var. Gongniang	65b	64a	64a	54ab	34a
14 Beichun	74b	68a	54a	44b	15b
15 Beta	54b	45b	44a	41b	31a
16 Huajia No.8	61b	53b	44a	40b	26a

Means (%) in the same column followed by different letters are significantly different using Tukey's studentized range test at α=0.05

Correspondence to: Prof. H. Zhai, Science and Engineering, Shandong Agricultural University, State Key Laboratory of Crop Biology, Tai'an, Shandong 271018, China. E-mail: hengz@sdau.edu.cn

Table 2

Comparision of phylloxera feeding position on different grape cultivars, percentage of starting eggs that becomes adults, size of adult, doubling time and resistance class

Resources tested	% tuberosities (mean±S.D)	% adults (mean±S.D)	Doubling time (DT) (mean±S.D)	Total number of eggs	Resistance class
1 SO4	0	0	–	0f	0
2 Cabernet Sauvignon	50.82±3.25ab	52.31±5.24a	4.89±1.03b	200.76c	3
3 *V. quinquangularis*	20.45±5.84c	26.67±5.09b	8.03±0.70a	69.73e	2
4 *V. yeshanensis J.X.Chen*	40.33±3.42ab	48.00±6.51a	5.23±0.85b	296.68a	3
5 *V. pseudoreticu lata*.	40.32±5.62ab	43.33±5.09a	5.35±0.75b	174.98c	3
6 *V. flexuosa*	38.64±3.02ab	40.00±7.64ab	5.05±0.99b	250.35ab	3
7 *V. heyneana*	53.33±5.30a	54.55±5.01a	4.58±0.91b	282.43a	3
8 *V.* suosuo grape	52.00±4.05a	55.71±5.02a	5.15±0.85b	189.20c	3
9 *V. davidii*	52.06±2.68ab	54.00±5.03a	4.38±0.94b	264.49a	3
10 *V. amurensis*	29.52±5.36c	39.00±7.21ab	6.54±0.94ab	110.66de	2
11 Beihong	38.24±4.00ab	43.00±5.13a	5.84±0.74b	145.93d	3
12 Beimei	32.00±6.28ab	43.33±5.09a	5.17±0.85b	203.38c	3
13 *V. amurensis* var Gongniang	38.75±5.40ab	40.00±7.64ab	6.10±0.84ab	197.17c	3
14 Beichun	22.65±4.36c	34.00±6.39ab	6.11±0.84ab	100.06de	2
15 Beta	31.65±4.01bc	40.00±5.77ab	6.08±0.84ab	216.24bc	3
16 Huajia No.8	33.00±5.41bc	40.00±5.77ab	4.97±0.99b	194.31c	3

Means in the same column followed by different letters are significantly different using Tukey's studentized range, Small letters show significant difference at α =0.05 and big letters showed significant difference at α = 0.01. Tuberosities were formed by phylloxera on ligneous roots by swelling of the root cortex.

osities of *V. quinquangularis*, *V. amurensis* and 'Beichun' were all between 20 % to 30 %; Others were all above 32 %. The percentage of starting eggs that became adults on *V. quinquangularis* was the lowest of resources tested, and on others were quite similar to 'Cabernet Sauvignon'.

Phylloxera on SO4 did not develop to the adult stage and therefore laid no eggs. The total egg numbers of phylloxera on *V. quinquangularis*, 'Beichun', *V. amurensis* and 'Beihong' laid were significantly lower than on 'Cabernet Sauvignon'; while the total egg numbers on *V. yeshanensis* J. X. Che, *V. davidii, V. flexuosa* and *V. heyneana* laid were higher than on 'Cabernet Sauvignon'; those laid on others were similar to 'Cabernet Sauvignon'.

The doubling time on all roots tested was all < 12 d. All were susceptable to grape phylloxera according to the criterion of Granett (1987). *V. quinquangularis* was significantly more resistant than 'Cabernet Sauvignon', others were quite similar to 'Cabernet Sauvignon'.

The data in our tests showed that there was a significant correlation between percentage of tuberosities and doubling time (r = -0.78). The correlation parameter between percentage of adults and doubling time was -0.83. So we evaluated the resistance by the numbers of tuberosities with root piece-bioassays rather than using whole plant tests. From the data of the % tuberosities, we determined that SO4 was in class 0; *V. quinquangularis*, *V. amurensis* and 'Beichun' were in class 2; Others were in class 3.

We conclude that plantings of cultivars and hybrids of Chinese grape species are at severe risk to phylloxera associated damage. Considering the high resistance of rootstocks to grape phylloxera (Granett *et al.* 1983, Omer *et al.* 1999, Du *et al.* 2008). Strongly resistant grape rootstocks and other control strategies should be researched for broad use in China's viticulture.

We sincerely thank Emeritus Prof. J. Granett (Department of Entomology, University of California, Davis, USA) for the technical guidance and editing the manuscript. This research was supported by the commonweal program of Ministry of Agriculture in 2007 (nyhyzx07-27), the National Natural Sciences Foundation of China in 2008 (30871680).

Boubals, D.; 1966: Hérédité de la résistance au phylloxera radicicole chez la vigne. Ann. Amélior. Plantes **16**, 327-347.

Du, Y. P.; Wang, Z. S.; Sun, Q. H.; Zhai, H.; Wang, Z. Y.; 2008: Evaluation on grape phylloxera resistance in several grape varieties and rootstocks. Acta Entomol. Sci. **51**, 33-39.

Galet, P.; 1988: Cépages et Vignobles de France: Tome I, Les vignes Américaines. Les presses de l'Imprimerie Déhan.

Granett, J.; Bisabri-Ershadi, B.; Carey, J.; 1983: Life tables of phylloxera on resistant and susceptible grape roots. Entomol. Expt. Appl. **34**, 13-19.

Granett, J.; Goheen, A. C.; Lider, L. A.; White, J. J.; 1987: Evaluation of grape rootstocks for resistance to type A and type B grape phylloxera. Am. J. Enology Vitic. **38**, 298-330.

He, P. C.; 2001: Viticulture. China Agricultural Press, Beijing, China.

King, P. D.; Meekings, J. S.; Smith, S. M.; 1982: Studies of the resistance of grapes (*Vitis* spp.) to phylloxera (*Daktulosphaira vitifoliae*). N. Z. J. Exp. Agric. **10**, 337-344

Meyer, J. S.; Ingersol, C. G.; McDonald, L. L.; 1986: Estimating uncertainty in population growth rates: Jackknife vs. Bootstrap techniques. Ecology **67**, 1156-1166.

Omer, A. D.; Granett, J.; Kocsis, L.; Downie, D. A.; 1999: Preference and performance responses of California grape phylloxera to different *Vitis* rootstocks. J. Appl. Entomol. **123**, 341-346.

USDA-ARS, Plant Genetic Resources Unit. Cornell University. Geneva. NY 14456-0462. USA.

Received May 28, 2008