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Research Note

Factors influencing mortality, fecundity and fertility of grape phylloxera (*Daktulosphaira vitifoliae* Fitch)

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K e y w o r d s : Grape phylloxera, mortality, fecundity and fertility.

Introduction: The movement, distribution and abundance of phylloxera populations are affected by environmental conditions (temperature, soil moisture, soil type), ability of establishing the feeding sites, grape variety and phylloxera strain. At temperatures below 15 ºC phylloxera cannot establish new feeding sites (DAVIDSON AND NOUGARET 1921); according to TURLEY *et al.* (1996) temperature must even exceed 18 ºC for phylloxera to establish feeding sites. As the soil temperature reaches 15 ºC or lower, phylloxera larvae cease and only the newly hatched crawlers survive as hibernants.

While in spring phylloxera is found primarily on the small feeder roots, during summer they are found mostly at mature older roots; in winter phylloxera stays at the mature roots (OMER *et al.* 1997). Once the stylet of phylloxera is inserted into the root cells, they inject saliva which activates the root cells to increase in size and number, and mobilize the stored nutrients so that the sugars and amino acids flow towards the feeding site. The phylloxera then sucks the liquid nutrients and grow (OMER *et al.* 2002). Since there is limited information on the relationship between gall formation and root size the aim of our study was to investigate the influence of various temperatures on survival, fecundity, fertility, and population of local phylloxera strains, and to determine whether the size of detached roots affects phylloxera longevity (oviposition period) and reproduction.

Material and Methods: Grape phylloxera colonies were established following the procedures reported by DE BENEDICTIS and GRANETT (1992). Fresh and healthy root pieces of the local cv. Balady (*Vitis vinifera*) were infested with 10-15 phylloxera eggs. The infested root pieces were incubated at 25 °C, 75 % RH in the dark.

Phylloxera eggs were surface-sterilized by formaldehyde (35 %) before they were used in the experiments. For each experiment the eggs were raised at the same time and sampled from a large randomized egg pool.

E x p e r i m e n t 1 : Newly laid eggs were placed on root pieces, 10-15 eggs per piece. Then the root pieces were kept at 5, 8,10,15, 20, 22, 25, 30, and 35 ºC for two weeks. During that period the number of hatched eggs were recorded daily. About 200 eggs were examined at each temperature.

E x p e r i m e n t 2 : Newly laid eggs were placed on fresh root pieces and left until hatching. Newly hatched nymphs (n=30-60) were kept at 5, 10, 15, 25, 30, and 35 ºC and 75 % RH in the dark.

The number of feeding nymphs and adults was used to calculate the percentage mortality during the nymphal stage. Also, the mean developmental time (egg to egg) was determined.

At each temperature, all eggs laid by each female were counted until the female's death; then the eggs were checked for one week to determine fecundity and percentage egg hatch.

E x p e r i m e n t 3 : Grape root pieces of different sizes (1-12 mm) were obtained from 10-year-old Balady vines. The root pieces were sorted according to their size, group 1: 1-3 mm, group 2: 4-6 mm, group 3: 7-9 mm, and group 4: 10-12 mm. In each group 15 root pieces were infested with 2-d-old eggs (10-15 eggs per piece). All groups were kept in separate Petri dishes with tightly fitting lids and incubated at 25 °C, 75 % RH in the dark. All phylloxera stages were inspected daily by microscop. In each group about 45 mature females were taken to determine female longevity, total number of eggs laid per female and percentage egg hatch.

For statistical analysis the Stat-View computer program (Abacus Concepts 1994) was unsed at the 5 % level (P = 0.05). Analysis of variance (ANOVA) followed by Fisher LSD test was used to determine the differences between means. A normal approximation test (analysis of proportion) was carried out to evaluate the differences between the percentages.

Results and Discussion: The result of experiment 1 shows that the highest egg hatch was between 22-25 ºC, at higher temperature values started to decline (Figure). Only about 1 % only of phylloxera eggs were able to hatch at 8 ºC. Similarly, GRANETT and TIMPER (1987) found that eggs of phylloxera hatched above 7 ºC.

Experiment 2 shows that the mortality of nymphal stage was associated with temperature. The mortality of the nymphal stage (%) at 5 and 35 ºC was significantly higher than that at all other temperatures (Table). The mortality of the nymphal stage did not differ significantly at 15, 25 and 30 ºC.

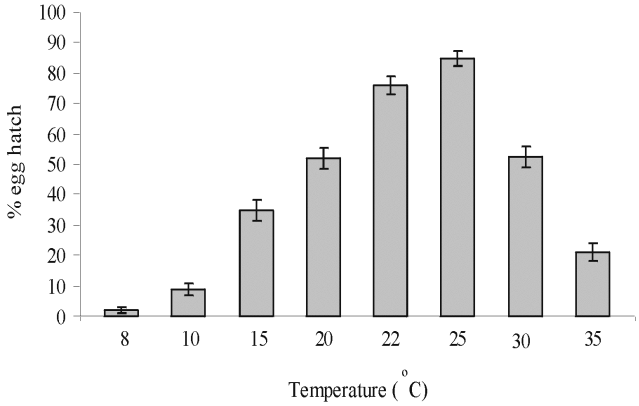

Figure: Effect of different temperatures on percentage egg hatch of grape phylloxera raised on excised roots of cv. Balady.

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Table

Effects of different temperatures and root sizes on grape phylloxera

Experiments	No. tested insects	nymphal mortality, %	Mean developmental time (d) (±SE)	Female longevity (d) (±SE)	Mean no.eggs (±SE)	fertility, %
Temperature (°C)	Nymphs					
5	30	100a	---	---	---	---
10	35	85.7bc	59.8 ± 2.9a	---	18.4 ± 2.42c	0e
15	35	68.5c	36.1 ± 1.7b	---	33.7 ± 2.93b	71.8ab
25	60	58.3dc	14.8 ± 0.87cd	---	71.1 ± 3.24a	80.5a
30	60	75bc	16.8 ± 1.1c	---	19.5 ± 2.66c	49.7bc
35	60	88.3ab	11.3 ± 1.7d	---	14.57 ± 2.67c	26.5ce
Root size groups (mm)	Adult females					
1 (1-3)	45	---	---	13.3 ± 0.42b	50.8 ± 2.84b	85.7a
2 (4-6)	45	---	---	14.7 ± 0.53a	68.5 ± 2.52a	86a
3 (7-9)	45	---	---	12.3 ± 0.46c	41.9 ± 3.74c	82a
4 (10-12)	45	---	---	10.0 ± 0.35d	28.5 ± 1.24d	81.6a

Means followed by the same letter are not significantly different at the *P*=0.05 level (Fisher LSD).
Percentages followed by the same letter are not significantly different at the *P*=0.05 approximation level (normal test, analysis of proportion).

Moreover, phylloxera fecundity and fertility were remarkably influenced by low and high temperatures. There was a significant difference in the mean number of eggs of phylloxera between all the tested temperatures ($P < 0.05$) (Table). At 25 ºC the mean number of eggs was significantly higher than that at the other tested temperatures. The percentage of fertility at 15 and 25 ºC was significantly higher than that at 10, 30, and 35 ºC (Table). Similarly, TURLEY *et al.* (1996) found that at low temperatures phylloxera egg production, egg hatch and growth were inhibited. Usually, survival, egg production, and fertility of insects are increased at normal range of temperature (CHAMPAN 1982), which corresponds with our results.

The results show that there was a significant difference in the mean developmental time of phylloxera at different temperatures ($P < 0.05$). The mean developmental time of phylloxera at 35 ºC was significantly shorter than that at the other tested temperatures. Below 10 °C phylloxera could not initiate development (Table). GRANETT and TIMPER (1987) reported that in California the thresholds for the nymphal development was between 13-16 ºC.

The results of experiment 3 show that the longevity and fecundity of phylloxera were significantly affected by the root size. The mean longevity and fecundity of phylloxera fed on group 2 of root size (4-6 mm) were significantly higher than those on groups 1, 3 and 4. Whereas, on group 4 (10-12 mm) the mean longevity and fecundity were significantly lower than those on groups 1, 2 and 3 (Table). Thus, our study reveals that root size had great effect on phylloxera. Not all root tissues are suitable for gall formation thus grape phylloxera is found primarily at swelling, small rootlets (nodosites) and rarely at larger roots (tuberosities) (GRANETT *et al.* 2001). So, the formation of galls is faster on young roots than on older roots. Unlike longevity and fecundity of phylloxera, the fertility was not influenced by the root size.

The present study confirms that phylloxera biology is directly influenced by temperature and root size. Such information is useful to understand the ecology and population dynamic of this pest.

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CHAPMAN, R. F.; 1982: The Insects Structure and Function, 3rd ed. Hodder and Stoughton, London.

DAVIDSON, W. M.; NOUGARET, R. L.; 1921: The grape phylloxera in California. USDA Bull. **903**, 1-129.

DE BENEDICTIS, J.; GRANETT, J.; 1992: Variability of responses of grape phylloxera (Homoptera: Phylloxeridae) to bioassay that discriminate between California biotypes. J. Econ. Entomol. **85**, 1527-1534.

GRANETT, J.; TIMPER, P.; 1987: Demography of grape phylloxera (*Daktulosphaira vitifoliae*) (Homoptera: Phylloxeridae). J. Econ. Entomol. **80**, 327-329.

GRANETT, J.; WALKER, A.; KOCSIS, L.; OMER, A. D.; 2001: Biology and management of grape phylloxera. Annu. Rev. Entomol. **46**, 387-412.

OMER, A. D.; GRANETT, J.; DOWNIE, D. A.; WALKER, A.; 1997: Population dynamics of grape phylloxera in California vineyards. Vitis. **36**, 199-205.

OMER, A. D.; GRANETT, J.; WALKER, A.; 2002: Influence of plant growth stage on grape phylloxera (Homoptera: Phylloxeridae) populations. Environ. Entomol. **31**, 120-126.

TURLEY, M.; GRANETT, J.; OMER, A. D.; DE BENEDICTIS, J.; 1996: Grape phylloxera (Homoptera: Phylloxeridae) temperature threshold for establishment of feeding sites and degree-day calculations. Environ. Entomol. **25**, 842-847.

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