Influence of *Lobesia botrana* Larvae on Field Severity of Botrytis Rot of Grape Berries

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ABSTRACT

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A 3-yr study was conducted in the vineyards of Bordeaux to assess the effects of the last two generations of *Lobesia botrana* larvae on the development of Botrytis rot. In the absence of fungicides to control *B. cinerea*, second-generation larvae favored the initiation of Botrytis rot on grapes in midseason (i.e., at the beginning of *véraison*). At this point, the number of second-generation larvae per cluster was highly correlated with the number of early disease centers. At harvest, the effect of second-generation larvae alone was also measurable and resulted in a significant increase in disease severity. In 1989, this effect was detected on the cultivar Merlot at an infestation level of eight larvae per 100 clusters. For the third-generation larvae, significant increases in rot severity at maturity were caused by infestation levels of eight and 12 larvae per 100 clusters on Merlot and Sauvignon, respectively. The cumulative damage caused by the larvae of the last two generations appeared to result in higher Botrytis rot severity. The effects of larvae on disease severity varied with year and cultivar. The potential of these biological thresholds for use by growers is discussed. A method for artificially infesting vineyards with laboratory-grown pupae was also studied.

Bunch rot of grapes (*Vitis vinifera* L.), caused by *Botrytis cinerea* Pers.:Fr., is an economically important disease in many viticultural regions of the world. In vineyards, disease development is mainly influenced by the susceptibility of the cultivar, climatic factors (22), and canopy management (9,16). However, *Botrytis* infection of grape clusters can also be increased by insect activity, especially that of grape berry moths (6,12,13, 24,25). In Europe, there are two species of grape berry moths (Lepidoptera: Tortricidae) of economic importance: *Lobesia botrana* (Denis & Schiffermueller), which completes three generations a year, and *Eupoecilia ambiguella* Hb., which completes two generations a year. The larvae of the first generation of both species attack the flowers, causing losses only in yield, whereas those of the following generations damage the green and ripening berries, predisposing the fruit to invasion by *B. cinerea*. Few studies have investigated the role of *L. botrana* larvae on the development of *B. cinerea* in vineyards. In northern Italy, Brunelli et al reported a 35% increase in the percentage of diseased clusters as a result of attack by second-generation larvae, in which 43% of the clusters were damaged (3). In southern France, disease severity increased from 5% rot per cluster in noninfested grapes to almost 50% in clusters infested by the insect (8). Schmid & Antonin (17) observed disease severities of 27% and 37% rot per cluster when second-generation infestation levels were maintained at 2.5 and six larvae per cluster, respectively. These values were significantly greater than that of the noninfested control (20%). In the absence of

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fungicide control, the incidence of *B. cinerea* was 10% greater on vines infested by both generations of *E. ambiguella*, with only one second-generation larva per cluster (23).

As for the mechanisms involved in this phenomenon, Agrios (1) suggested that the larvae bore openings through which windborne conidia of *B. cinerea* enter the grapes. Fermaud and Le Menn (7) demonstrated the potential role of the larvae of *L. botrana* as a vector of *B. cinerea*.

Little is known about the exact role of *L. botrana* larvae from either of the last two generations on the progression of Botrytis fruit rot epidemics. This is particularly true in mid-August at the beginning of *véraison* (growth stage 35) (5), after the second-generation larvae have completed their damage and the first symptoms of disease generally appear (10). This study reports the results of experiments conducted in 1987, 1988, and 1989 in the vineyards of Bordeaux to determine the relationship between the last two generations of *L. botrana* larvae and infection of grape clusters by *B. cinerea*.

MATERIALS AND METHODS

Experiments were carried out in the INRA experimental vineyard near Bordeaux. This vineyard had a very low natural infestation level of grape berry moth. The planting consisted of 51-row × 57-vine plots and was planted in 1976. Vine spacing was 1.10 × 1.80 m. The planting was arranged with three rows of Merlot vines alternating with three rows of Sauvignon vines. These varieties were chosen because they differ in their susceptibility to Botrytis rot. The cultivar Sauvignon is more susceptible to *B. cinerea* infection because of its compact berry clusters.

Experimental design. Two adjacent and identical 0.55-ha plots were used. In each of these two plots, three levels of grape berry moth infestation, designated as "noninfested control," "light," and "heavy," were produced. One plot (no. 1) was used for artificial infestations of the grape berry moth of the second flight period (at the beginning of July), the other (no. 2) was used for infestations for the third flight period (mid-August). The three infestation levels corresponded to three adjacent blocks of similar size (17 rows wide). In 1987, only two blocks were delimited corresponding to the heavy infestation level and the noninfested control.

Artificial infestation technique. Controlled infestations of grape berry moth were introduced with pupae of the insect from laboratory-grown larvae, using breeding methods previously described (21). In infested blocks, infestations were introduced by hanging "pillboxes" containing laboratory-grown pupae on the wire of the training system. Each pillbox was placed in the middle of a vine canopy. The pillboxes were evenly spaced every third row, every tenth vine in the row (i.e., one pillbox for 30 vines).

During the period of the second flight, different levels of infestation were produced as follows: 1) in 1987, by placing 100 pupae per pillbox in the single infested block; 2) in 1988, by placing 75 and 150 pupae per pillbox in the light and heavy infested blocks, respectively; and 3) in 1989, by placing 50 and 150 pupae per pillbox in the light and heavy infested blocks, respectively.

During the period of the third flight, different levels of infestation were created as follows: 1) in 1988, by placing 50 and 100 pupae per pillbox in the light and heavy infested blocks, respectively, and 2) in 1989, by placing 75 and 150 pupae per pillbox in the light and heavy infested blocks, respectively.

In the noninfested block, in order to minimize effects of casual contamination with local moths, berry moth larvae were eradicated by means of two insecticide applications. Concerning the second flight, the clusters were sprayed twice with methomyl at 400 g a.i./ha at 12-day intervals. Insecticides were first applied on July 7, July 14, and June 30 in 1987, 1988, and 1989, respectively. Furthermore, the population density in the light infested block was partly limited with one insecticide application (cypermethrine at 30 g a.i./ha) on July 22 and July 7 in 1988 and 1989, respectively. During the third flight, only one insecticide application (methomyl at 400 g a.i./ha) was made in the noninfested block on August 10 in 1989, and no insecticide was applied in 1988. During these field experiments, the first generation of berry moth larvae, resulting from the first flight, was systematically eliminated with an insecticide application (methomyl at 400 g a.i./ha). No fungicide was applied to control *B. cinerea* except one application made for economical reasons (so that at least a portion of the fruit would be suitable for sale) on September 4, 1987 (iprodione at 750 g a.i./ha).

Forecasting of the infestation date. Starting from eggs, 40 days were required to produce approximately 7,000 pupae necessary to infest a plot. Therefore, it was necessary to forecast the date of the infestation about one and a half months in advance. For a given berry moth flight period, the date of the first appearance of the adults was chosen as the infestation date and was forecast as follows. The first day was considered the date when flying males of the previous generation were trapped using a sex trap baited with 1 mg of the synthetic pheromone for *L. botrana* (E7, Z9 DDA). From this date, three or four more days were required for copulation and egg maturation in the ovaries of the females (14). The time needed for completion of larval and pupal development was calculated according to the following sums of daily effective temperatures required for the complete development of each instar above a threshold of 10 C: 75 C for eggs, 130 C for pupae, 170 C for larvae attacking flower clusters, and 255 C for larvae attacking grape berries (14). In this manner, the exact date of first emergence was predicted with the aid of a table

Table 1. Second-generation larvae infestation and Botrytis rot severity for the various levels of artificial infestations with *L. botrana*[x] at the beginning of *véraison*

	Second generation larvae infestation[y]								
	Percent grape clusters infested			Larvae per 100 grape clusters			Disease severity[z]		
	N I	L I	H I	N I	L I	H I	N I	L I	H I
Sauvignon									
1987	1.7 a	...	72 b	1.7 a	...	134.6 b	41.3 a	...	68 b
1988	6.3 a	35.3 b	52.7 c	6.3 a	41.1 b	80.1 c	21.1 a	30 b	60.8 c
1989	0 a	0.4 a	7.9 b	0 a	0.4 a	8.3 b	67 b	62 a	48 a
Merlot									
1988	1.2 a	12.4 b	42.9 c	1.7 a	17.8 b	68.1 c	4.6 a	12.8 b	38.3 c
1989	2 a	1.2 a	6.8 b	2 a	1.6 a	8 b	47.8 a	48 a	37 a

[x] Artificial infestations induced by introducing laboratory-grown pupae in an experimental plot (0.55 ha) divided into 3 blocks: N I = noninfested (control); L I = light infested; H I = heavy infested.

[y] Values are based on examination of about 250 clusters per block for visual evidence of *L. botrana* damage and larvae. Means within a row not followed by the same letter are significantly different ($P = 0.01$) according to the X^2 test.

[z] Number of early centers of Botrytis rot per 100 grape clusters determined by examining visually 250 clusters per block. Means within a row not followed by the same letter are significantly different ($P = 0.05$) according to the X^2 test.

listing the average daily mean temperatures at the vineyard site for each day of the year, from 1960 to 1979. For the second flight period, the vines were artificially infested as described above on July 1, July 4, and June 22 in 1987, 1988, and 1989, respectively. For the third flight period, the dates of artificial infestations were August 17 in 1988 and August 4 in 1989.

Monitoring *L. botrana* populations in the experimental plots. In both experimental plots, the grape berry moth flight patterns were monitored with the aid of INRA sex traps baited with 1 mg of the synthetic pheromone for *L. botrana* (E7, Z9 DDA) on a rubber dispenser. The pillboxes were examined about 20 days after installation. The actual number of moths released was determined by counting the remaining pupae per pillbox. To calculate the emergence ratio, the number of moths released was divided by the initial number of pupae introduced per pillbox.

Larval infestation and disease severity assessments. Bunch rot evaluations and larval infestation counts were conducted on both varieties at the beginning of *véraison* and at harvest (July 28 and September 22 in 1987; August 1–8 and September 22 in 1988; July 17–22 and August 30 in 1989).

At the beginning of *véraison*, all grape clusters were examined on 15, 25, and 15 randomly selected vines of each variety in each block in 1987, 1988, and 1989, respectively. The total number of sampled clusters was, therefore, a minimum of 250 clusters per treatment per year. Early bunch rot severity was evaluated by counting centers of infection per cluster. At the beginning of *véraison*, a few adjacent berries showing Botrytis rot symptoms in a cluster was considered as a center of infection. Second-generation larval infestation, resulting from the second flight, was jointly determined by examining the same clusters for visual evidence of grape berry moth damage and larvae (one injury being defined as damage caused by one larva on about three berries). In order to increase the accuracy of counting, grapes were removed from the bunch.

At harvest, disease severity was determined within each block by rating 100 clusters in each of six randomly selected sets of eight adjacent vines. Disease severity was estimated using the rating system of Desaymard (4). At that time, infestations of third-generation larvae, resulting from the third flight, were determined in 100 randomly selected clusters of both varieties per block, employing the counting method previously described (2).

Analysis of data. At the beginning of *véraison*, although observations were made on a per-cluster basis, average values were calculated for all the clus-

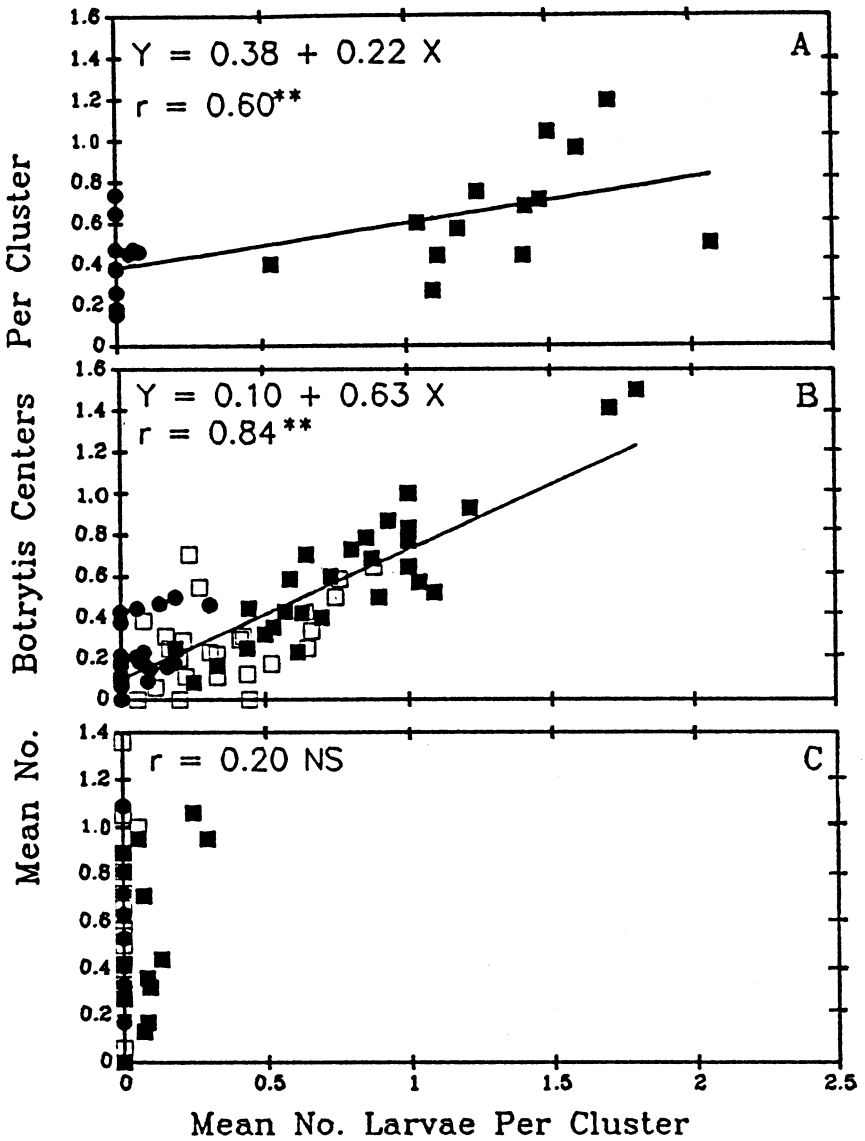

Fig. 1. Relationship of grey mold severity at the beginning of *véraison* to the infestation with second-generation larvae of *L. botrana* for (**A**) 25 Sauvignon vines in 1987, (**B**) 80 in 1988, and (**C**) 40 in 1989. NS = not significant; asterisks denote significance at $P < 0.01$. Vines surveyed in a heavy (■), light (□), or nonartificially infested (●) block with *L. botrana*.

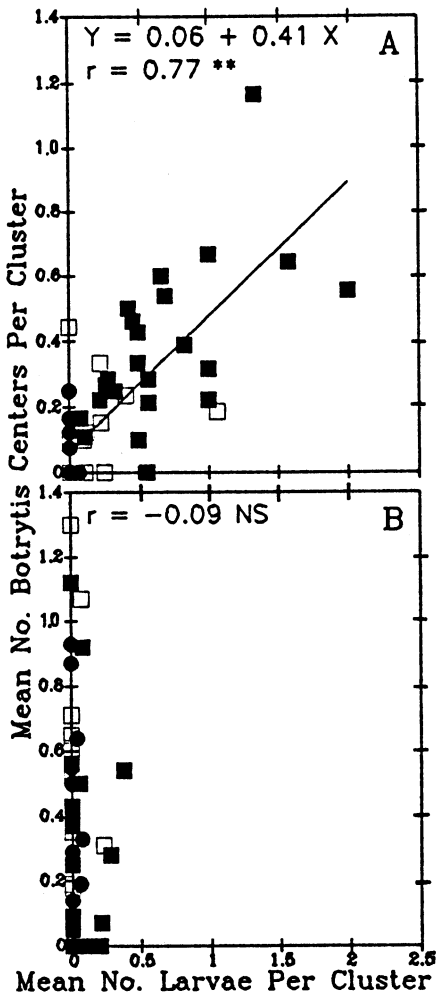

Fig. 2. Relationship of grey mold severity at the beginning of *véraison* to the infestation with second-generation *L. botrana* larvae for (**A**) 71 Merlot vines in 1988 and (**B**) 44 in 1989. NS = not significant; asterisks denote significance at $P < 0.01$. Vines surveyed in a heavy (■), light (□), or noninfested (●) block with *L. botrana*.

ters on each vine sampled. Using these average values, the relationship between second-generation larval infestation and the number of first symptoms of disease was examined using linear regression. Second, third-generation larvae numbers and percent clusters infested were compared in pairs at $P = 0.05$ and $P = 0.01$ using the chi-square test or the hypergeometric distribution on the basis of the frequency distributions of the number of larvae per cluster. Disease severity at the beginning of *véraison* was compared in pairs at $P = 0.05$ using the chi-square test or the hypergeometric distribution on the basis of the frequency distributions of the number of early centers of infection per cluster. At harvest, grey mold severity, determined in the three blocks of each plot, was compared in pairs at $P = 0.05$ using the Mann-Whitney rank test with correction due to the equally placed marks (18,19). STAT-ITCF (20) and SAS-STAT (15) were used for statistical analysis.

RESULTS

Effects of second-generation larval infestation on disease development at the beginning of *véraison*. During the second flight in 1987, 1988, and 1989, the first males were caught in sex traps near the period of shatter, growth stage 27 (5), on June 29, 24, and 16, respectively. The total numbers of males trapped during the second flight periods were 117, 81, and 109, and maximal catches were recorded on July 4, July 6, and June 25 for the same years. These maximal catches occurred soon after artificial infestations were induced with pupae on July 1, 1987, July 4, 1988, and June 22, 1989. Twenty days after the infestation dates, average emergence ratios from the artificially introduced pupae reached 71.4%, 50.2%, and 64.7% in 1987, 1988, and 1989, respectively.

Infestation counts are summarized in Table 1. The percentage of grape clusters infested with second-generation larvae and the total number of these larvae per 100 clusters showed similar variations. The control blocks containing both varieties remained almost insect-free during all three years. Tight infestation associated with one insecticide application resulted in a sizeable increase in larval infestation in 1988 but not in 1989. Heavy infestations resulted in the maximal larval infestations, that is, 134.6, 80.1, and 8.3 larvae per 100 clusters in 1987, 1988, and 1989, respectively, on Sauvignon, and 68.1 and 8 larvae per 100 clusters in 1988 and 1989, respectively, on Merlot. In addition, larval infestation was lower on Merlot as compared to Sauvignon. Botrytis rot severity at the beginning of *véraison* appeared to be related to the degree of infestation by the second-generation larvae of *L. botrana*. In 1987 and 1988, the number of early centers of *Botrytis* infection increased in grape clusters as the number of larvae increased. However, in 1989, disease severity did not increase in either variety with infestation.

In order to more precisely establish this relationship, a linear regression analysis was done on the basis of average values per vine. A highly significant linear relationship was observed in 1987 and 1988 between the average number of second-generation larvae per cluster and disease severity at the beginning of *véraison*, expressed as the average number of disease centers per cluster (Figs. 1A, 1B, and 2A). Correlation coefficients (r) for Sauvignon were +0.60 ($P < 0.01$) and +0.84 ($P < 0.01$) in 1987 and 1988, respectively, and for Merlot, +0.77 ($P < 0.01$) in 1988. On Sauvignon, the slope of the line was less in 1987 (0.22) than in 1988 (0.63). Moreover, the average number of Botrytis rot centers per cluster in the absence of larvae was greater in 1987 (0.38), showing that the conditions were favorable for severe early disease development. The comparison between varieties in 1988 (Figs. 1B and 2A) showed that the slope was less for the less susceptible variety (Merlot). Lastly, in 1989 (Figs. 1C and 2B), there was no correlation between larval infestation and early disease severity on Sauvignon ($r = +0.20$, $P = 20.6\%$) or on Merlot ($r = -0.09$, $P = 54.8\%$).

Effects of infestations with second- and third-generation larvae on Botrytis rot severity at harvest. During the third flight, males were first caught in sex traps at *véraison* on August 11, 1988, and July 31, 1989. The total number of males trapped for the entire third flight period was 144 in 1988 and 57 in 1989. Maximal catches were recorded on August 21 and August 6 in 1988 and 1989, respectively, and came closely after the artificial infestations induced with pupae on August 17 and August 4 in 1988 and 1989, respectively. The results obtained on Sauvignon and Merlot clusters are shown in Tables 2 and 3.

The effect of second-generation larvae on disease severity at harvest was studied in plot 1. This effect was clearly demonstrated in 1987 and 1989 when the insecticidal control led to a minor infestation with third-generation larvae on both varieties. In 1987, disease development was severe on Sauvignon as indicated by the disease severity of 43% in the noninfested control block. A very large increase in second-generation larval infestation (from 1.7 to 134.6 larvae per 100 clusters) resulted in a significant, but relatively slight (9%), increase in bunch rot severity. In 1989, disease severity on Merlot significantly increased as a result of an infestation of eight second-generation larvae per 100 clusters.

In 1988 in plot 1, data showed that the addition of the damage caused by the larvae of the last two generations, each at the rate of about 100 larvae per 100 clusters, resulted in an increase of about 14% in disease severity on Sauvignon and 5% on Merlot.

Table 2. On Sauvignon, influence of various infestation levels with *L. botrana* (resulting from artificial infestations[w]) upon percent Botrytis rot at harvest.

		Second generation larvae per 100 grape clusters[x]			Third generation larvae per 100 grape clusters[y]			Disease severity (%)[z]		
		NI	LI	HI	NI	LI	HI	NI	LI	HI
1987	Plot 1	1.7 a	...	134.6 b	2 a	...	17 b	43 a	...	52 b
1988	Plot 1	6.3 a	41.1 b	80.1 c	3 a	13 b	132 c	16 a	22.5 b	29.7 c
	Plot 2	9 a	9 a	9 a	16 a	11 a	12 a	21.3 a	23.6 b	23.4 b
1989	Plot 1	0 a	0.4 a	8.3 b	0 a	0 a	0 a	20.5 a	19.9 a	19.8 a
	Plot 2	0 a	0 a	0 a	0 a	12 b	16 b	41 a	48.5 b	55.5 c

[w] Induced by introducing laboratory-grown pupae in an experimental 0.55-ha plot divided into 3 blocks: NI = noninfested (control); LI = light infested; HI = heavy infested. Two experimental plots, 1 and 2 were given over to artificial infestations for the second and third flight periods, respectively.

[x] Values are based on examination of about 250 clusters per block for visual evidence of *L. botrana* damage and larvae at the beginning of *véraison*. Means within a row not followed by the same letter are significantly different ($P = 0.01$) according to the X^2 test.

[y] Values are based on examination of 100 randomly selected clusters per block according to the method previously described (2). Means within a row not followed by the same letter are significantly different ($P = 0.05$) according to the X^2 test.

[z] Mean percentage of rotted berries per cluster based on six randomly selected replicates of 100 adjacent clusters in a row. Each of the 600 clusters per block was rated according to the Desaymard 0–10 scale (4). Means within a row not followed by the same letter are significantly different ($P = 0.05$) according to Mann-Whitney's test.

The effect of third-generation larvae on disease severity at harvest was studied in plot 2. In 1988, the two insecticide applications for control of second-generation larvae limited the population densities of larvae to nine and one per 100 clusters on Sauvignon and Merlot, respectively. In 1989, chemical control eradicated second-generation larvae on both varieties. The percentage of rotted berries per cluster at harvest generally increased as the third-generation larval infestation increased. On Sauvignon, in 1989, a significant increase in the percentage of rotted berries was observed starting from 12 larvae per 100 grape clusters. In 1988, however, the infection rate did not appear to be related to third-generation larval infestation levels. On Merlot, in both years, data showed that eight larvae per 100 clusters were necessary before a significant increase in disease severity was noted. The very low percentage of Botrytis rot per cluster (i.e., less than 6%) confirmed the low susceptibility of this variety to the disease.

DISCUSSION

Results of these studies indicate that damage caused by the last two generations of *L. botrana* larvae predisposed grape clusters to invasion by *B. cinerea* and was associated with increased gray mold severity. Data from field trials conducted in 1987 and 1988 on Sauvignon and Merlot showed that infestation with second-generation larvae resulted in increased disease severity at the beginning of *véraison*, when the first symptoms of disease generally appear. Second-generation larvae contribute to the increase in the number of sites of primary infection. In support of this, our results showed that the number of sites of primary infection was positively correlated with the number of larvae per cluster. The discrepancy between data obtained in 1989 (in which this linear relationship was not established) and both preceding years can be explained partially on the basis of the weather conditions more or less favorable to infection by *B. cinerea* before *véraison*. In 1987, the climatic conditions were favorable for severe early disease development as compared to those in 1988 and 1989. At the vineyard site, the rainfall during the months June, July, and August reached 231 mm in 1987, 181 mm in 1988, and 187 mm in 1989. As indicated by the regression lines, the effect of second-generation larvae was less marked in 1987, when climatic conditions were more favorable for numerous primary infections, than in 1988. Valli obtained similar evidence in northern Italy (23). However, in 1989, the absence of such a relationship may be due to the very small number of second-generation larvae (a maximum of eight larvae per 100 clusters was observed in the experimental vineyard). These data indicate that, when climatic conditions are not favorable for early disease development, second-generation larvae have no effect on *B. cinerea* infection at the beginning of *véraison* when there are less than eight larvae per 100 clusters. At harvest in 1989, our data on Merlot showed that this infestation level with second-generation larvae by itself can cause a significant increase in disease severity. From this, it would seem that, in 1989 on Merlot, *Botrytis* infection was not promoted immediately after the second-generation larvae had completed their damage at the beginning of *véraison* but was promoted later in the season. These data and those obtained in 1987 on Sauvignon agree with other studies that have shown increases in disease severity at harvest as the infestation with second-generation larvae of *L. botrana* increased (3,17).

In addition, our results showed that, on the relatively resistant variety Merlot, rot severity remained very low (i.e., about 1%), in spite of infestation levels with second-generation larvae of 18 and eight larvae per 100 clusters in 1988 and 1989, respectively. On the susceptible variety Sauvignon, an infestation level of eight second-generation larvae per 100 clusters in 1989 did not affect disease severity at harvest. This suggests that control of the second-generation larvae of *L. botrana* is unwarranted until the green berries are infested at the rate of eight larvae per 100 clusters.

Trials to determine the effect of the infestation with third-generation larvae alone on Botrytis rot severity at harvest led to conclusions similar to those in the case of second-generation larvae. Increased disease severity was noted with 12 larvae per 100 clusters on Sauvignon and eight larvae per 100 clusters on Merlot.

Lastly, when grapes are attacked by both second- and third-generation larvae, our results showed that disease severity was notably increased. In 1988, heavy infestations with about 80 second-generation larvae and 130 third-generation larvae per 100 clusters resulted in an increase in disease severity of 5% on Merlot and almost 14% on Sauvignon. Thus, the effect of larvae on Botrytis rot development was modified by the varietal susceptibility to the disease. This observation supports the view that practical thresholds should be greater in the case of the less susceptible varieties.

Fungicides are widely used in vineyards of Bordeaux to control *B. cinerea* on grapes, especially at or near *véraison*. When fungicides are used to control *B. cinerea*, Valli (23) reported that the effect of larvae of *E. ambiguella* on disease severity was notably reduced. It follows that, in the case of second-generation larvae of *L. botrana*, the practical threshold of concern to growers should be greater than eight larvae per 100 clusters. For the same reason, the biological thresholds concerning the third-generation larvae are probably lower than practical thresholds.

Obviously, more than one factor must

Table 3. On Merlot, influence of various infestation levels with *L. botrana* (resulting from artificial infestations[w]) upon percent Botrytis rot at harvest.

		Second generation larvae per 100 grape clusters[x]			Third generation larvae per 100 grape clusters[y]			Disease severity (%)[z]		
		NI	LI	HI	NI	LI	HI	NI	LI	HI
1988	Plot 1	1.7 a	17.8 b	68.1 c	0 a	4 a	132 b	0.6 a	1.1 b	5.7 c
	Plot 2	1 a	1 a	1 a	4 a	0 a	8 b	0.5 a	0.3 a	0.7 b
1989	Plot 1	2 a	1.6 a	8 b	0 a	0 a	0 a	0.6 a	0.55 a	1.05 b
	Plot 2	0 a	0 a	0 a	0 a	8 b	24 c	0.3 a	0.6 b	0.7 b

[w] Induced by introducing laboratory-grown pupae in an experimental 0.55-ha plot divided into 3 blocks: NI = noninfested (control); LI = light infested; HI = heavy infested. Two experimental plots, 1 and 2 were given over to artificial infestations for the second and third flight periods, respectively.

[x] Values are based on examination of about 250 clusters per block for visual evidence of *L. botrana* damage and larvae at the beginning of *véraison*. Means within a row not followed by the same letter are significantly different ($P = 0.01$) according to the X^2 test.

[y] Values are based on examination of 100 randomly selected clusters per block according to the method previously described (2). Means within a row not followed by the same letter are significantly different ($P = 0.05$) according to the X^2 test.

[z] Mean percentage of rotted berries per cluster based on six randomly selected replicates of 100 adjacent clusters in a row. Each of the 600 clusters per block was rated according to the Desaymard 0–10 scale (4). Means within a row not followed by the same letter are significantly different ($P = 0.05$) according to Mann-Whitney's test.

be considered in attempting to control *B. cinerea* on grapes. For example, high humidity predisposes the grapes to invasion by *B. cinerea* (11). Thus, even complete control of grape berry moth larvae may not maintain low or zero levels of disease severity when vines are extremely vegetative or with tight berry clusters. It would be interesting to study whether these factors modify the interaction between *L. botrana* larvae and Botrytis rot epidemics. Use of canopy management treatments to encourage airflow around clusters (9,16) plus maintenance of grape berry moth levels below the biological thresholds may produce better control of *B. cinerea.*

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