Analysis of Resistance in Cabbage Varieties to Damage by Lepidoptera and Thysanoptera

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ABSTRACT Differences in susceptibility to damage by Thrips tabaci Lindeman and the lepidopteran pest complex (Plutella xylostella (L.), Artogeia rapae (L.), and Trichoplusia ni (Hübner)) were documented and analyzed for fresh market and experimental cabbage varieties. Patterns of resistance to damage were different for Lepidoptera and T. tabaci. The commercial green varieties did not differ in susceptibility to damage by Lepidoptera but did differ in susceptibility to damage by T. tabaci. The two experimental varieties and one commercial red variety, used for comparison, were less susceptible to damage by Lepidoptera but varied in susceptibility to damage by T. tabaci. The best regression models for predicting damage rating, without including the effect of variety, included one measure of seasonal pest total and one plant parameter, head weight. Further regression analysis showed that, in most cases, the relationship of seasonal pest total to damage had the same slope for all varieties but different intercepts. This result indicates that, at a given population density, the models predict different damage ratings for the varieties, implying that nonpreference is not the only resistance mechanism operating and that mechanisms involving tolerance or antibiosis were involved. Use of regression models that test for varietal differences in the relationship of plant parameters and pest population densities to damage would be helpful in designing good assays of resistance for selection of new breeding lines.

KEY WORDS Insecta, plant resistance, cabbage, damage prediction.

AN IMPORTANT component in the management of agricultural pests should be the use of resistant or less susceptible varieties. These are particularly useful when other control methods, such as natural or chemical control, are not completely effective in preventing economic injury. Management of pests on New York cabbage, particularly onion thrips, Thrips tabaci Lindeman, and Lepidoptera (Plutella xylostella (L.), Artogeia rapae (L.), and Trichoplusia ni (Hübner)), can be difficult if reliance is placed solely on insecticides or natural control.

Several studies have evaluated plant resistance to Lepidoptera in crucifers (Harrison & Brubaker 1943, Pimentel 1961, Radcliffe & Chapman 1965a,b, Radcliffe & Chapman 1966a,b, Wolfenbarger 1967, Brett & Sullivan 1974, Creighton et al. 1975, Dickson & Eckenrode 1975a,b, Dunn & Kempton 1976, Kim 1979, Latheef & Irwin 1979, Lin et al. 1983). These studies vary considerably in the methods used (e.g., evaluating plant damage or insect populations), in the range of varieties tested, the severity of insect pressure, and the results for even a single variety. Some previous studies on cabbage resistance to Lepidoptera show that red varieties generally have reduced oviposition by A. rapae; plant maturity may affect resistance; and lines derived from the dark green glossy cauliflower PI 234599 have shown high levels of resistance, but this resistance is partially linked to the glossy nature of the leaf (Dickson & Wallace 1986).

Although onion thrips has been reported as a pest of cabbage since the late 1800s (Sirrine & Lowe 1894), plant resistance has been only studied recently. In a survey of varietal resistance to thrips in processing cabbage, Shelton et al. (1983) found that no commercial varieties were immune from damage but that substantial differences were found in the severity and numbers of layers injured. Recent work by Stoner & Shelton (unpublished data) indicated that resistance is caused largely by differences in within-plant distribution of thrips. Thus, on susceptible and resistant varieties the thrips populations on the entire plant may be equal, but the ratio of thrips on the head to frame leaves will be lowest in resistant varieties.

From all of the published studies surveying the range of susceptibility of commercial and experimental cabbage lines to various foliage insect pests, a fundamental question arises—how can cabbage resistance to insects be assessed in small plot trials under natural infestations? In small plot trials, differences in ovipositional preferences may cause differences in larval counts and plant injury, but in a
"nonchoice" situation such as a commercial field, such ovipositional differences may not occur (Cantelo & Sanford 1984). Although some people involved in breeding plants resistant to insects have overcome this limitation by artificially infesting plants, this is not always possible. Another way of overcoming such limitations is to use data from a small plot trial and then create a paradigm that would predict the amount of plant injury to each variety based on an equal number of pests being present on all varieties. Ultimately, a model that could predict plant injury to each variety at a common pest density would aid in designing good assays of resistance for selection of new breeding lines.

The goals of our study were to document susceptibility of storage and fresh market cabbage varieties for New York’s major foliage insect pests and construct statistical models that demonstrate that resistance to damage among cabbage varieties can be explained as varietal differences in the relationship of insect densities and plant parameters.

**Materials and Methods**

Twenty-four cabbage varieties were tested for susceptibility to *T. tabaci* and the lepidopteran pest complex at the Vegetable Research Farm, New York State Agricultural Experiment Station, Geneva. These included 17 varieties of green cabbage that are grown commercially for fresh market in New York, and several other cabbage types for comparison: one savoy cabbage, two commercially grown varieties of red cabbage, two green varieties that were developed more than 50 years ago and are no longer commonly grown commercially (‘Danish Ballhead’ and ‘Early Jersey Wakefield’), and two experimental glossy varieties (Geneva 8329 and Geneva 8395, both of which had PI 734599 as a parent). Eighteen of the varieties were transplanted on 10 June 1982 and 14 June 1983; six shorter season varieties were transplanted on 30 June 1982 and 25 June 1983 (‘King Cole’ and ‘Superette’), and 12 July 1982 and 7 July 1983 (‘Danish Ballhead’, ‘Sunup’, ‘Special Golden Acre’, and ‘Early Jersey Wakefield’).

Staggered planting dates were intended to result in all varieties reaching maturity at approximately the same time and to be subject to the same pest pressure (high pest populations do not normally begin until late July). Varieties were transplanted into blocks consisting of 24 rows (9.1 m), with 22 plants of a single variety per row, replicated four times in a randomized complete block design. Unplanted alleys (4.5 m) separated blocks. Each row was split into two plots, one of these, chosen randomly, received treatments of *Bacillus thuringiensis* Berliner (Dipel; 1.12 kg [AI]/ha) twice during each season to suppress lepidopterous populations. Applications were made with a backpack sprayer delivering 141 liters/ha. Treated plots were evaluated only for *T. tabaci*; untreated plots, separated by a 1-m alley, were evaluated only for Lepidoptera. This split plot design was used to eliminate possible interactions between defoliation by Lepidoptera and infestation by onion thrips. Larvae and eggs of the three species of Lepidoptera were counted on four plants per plot in the 18 earlier varieties planted on 22 and 29 July, 17 August, 2 September, and 23 September in 1982, and on three plants per plot of all varieties on 19 July, 3, 15, and 30 August, and 14 and 27 September in 1983. Lepidoptera were not counted on the six varieties planted later in 1982 because the plants’ growth was retarded by poor weather conditions soon after transplantation and the relationship of these counts to damage rating could not be compared with the 18 earlier planted varieties.

At harvest (25 September 1982 and 27 September 1983), damage by Lepidoptera in the unsprayed plots was scored on a scale of 0 to 5 according to the amount of feeding damage on the head and wrapper leaves (Greene et al. 1969, modified by Chalfant et al. [1979]). Three heads per block, free of disease and other damage, were taken at harvest from the treated plots and examined for onion thrips injury by splitting the head along the core axis and peeling back each of the outer 10 leaves on one half. A scale of 0 (no injury) to 4 (severe injury) was assigned to each half head. This scale was based on the number of injured leaves and the extent of injury to each leaf (Shelton et al. 1983). In addition, four heads from each of five varieties which showed distinct differences in thrips injury in 1982, and heads of all varieties in 1983, were dissected and washed with alcohol to collect and enumerate all stages of *T. tabaci* present.

Amount of damage (mean damage rating for each of the four replicates) for both pest types at harvest in each year was analyzed by analysis of variance. To examine the causes of plant damage at harvest, a two-step analysis was performed. First, data from all varieties were combined and regression analyses were performed to determine the best predictors of damage ratings, in addition to varietal effects. For Lepidoptera, the predictors were seasonal totals per plant of each pest; seasonal larval units per plant (Shelton et al. 1982) (in this study, 1 larval unit was equivalent to 1 large *T. ni*, 1.5 small *T. ni* or large *A. rapae*, and 10 small *A. rapae* or any *P. xylostella*, with the “small” category equal to the first three instars); plant frame weight; and plant head weight. For *T. tabaci*, predictors were the square root of the 1982 single count and the 1983 seasonal total, head weight, and head diameter. All possible regressions were performed for damage rating predicted by the plant parameters and the appropriate pest totals, and selection of the best candidate regression models was based on Mallows’s C(p) statistic (Hocking 1976), $R^2$, and residual mean square (RMS). The best of these predictors were then used to describe the relationship of insect abundance and plant parameters to damage rating for both Lepidoptera and *T. tabaci*. Once this first
step was completed, the effect of variety on that relationship was evaluated by analysis of variance (i.e., the predictors selected in the first step were used as covariates). Results from this step could then be used to predict whether or not, given the same insect abundance and plant size, varieties would have different damage ratings.

Results and Discussion

Damage Ratings. Observed damage ratings for Lepidoptera were fairly consistent during the two years of the study (Fig. 1). Differences in lepidopteran damage rating were readily apparent, with consistently lower ratings observed for the experimental (glossy) varieties ('Geneva 8329' and '8395'). The red varieties ('Red Head' and 'Red Danish') had higher and nearly equal ratings in 1982, but differed in 1983. The green varieties had the highest ratings and, among them, there were no substantial differences in observed damage. The differences in T. tabaci damage ratings were more variable between years, although the eight most damaged varieties in 1982 were also the eight most damaged varieties in 1983. For thrips injury, no pattern was readily apparent between red, green, or glossy types; within each type there was considerable variability. Thrips damage to the older varieties, 'Danish Ballhead' and 'Early Jersey Wakefield,' was consistently low throughout the study. Varietal susceptibility to damage by Lepidoptera and T. tabaci differed considerably. Noteworthy exceptions were the experimental varieties and 'Red Danish' which were only moderately or lightly damaged by both orders of insects.

Analysis of Lepidoptera. Using the data from all varieties on seasonal pest totals, plant size measurements, and damage ratings, we first selected regression models for predicting damage rating from factors other than variety. Selected regression models for predicting damage were chosen on the basis of fewest parameters, highest $R^2$, lowest residual mean square (RMS), and Mallow's C(p) statistic closest to the number of parameters (p) (Table 1). Mallow's C(p) provides an indication of the number of parameters that should be included in the model. We selected as candidate models those with the smallest number of parameters (p) for which the C(p) statistic is less than or nearly equal to p. For the 1982 data, the C(p) statistic was never equal to or less than p, but it came close for some of the three parameter models. In 1983, C(p) was $< p$ for 2-, 3-, and 4-parameter models. This indicates that a single measure of pest population density alone (for example, larval units) does not give the best model for predicting damage rating, and additional predictors should be included. The best additional predictors can be selected by $R^2$ and RMS. The $R^2$ statistic, an indication of the proportion of variation in the data explained by the model, is fairly low for all of the models. However, the effects of variety had not yet been included as a predictor in this analysis, so we expected $R^2$ to be low. Because the purpose of this analysis was to compare predictor variables, $R^2$ and the RMS are used only to compare candidate models. Larval units, P. xylostella, and head weight were the predictors most often included in the 1982 candidate models (Table 1). Larval units alone should explain the variability in damage rating due to P. xylostella; however, inclusion of P. xylostella indicates that larval units do not adequately represent the potential effects of P. xylostella on damage rating. This discrepancy between larval units and P. xylostella was again found in the 1983 data, in which P. xylostella was included in all of the best models, and larval units in none (Table 1). A possible explanation is that feeding damage caused by P. xylostella tended to be numerous small, irregularly shaped holes, which would increase visual damage ratings more than if the same area of feeding occurred at the edge of the leaf or in fewer, larger holes. Head weight was also included in all of the 1983 candidate models (and frame weight in two of them), indicating that a measure of plant size can help explain differences in damage rating. The sign of the head weight parameter estimates is positive, indicating that as the heads get larger they receive higher damage ratings. However, the
sign for the frame weight parameter estimates is negative, indicating that damage rating decreases as frame size increases. This could be because damage is less obvious on a large plant frame. Based on these results and all of the selection criteria combined, we included head weight and seasonal totals for either _P. xylostella_, _A. rapae_, _T. ni_, or larval units in regression models used to test for varietal differences in the relationship of these variables to damage rating. Thus, the next step was to test for differences in these relationships; i.e., in slopes or intercepts of regression equations among the different varieties.

The slope for seasonal pest total is an estimate of the increase in damage rating for a unit increase in seasonal pest total. When the slope is the same for each variety, the damage is inflicted by pests at a similar rate for all the varieties at the population densities experienced during the study. If the slopes are the same for both seasonal pest total and head weight, we can compare the varieties at any common seasonal pest total and head weight and expect the same differences in damage ratings. If the slopes are different, the predicted differences in damage ratings among the varieties at a common seasonal pest total and head weight will depend on the common pest total and head weight chosen. If the interaction term between variety and seasonal pest total is not significant in the analysis of variance, we conclude that the slopes are not significantly different. In this case, a type II error, concluding that the slopes are not significantly different when they are, is more serious than a type I error; thus, we use a higher significance level than 0.05 to reduce the probability of making a type II error. The term for interaction between variety and seasonal pest total was not significant for any of the models tested in 1982 (F = 1.92; df = 23, 24; P = 0.06), which is an indication that the slopes of these regression equations may differ for different varieties when some of the measures of seasonal pest total are used in some years. The term for interaction between variety and head weight was not significant in any of the models in 1982 (F = 1.21; df = 17, 18; P > 0.347), or in the model including _P. xylostella_ in 1983 (F = 1.15; df = 23, 24; P > 0.36), indicating that the increase in damage rating for a unit increase in head weight is the same for each variety. Interaction between variety and head weight was significant when _A. rapae_, _T. ni_, or larval units were included in models in 1983 (F = 1.92; df = 23, 24; P = 0.059), indicating that the relationship of head weight to damage rating may also differ at times among the varieties.

For each model, the effects of seasonal pest total were significant (F = 64.05; df = 1, 52; P = 0.0001 in 1982; F = 12.85; df = 1, 24; P = 0.0015 in 1983), as were the effects of head weight (F = 29.40; df = 1, 52; P = 0.0001 in 1982; F = 116.0; df = 1, 24; P = 0.0001 in 1983). Damage by each of these pest populations over time on different parts of the plant may not be best described by the total number of larvae found during biweekly samples. A better measure of the impact of pest populations on damage rating (e.g., more frequent samples and a function to calculate expected cumulative area of feeding over time) would improve the analysis. However, the terms for pest total and head weight explained enough variation in damage rating to merit their inclusion in the models as covariates before testing for effects of variety.

Testing for effects of variety in the analysis of variance, after the variation due to seasonal pest total and head weight has been explained, gives an indication of whether or not the intercept terms are different in regression equations for the different varieties. The effects of variety on the intercept terms were significant (F = 12.06; df = 17, 52; P <

### Table 1. Selected regression models for predicting visual damage rating (see text) by Lepidoptera on fresh market cabbage in Geneva, N.Y., in 1982 and 1983

<table>
<thead>
<tr>
<th>No. parameters</th>
<th>R²</th>
<th>RMS</th>
<th>C(p)</th>
<th>Intercept</th>
<th>Seasonal total of</th>
<th>Frame wt</th>
<th>Head wt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><em>A. rapae</em></td>
<td><em>P. xylostella</em></td>
<td><em>T. ni</em></td>
</tr>
<tr>
<td>1982</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>0.1196</td>
<td>1.648</td>
<td>3.461</td>
<td>3.308</td>
<td>—</td>
<td>0.045</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>0.1864</td>
<td>1.634</td>
<td>3.677</td>
<td>3.251</td>
<td>—</td>
<td>0.048</td>
<td>0.037</td>
</tr>
<tr>
<td>3</td>
<td>0.1537</td>
<td>1.639</td>
<td>3.962</td>
<td>3.081</td>
<td>—</td>
<td>0.036</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>0.1483</td>
<td>1.629</td>
<td>4.407</td>
<td>2.918</td>
<td>0.032</td>
<td>0.047</td>
<td>—</td>
</tr>
<tr>
<td>1983</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.250</td>
<td>1.270</td>
<td>1.970</td>
<td>2.857</td>
<td>—</td>
<td>0.091</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>0.263</td>
<td>1.262</td>
<td>2.429</td>
<td>3.042</td>
<td>—</td>
<td>0.095</td>
<td>—</td>
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<tr>
<td>3</td>
<td>0.260</td>
<td>1.268</td>
<td>2.820</td>
<td>2.618</td>
<td>0.025</td>
<td>0.109</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>0.272</td>
<td>1.261</td>
<td>3.341</td>
<td>2.806</td>
<td>0.024</td>
<td>0.112</td>
<td>—</td>
</tr>
</tbody>
</table>

² Larval units (see text).
0.01 in 1982, \( F \geq 2.0; \) \( df = 23, 24; \) \( P < 0.05 \) in 1983) for all of the models, indicating that the intercepts are different among the varieties. For models in which the slopes are not significantly different, the differences in intercept terms provide an estimate of differences in damage ratings for any common seasonal pest total and head weight within the range of these variables present during the study. Estimates of these intercept terms for the best of the regression models, damage rating predicted by \( P. xylostella \) and head weight are given in Table 2. Estimates for the other regression models were very similar to those in Table 2. We speculate that differences in the intercept terms among the varieties is caused either by tolerance or antibiosis. Tolerance could be the result of differences in location of feeding on these varieties, because the damage rating system gives higher values to feeding on the head and wrapper leaves than on the frame leaves. Differences in appearance of feeding damage on the different varieties could also result in differences in intercepts, because many small or irregular holes may receive higher damage ratings than fewer large, round holes or strip feeding at the edge of the leaf. Antibiosis could result in pests being present but not feeding or feeding less than on other varieties. If the experimental or red varieties are removed from the analysis, the varietal effects are still significant (\( P \leq 3.59; \) \( df = 15, 46 \) in 1982, \( F \geq 2.83; \) \( df = 21, 64 \) in 1983, both \( P < 0.01 \)), but if they are both removed, the differences are no longer significant (\( F \leq 0.82; \) \( df = 13, 40; \) \( P > 0.63 \) in 1982, \( F \leq 2.03; \) \( df = 19, 58; \) \( P > 0.05 \) for all but \( A. rapae \) in 1983). Thus, the important differences lie between these two groups and the other varieties. Actual differences in damage ratings could be because of either a different capacity for injury at a given pest infestation level, or to varietal differences in numbers of pests present. In general, differences in intercepts corresponded with differences in damage ratings. For example, the red and experimental varieties had both lower damage ratings and lower intercepts than the other varieties.

Analysis of seasonal egg total showed significant differences (\( P = 0.05 \)) for each species, except for \( A. rapae \) in 1983 (\( F \geq 1.4; \) \( df = 17, 54 \) in 1982, \( F = 1.2; \) \( df = 23, 72 \) in 1983, both \( P \leq 0.047 \)). The red and experimental varieties were consistently lower in seasonal egg totals, except for \( T. ni \) on red cabbages in 1983. Without the regression models, the lower damage ratings could be attributed to fewer eggs (i.e., nonpreference). The regression analysis indicates that, even with the same number of larvae on the red or experimental lines, the damage ratings would be lower (suggesting tolerance or antibiosis). For the experimental lines, antibiosis seems most likely because these lines had a much higher ratio of eggs to subsequent larvae than the other varieties. This suggests antibiosis or lack of feeding by early instars and explains the very low intercepts found in the regression analysis and low damage ratings seen in the tests. Additional data (unpublished) indicates that, at least for \( A. rapae \), resistance is manifested in the first instar’s inability to feed on glossy resistant varieties.

**Thrips tabaci.** As was the case with Lepidoptera, thrips numbers alone did not provide the best predictor of damage rating when potential regression models were compared for the 1983 data (Table 3). The addition of some measure of head size, either head weight or head diameter, improved \( R^2 \) by ca. 6% above square root transformed seasonal thrips totals alone, and brought the C(p) statistic close to the number of parameters in the model. Neither measure of head size alone explained as much of the variation in the data as thrips numbers. Our conclusion is that a measure of head size and thrips population density should be included in regression models before testing for effects of varieties. For the five varieties on which thrips were sampled in 1982, neither head weight nor head diameter explained a significant amount of variation in the model, and they were not included in the analysis.

The interaction between seasonal thrips total and variety was not significant (\( F = 0.803; \) \( df = 4, 10; \) \( P > 0.2 \) in 1982, \( F = 1.74; \) \( df = 23, 24; \) \( P = 0.093 \) in 1983), indicating a common positive slope for the five varieties tested in 1982 and the 24 varieties tested in 1983. The interaction term between variety and head weight was not significant either (\( F = 1.15; \) \( df = 23, 24; \) \( P = 0.37 \)) for the 1983 data. Varietal effects were significant (\( F = 6.53; \) \( df = 4, 14 \) in 1982, \( F = 8.38; \) \( df = 23, 24 \) in 1983, both \( P < 0.01 \)) indicating, because the slopes were not different, the same differences in the thrips damage rating at any given seasonal total number of thrips (Table 2). Again, we speculate that this could be caused either by tolerance or antibiosis. One example of tolerance could be thrips moving and feeding deeper into the head in more susceptible varieties, because the damage rating depends on both the severity and depth of feeding damage. Stoner & Shelton (unpublished data) found that total numbers of thrips on certain susceptible varieties were the same as found on resistant varieties, but a greater proportion of the thrips were in the head on the susceptible varieties. Another example of tolerance could be the way the plant responds to thrips feeding. Original feeding damage is visible only under a microscope, but it eventually becomes a rough bronzed edema. This bronzing and roughening could occur to different degrees in different varieties.

Differences in susceptibility to thrips damage could not be attributed strictly to any obvious category (experimental, red, older varieties, savoy, or seed company lines). When any of these categories, or a combination of them, were restricted from the analysis, the slopes of regression lines for the remaining varieties were still not significantly different, and differences still remained in the inter-
Table 2. Parameter estimates for regression models, grouped by variety, of visual damage rating predicted by seasonal pest total and cabbage head weight

<table>
<thead>
<tr>
<th>Variety</th>
<th>Seasonal total of P. xylostella</th>
<th>T. tabaci</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common slope for pest</td>
<td>0.019 (0.023)</td>
<td>-0.0532 (0.034)</td>
</tr>
<tr>
<td>Common slope for head wt</td>
<td>0.183 (0.111)</td>
<td>0.1237 (0.0494)</td>
</tr>
</tbody>
</table>

Intercept for variety

- Hitoma: 3.272 (0.450) 4.685 (0.388) 1.761 (0.341) 1.360 (0.350)
- Bartolo: 3.878 (0.388) 5.004 (0.365) 1.499 (0.420)
- Excel: 4.053 (0.429) 4.983 (0.573) 1.978 (0.354)
- Superdane: 3.858 (0.438) 4.239 (0.439) 0.766 (0.420)
- Red Head: 1.919 (0.443) 4.127 (0.420) 0.899 (0.458)
- Hinova: 3.948 (0.436) 4.222 (0.401) 0.939 (0.398)
- Market Prize: 3.754 (0.378) 4.641 (0.445) 1.355 (0.401) 1.120 (0.658)
- Decena Extra: 3.917 (0.381) 4.499 (0.520) 1.980 (0.272)
- Green Winter: 4.348 (0.411) 4.231 (0.555) 0.675 (0.259)
- Little Rock: 3.529 (0.474) 4.493 (0.416) 0.569 (0.375)
- Sunup: 3.590 (0.575) 4.559 (0.476) 0.232 (0.436)
- Roundup: 3.600 (0.438) 4.128 (0.340) 0.778 (0.297)
- Genoa 8329: 3.986 (0.522) 4.427 (0.419) 1.026 (0.389) 0.172 (0.400)
- Special Golden Acre: 5.033 (0.299) 0.801 (0.326)
- Falcon: 3.364 (0.544) 4.195 (0.363) 0.554 (0.376) 0.0277 (0.327)
- Chieflain Savoy: 3.820 (0.396) 4.305 (0.369) 0.044 (0.257)
- King Cole: 5.260 (0.425) 2.564 (0.340) 0.508 (0.270)
- Red Danish: 3.986 (0.522) 4.427 (0.419) 0.126 (0.400)
- Danish Ballhead: 5.021 (0.391) 0.469 (0.360)
- Early Jersey Wakefield: 4.443 (0.288) 0.133 (0.242)
- Geneva 8335: 0.205 (0.287) 0.329 (0.276) -0.112 (0.243)

Table 3. Candidate regression models for predicting visual damage rating by T. tabaci on fresh market cabbage in Geneva, N.Y., 1983

<table>
<thead>
<tr>
<th>No. parameters</th>
<th>$R^2$</th>
<th>MSE</th>
<th>C(p)</th>
<th>Parameter estimates for</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Intercept</td>
</tr>
<tr>
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<td>0.4688</td>
<td>0.4717</td>
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<td>0.6135</td>
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<tr>
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<td>5.3488</td>
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<td>0.4182</td>
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<td>0.6394</td>
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</table>

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