The Role of Cyanide in Host Plant Resistance to Japanese Beetle

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Nature of Work: The genus *Prunus* is highly diverse and includes many important nursery crops. Although a variety of insect pests feed on *Prunus* species, Japanese beetles (*Popillia japonica* Newman) are damaging foliar feeders that often require chemical control. Some *Prunus* taxa are known to contain cyanogenic glycosides that may play a role in host plant resistance to insect pests. Cyanide potential has been found to be an important factor in deterring the oblique-banded leaf roller (*Choristoneura rosaceana*) in peach and for *Locust migratoria* on sorghum (Kaethler, et al. 1982; Woodhead and Bernays, 1978). Identification and development of taxa with natural pest resistance would minimize the need for pesticide usage and aid in the development of more sustainable landscapes. The objectives of this study were to evaluate the role of cyanide in host plant resistance to Japanese beetle and to quantify variations in cyanide potential among *Prunus* taxa.

Foliage of twenty-seven taxa, representing a naturally occurring range of cyanide potential, were screened for resistance to Japanese beetle under no-choice feeding conditions. Ten replications of single leaves from each taxa were maintained in a fully hydrated state. One female Japanese beetle which had been starved for twenty-four hours was allowed to feed on a leaf for twenty-four hours in a continuously lighted growth chamber at 25C. Fecal material was dried and cyanide potential was determined with an enzymatic assay of lyophilized leaf tissue collected concurrently with leaf tissue collected for feeding trials. The experiment was arranged as a randomized complete block design. In addition to the above feeding study, a dose:response trial was performed with the compound prunasin, the cyanogenic glucoside that occurs in the leaf tissue of *Prunus* species. The artificial diet consisted of agar, cellulose, sucrose, water and prunasin at 0, 1, 5, 10, 20, and 40 mM concentrations. Single starved beetles were allowed to feed on the media for twenty-four hours. This experiment was arranged as a completely randomized design with n=10.

Results and Discussion: As foliar cyanide potential increased, feeding intensity of adult Japanese beetle showed a significant sigmoidal decrease (Fig. 1). Taxa with cyanide potentials equaling 2.48 mM/kg fresh weight (FW) and above inhibited feeding to levels not significantly different from zero (Table 1). In general, taxa with cyanide potentials less than 2.48 mM/kg FW were fed on more intensely and in a more random fashion. This data indicates that an apparent threshold level of approximately 2.5 mM/kg FW is needed to effectively deter feeding. An exception to these trends was *P. mahaleb*. This taxon exhibited a low level of cyanide potential but was highly resistant (mean FDW=0.3 mg). The resistance of *P. mahaleb* to feeding of Japanese beetle is therefore due to a mechanism other than cyanide potential. One possibility is the presence of coumarin compounds that have been found in *P. mahaleb* (Santamour and Riedel, 1994).

As the dose of prunasin increased in an artificial diet, feeding intensity also decreased (Fig. 2), with a response similar to that found for endogenous cyanide potential. These data substantiate the hypothesis that cyanogenic glycosides play a role in the deterrence of insect feeding. The effective dose of prunasin which reduced feeding by 50% (ED_{50}) was 4.9 mM. This concentration was higher than the concentration found to reduce feeding by the same amount in leaf tissue. The greater efficacy in the plant may be due to the localization of cyanogenic glycosides near the leaf surface or the presence of catabolizing enzymes in the plant capable of releasing larger amounts of hydrogen cyanide.

The selection and development of taxa with enhanced cyanide potential may yield more pest resistant plants. Further work is warranted to screen additional taxa for cyanide potential in order to identify plants which could be used in selection and improvement programs.

Significance to Industry: Alternatives to chemical control of insect pests are becoming increasingly desirable. Selecting more naturally pest resistant plants such as *P. padus, P. laurocerasus, P. virginiana, P.* x *yedoensis, and P. besseyi* for use in the landscape will lessen the need for chemical control measures. In addition, the identification of compounds responsible for antixenosis, such as cyanogenic glycosides, will aid in the development of more pest resistant plants through breeding and molecular techniques.

Literature Cited

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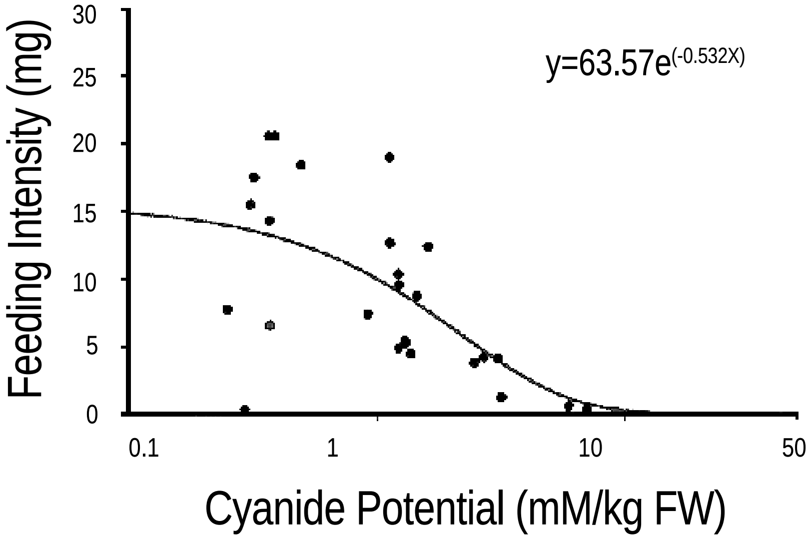

Figure 1. Relationship between feeding intensity (fecal dry weight) and cyanide potential measured in leaf tissue of 27 *Prunus* taxa. Each symbol represents the mean for a given taxa of *Prunus*, n=10.

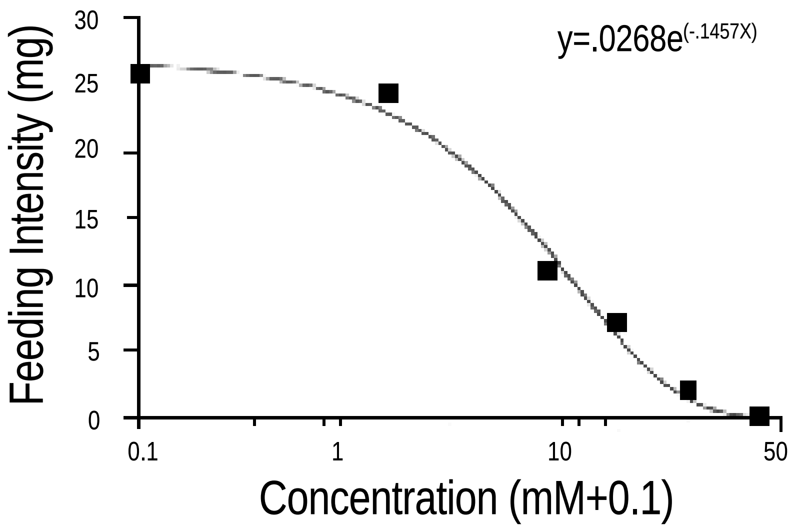

Figure 1. Feeding intensity (fecal dry weight) as a function of prunasin content in an artificial diet. Each symbol represents a mean, n=10.

Table 1. Feeding intensity (fecal dry weight) of Japanese beetles and foliar cyanide potential for 27 taxa of *Prunus*.

Taxa	Feeding Intensity (mg)	Cyanide Potential mM/kg FW
P. padus	0.00	9.24
P. laurocerasus	0.20	7.02
P. mahaleb	0.30	0.29
P. serotina	0.50	5.94
P. virginiana	1.10	3.18
P. x yedoensis	3.70	2.48
P. americana	4.00	3.07
P. besseyi	4.10	2.69
P. pennsylvanica	4.40	1.37
P. persica 'Redhaven'	4.80	1.23
P. persica 'Saharanpur'	5.20	1.30
P. persica 'Ta Tao #6'	5.30	1.30
P. artmeniaca	6.50	0.37
P. serrulata	7.30	0.92
P. mume	7.70	0.25
P. cerasifera	8.60	1.46
P. persica '134401'	9.40	1.24
P. persica 'Quetta'	10.20	1.23
P. subhirtella	12.20	1.62
P. x cistena	12.50	1.14
P. domestica	14.20	0.37
P. cerasus 'North Star"	15.40	0.31
P. avium	17.40	0.32
P. salicina	18.30	0.50
P. dulcis	18.80	1.14
P. sargentii	20.40	0.39
P. tomentosa	20.40	0.37
$LSD_{0.05}$	4.30	0.52