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Crabapple Cultivar Preferences of the Plum Curculio, *Conotrachelus nenuphar* (Herbst) (Coleoptera: Curculionidae)

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Abstract

Crabapple cultivars were surveyed for susceptibility to plum curculio attack. Three of the least susceptible cultivars and one susceptible cultivar, from 1984 and 1985 survey data, were tested in choice tests in the laboratory to confirm the ovipositional and feeding preference for 'Centennial' crabapples over 'Ormiston Roy,' 'Donald Wyman,' and 'Snowdrift' crabapples.

Introduction

Lipke and Fraenkel (5) regarded the study of host preferences by insects as the heart of agricultural entomology. Greater understanding of how insects locate their hosts should provide new tactics for pest control and help plant breeders to establish priorities. Crabapple cultivars have been extensively planted on the campus of the Ohio Agricultural Research and Development Center in Wooster, Ohio and are commonly attacked by the plum curculio. A greater range of susceptibility to *C. nenuphar* injury was noted on crabapples than on commercial apple cultivars. This observation suggested that factors involved in host plant selection and/or resistance or tolerance to plum curculio attack could be identified more readily by studying weevil damage to crabapple cultivars rather than commercial apple cultivars.

Currently, only two insect pests attacking apple in North America are being controlled to varying degrees by resistant host plants (2). The cultivar 'Northern Spy' is resistant to woolly aphids, *Eriosoma lanigerum* (Hausman), and certain late maturing apple cultivars are resistant to the apple maggot fly, *Rhagoletis pomonella* (Walsh) attack. In these cases, resistance has not been developed through breeding, but rather discovered. Specific intent to develop resistance in apple is likely to be slow due to the 2 to 3 decades required for the development of new cultivars (2). An apple cultivar with resistance then, should be investigated for possible inclusion in plant breeding programs.

Materials and Methods

During the periods, 10-19 July, 1984, and 10 July, 1985, samples of 100 fruit were taken from 47 different single crabapple tree cultivars on the Ohio Agricultural Research and Development Center Campus, Wooster, Ohio. The percentage of crabapples with oviposition scars were recorded as well as the diameters of 20 randomly selected fruits per sample. Regression analysis was used to determine if there were any association between fruit size and *C. nenuphar* damaged fruit.

In 1985, three cultivars which had consistently fewer damaged fruit in the 1984 and 1985 surveys, 'Ormiston Roy,' 'Donald Wyman,' and 'Snowdrift,' and one susceptible cultivar, 'Centennial,' were selected to determine if there were ovipositional preferences by *C. nenuphar* females. Since there was a size and weight difference between the susceptible and non-susceptible fruits, replicates were based on weight. For each replicate a larger 'Centennial' fruit was selected and weighed, then smaller fruits of 'Ormiston Roy,' 'Donald Wyman,' and 'Snow-

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Table 1. Susceptibility of *Malus* spp. and cultivar fruit to *C. nenuphar* damage, 1984-1985.

Selection	1984		1985	
	% damaged fruit[a]	X̄ fruit diameter (cm)[b]	% damaged fruit[a]	X fruit diameter (cm)[b]
M. baccata columnaris	0	.92	15	1.08
Ormiston Roy	2	.74	2	.79
M. sargenti rosea	4	.56	0	.61
Donald Wyman	4	.77	3	.85
Beverly	4	1.13	1	.96
Snowdrift	5	.58	1	.76
Winter Gold	10	.69	2	.69
Evelyn	11	.71	2	.77
M. sieboldii zumi	17	.51	1	.59
M. zumi calocarpa	21	.74	0	.77
M. robusta leucocarpa	22	1.04	13	1.70
Pygmy	27	.94	29	1.08
M. hartwigi	29	.94	—	—
M. lancifolia	30	1.80	9	2.29
M. robusta	31	.97	17	1.26
Hopa	32	1.12	13	1.66
Rosseau	32	1.28	13	1.50
Mary Potter	33	.69	0	.74
M. coronaria kelms	35	2.04	15	2.52
M. sikkimensis	35	.85	1	.83
Simcoe	41	1.59	7	2.10
Sundog	41	1.44	9	1.82
M. robusta persicifolia	42	1.29	6	1.60
Valley City	44	1.00	—	—
Henry F. DuPont	46	.76	17	1.09
M. coronaria nieuwlandiana	49	2.30	25	2.56
Makamik	51	1.31	12	1.67
Pink Spires	53	.96	16	1.27
Cowichan	53	1.39	34	2.59
M. baccata	54	1.45	21	1.77
M. Halliana	54	1.07	5	1.07
Liset	56	.91	10	.91
M. glaucescens	58	2.37	—	—
Hillier	60	.90	6	.95
Red Jade	64	.88	4	.88
Scugog	75	2.24	—	—
Geneva	81	2.91	36	3.87
Chestnut	82	2.59	46	3.39
Marshal Oyama	83	2.22	18	2.99
Dolgo	84	2.05	42	2.40
Cheals Crimson	85	1.30	32	1.77
Wooster #1	87	1.17	70	1.68
Leslie	88	2.52	8	4.00
Aldenham	91	1.26	33	1.53
Centennial	92	2.33	61	3.22
Selkirk	94	1.19	33	1.90
Pink Beauty	98	1.31	28	1.77

[a]100 randomly selected fruit from single trees.
[b]Randomly selected fruits from the 100 apple sample.

drift' were selected to equal the weights of the 'Centennial' fruit in each replicate (^{3} 0.5 g). Each paired comparison test included one susceptible cultivar ('Centennial') and one non-susceptible cultivar. Each of four replicates was randomized as to position and placed in one of the four corners of a 18 x 13 x 10 cm plastic rearing container. Ten *C. nenuphar*-females reared on apple cultivars were placed in each of the choice test rearing containers and oviposition and feeding scars were counted after 48 hours. Two separate trials were performed.

Results

Table 1 lists the selections sampled, % damaged fruit, and mean diameters of 20 randomly selected fruits. The relationship between fruit size and oviposition damaged fruit in 1984 and 1985 for all cultivars is shown in Figures 1 and 2. There is a relationship between fruit size and oviposition damage since the correlation coefficents were significant in the .001% level. Table 2 shows that *C. nenuphar* does prefer 'Centennial' to 'Ormiston Roy,' 'Donald Wyman,' or 'Snowdrift' crabapples. *C. nenuphar* will feed on the non-preferred selections but very few eggs were laid in them. 'Snowdrift' appears to be the most resistant to oviposition damage as no eggs were laid in those fruits.

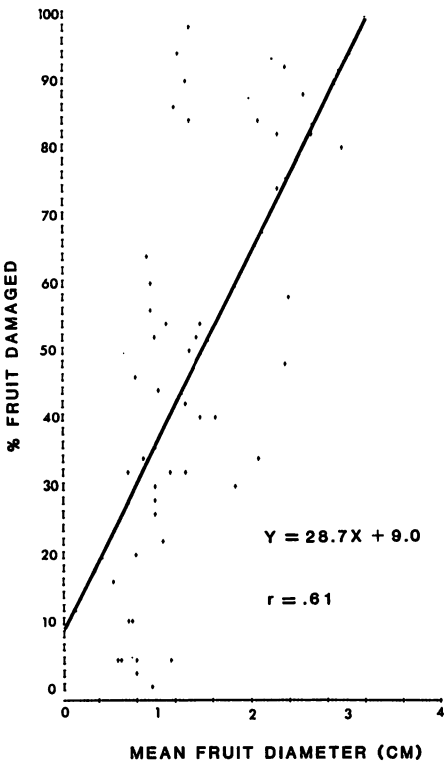

Figure 1. Linear regression of mean fruit diameter vs. percent fruit damaged, 1984.

Table 2. Susceptibility of crabapple selections to *C. nenuphar* oviposition and feeding damage.

Selection	Trial 1		Trial 2	
	Mean no. oviposition scars (± SE)[a]	Mean no. feeding and oviposition scars (± SE)[a]	Mean no. oviposition scars (±)[a]	Mean no. feeding and oviposition scars (±SE)[a]
Ormiston Roy	0.0 ± 0.0a	1.8 ± 0.5a	0.3 ± 0.3a	1.5 ± 0.5a
Centennial	7.3 ± 0.6b	9.4 ± 1.2b	9.5 ± 1.7b	12.0 ± 1.8b
Donald Wyman	0.0 ± 0.0a	1.3 ± 0.5a	0.8 ± 0.3a	2.5 ± 0.6a
Centennial	5.8 ± 0.9b	8.8 ± 1.2b	9.0 ± 1.8b	12.8 ± 2.1b
Snowdrift	0.0 ± 0.0a	1.0 ± 0.6a	0.0 ± 0.0a	0.5 ± 0.5a
Centennial	5.8 ± 1.7b	6.8 ± 1.5b	5.8 ± 0.8b	7.3 ± 0.6b

[a]Means followed by the same letter are not significantly different at the $\alpha = 0.05$ level (Duncan's [1955] multiple range test).

Discussion

Crabapple cultivars 'Ormiston Roy,' 'Donald Wyman,' and 'Snowdrift' showed some resistance to *C. nenuphar* oviposition damage. Just what mechanisms are involved remain to be determined. Caution is always in order in regression analysis since there is nothing in the definition of correlation that indicates or implies that the relationship between two variables is one

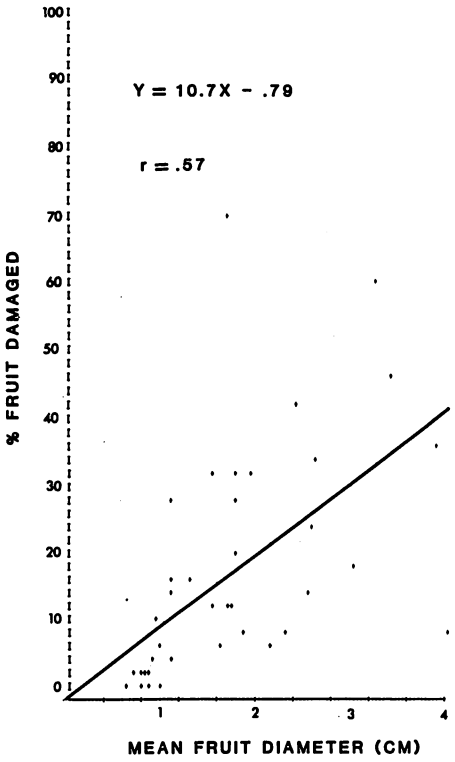

Figure 2. Linear regression of mean fruit diameter vs. percent fruit damaged, 1985.

of cause and effect. Our study indicates that fruit size is one factor in a probable host of factors in the ovipositional preference of *C. nenuphar* females. The non-preferred selections could be lacking in ovipositional stimulants or they could contain repellent or antibiotic chemicals (6). It is interesting to note that all of the weevil-resistant cultivars were previously found to be resistant to the fruit diseases, apple scab, cedar apple rust, powdery mildew, and fire blight, with the exception that 'Snowdrift' was susceptible to fire blight (1). These cultivars also have potential as pollinizers in solid set apple blocks and the fact that they are non-preferred hosts of *C. nenuphar* is another positive trait.

Physical factors such as fruit size, stem length, or physiological factors such as susceptibility of fruit to abscise after attack, could also be involved. Fruit size may be one factor in host selection by *C. nenuphar* as all of the non-preferred host fruits were quite small. Small fruits are probably not suitable for *C. nenuphar* oviposition for two reasons, 1) larvae may be unable to reach maturity in small fruits especially if more than one larva is feeding in the fruit (4), and 2) it is probably not as efficient for females to oviposit in several small fruits as it is to oviposit several times in a larger fruit. Therefore, selection pressures may have forced the preference for larger fruits.

Experiments to explore the physical and biochemical mechanisms involved in 'Snowdrift,' 'Donald Wyman,' and 'Ormiston Roy' resistance or 'Centennial' preference can now proceed. Since *C. nenuphar* is found in smaller fruits such as blueberry, wild plum, and two other smaller crabapple cultivars, 'Henry DuPont,' and 'Mary Potter,' this would suggest that the resistance/preference found is more likely due to a chemical mechanism, or another physical mechanism, rather than to fruit size. Future studies will expand our present limited knowledge of resistance/preference mechanisms in *Malus* cultivars.

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Malling 13 Survives Waterlogging

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A block of 'Delicious' and 'Starkrimson Delicious' on 5 rootstocks was set in a poorly drained, non-tiled Collamer silt loam and evaluated for survival after growing 2 seasons. The site was flooded for 4 days in the first growing season, a month after planting, and for 6 days in May the second growing season. Fifteen of the 20 trees on other stocks were severely stunted. These observations support our recommendations that M.13 be used in "wet feet" situations.

	Delicious		Starkrimson Delicious		Both scions
	No. planted	No. survived	No. planted	No. survived	Survival%
Malling 26	8	5	—	—	62
MM.106	8	5	8	4	56
Malling 13	10	8	10	7	75
MM.109	9	4	7	4	50
Seedling	9	6	—	—	67

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Cultivated Fruits of Britain

"Cultivated Fruits of Britain" is the title of a new book by F. A. Roach, a former member of the British Ministry of Agriculture's National Advisory Service. The book provides a background on the fruits and nuts grown in British gardens and commercial orchards dating from Roman times. Although varieties are listed, Roach's book deals mainly with historical aspects of varieties, and where and how fruit was grown. For example, in the 17th century, dwarf apple trees were recommended, but standard trees suggested where cattle grazing was done. The book is fascinating reading by all who enjoy tree fruits, small fruits, grapes and nuts, and can be obtained through Basil Blackwell, Inc., 432 Park Avenue South, New York, NY 10016. The price is $50.00—L. D. Tukey, Penn State Hort. Rev. 35:1.