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FORAGING BEHAVIOR OF HONEY BEES ON MANCHURIAN CRABAPPLE AND RED DELICIOUS APPLE[1]

D.F. MAYER AND J.D. LUNDEN
DEPARTMENT OF ENTOMOLOGY
WASHINGTON STATE UNIVERSITY, IAREC
PROSSER, WA 99350

Abstract

'Manchurian' crabapple pollinizer trees bloomed several days before red 'Delicious' trees. Of the honey bees collecting nectar, 98% foraged from the top of 'Manchurian' flowers but only 44% topworked 'Delicious' flowers. Topworkers spent less time per flower on 'Manchurian' than on 'Delicious'. Individual bees foraging from the side of the flower on 'Delicious' spent even less time per flower than topworkers.

INTRODUCTION

'Delicious' apple (*Malus sylvestris* Mill.) requires cross-pollination before setting fruit, so suitable pollinizer varieties must be planted throughout the orchard. Honeybee (*Apis mellifera* L.) pollinators are recommended for pollen transfer between varieties. The number and placement of pollinizer trees required for best production are largely determined by the foraging habits of honeybees, which tend to work along tree rows rather than cross the aisle spaces (Mayer *et al.*, 1986). Good pollinizers must bloom at the same time and have pollen compatible with the main variety. In addition, bee behavior must be compatible between varieties.

Pollinizers planted as every third tree in every third row ensure that each main-variety tree is adjacent to a pollinizer but minimizes the number of pollinizers. Having every second tree in every row a pollinizer ensures maximum pollination, but is not economically practical.

Pollinizers take up usable production space in the orchard. An alternative planting arrangement being tested in apple orchards uses flowering crabapples. (Williams and Church, 1983; Mayer *et al.* 1986). Crabapple pollinizers are planted between main variety trees every 72 to 120 m in each row with adjacent rows offset. They take up minimal space and their sole function is to provide pollen. Honey bee behavior on crabapple pollinizers and main varieties must be compatible for maximum pollination. The objective of this study was to compare the foraging behavior of honeybees on 'Manchurian' crabapple and 'Delicious'.

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Material and Methods

Data on honeybee foraging behavior were collected during bloom from 1982 through 1984 in a 9-ha block of 'Oregon Spur Red Delicious.' Part (0.05-ha) of the block was interplanted every 72 m in each row with 'Manchurian' crabapple as a pollinizer. The 'Delicious' trees were planted in 1978 and the 'Manchurian' crabapple in 1980.

Foraging honeybees were observed every second day during the study. Our classification of honeybee behavior was similar to that used by others (Free, 1970; Robinson and Fell, 1981; Kuhn and Ambrose, 1982). Nectar foraging topworkers put all their legs on the stamens and touched the stigma; sideworkers put at least the metathoracic legs on the petals and took nectar without touching the stigma. Pollen collectors scrabbled for pollen on the anthers and touched the stigma.

Counts were made by randomly moving through the test block. The frequency and times of each type of foraging behavior was recorded for a minimum of 500 visits by individual bees per apple variety each year. Only one observation was made per honeybee, and data were collected noting the time taken by a nectar collector to visit five flowers. Bee numbers were determined by slowly moving around 10 individual trees and counting the number of bees seen foraging in one minute. Percent total bloom was estimated on different dates for both varieties. Untransformed data were analyzed as a randomized design by analysis of variance with Duncan's (1951) multiple range test used for mean separations.

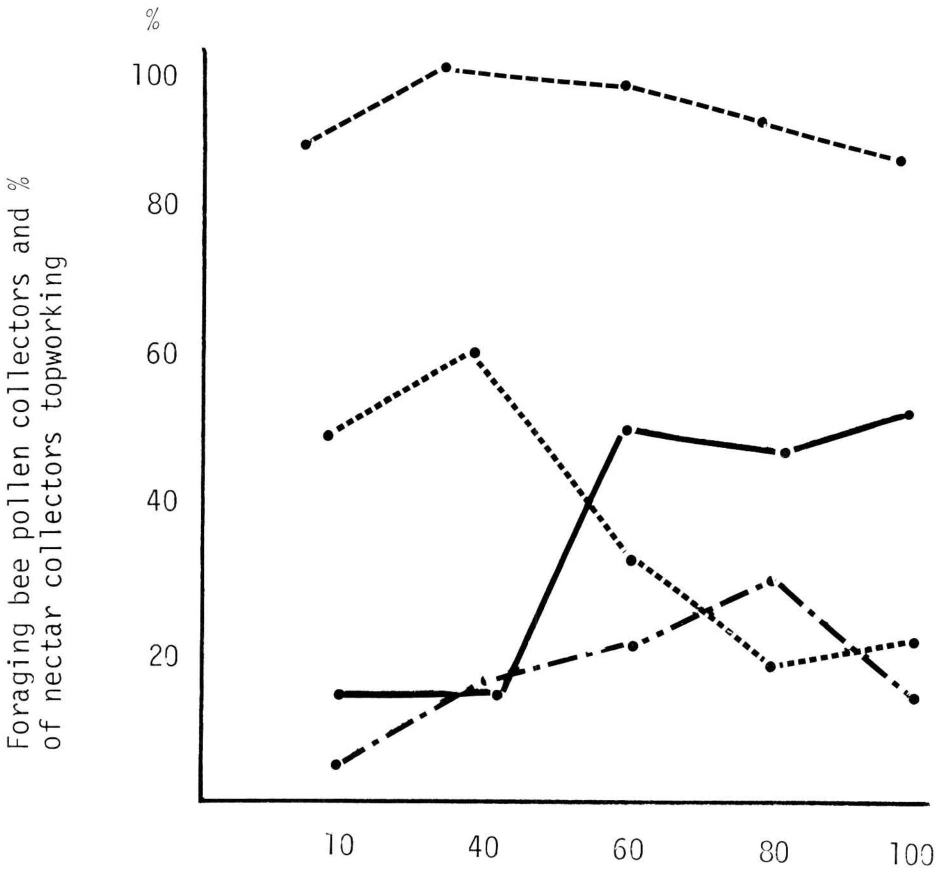

Fig 1. Comparison of topworking and pollen collecting behavior of honey bees at various bloom stages of 'Manchurian' crabapple and 'Delicious' apple. ▬▬▬▬▬▬ Topworking on 'Manchurian'; ▪▪▪▪▪▪▪▪▪ Topworking on Red Delicious; ▬ ▪ ▬ ▪ ▬ Pollen collectors on 'Manchurian'; ▬▬▬▬▬ Pollen collectors on Red Delicious.

Results and Discussion

On 'Manchurian' crabapple, most of the nectar collectors were topworkers (Table 1). This behavior remained consistent as bloom progressed (Fig. 1). Honeybees learn to sidework, taking nectar without touching the stigma and a pollinizer variety may contribute to a higher than normal percent of sideworkers on 'Delicious' (Robinson, 1979). Therefore, a flower shape and structure that encourages topworkers is desirable in a pollinizer since topworkers contact the stigma and accomplish pollination (Free, 1970). 'Manchurian' possesses this character.

On 'Delicious,' less than half of the nectar collectors were topworkers (Table 1) and as bloom progressed, the number of topworking bees decreased (Fig 1). Other observers have noted increases in sideworking behavior as bloom progresses, and we found our ratio of topworkers to be comparable to theirs (Kuhm and Ambrose, 1982; DeGrandi-Hoffman *et al.*, 1985).

Percent pollen collectors was variable between years for both cultivars although the overall means were not significantly different (Table 1). We suspect the ratio of pollen collectors to be determined by the amount of brood in a colony, which varies from year to year, rather than by the crop. We observed an increase in percent pollen collectors on 'Delicious' but little change on 'Manchurian' crabapple as bloom progressed (Fig. 1). On 'Delicious', DeGrandi-Hoffman *et al.* (1985) reported fewer pollen collectors as bloom progressed while Kuhn and Ambrose (1982) observed no changes.

The times required for sideworkers to take nectar, pollen collectors to work a flower, and one nectar collector to visit five flowers was not significantly different between 'Manchurian' crabapple and 'Delicious' (Table 1). We are aware of no other reports on time requirements for these events. There was little difference in these aspects of bee behavior between the two cultivars, except that topworkers worked faster on 'Manchurian' crabapple than on 'Delicious'. 'Manchurian' crabapple did not contribute to any adverse bee behavior.

The times for top- and sideworkers to work a flower were not significantly different on 'Manchurian' crabapple, but were on 'Delicious'. Sideworkers on 'Delicious' took about half the time to work a flower as topworkers (Table 1). Kuhn and Ambrose (1982) suggested that the predominance of sideworkers on 'Delicious' may be due to less energy expenditure needed for this type of nectar collecting. We suggest that sideworkers are more efficient since they can collect nectar faster than topworkers.

'Manchurian' crabapple generally blooms several days ahead of 'Delicious'. This is a desirable pollinizer characteristic. In 1982, it was at 20% bloom 10 days earlier than 'Delicious', but after the 'Manchurian' crabapple trees were more than two years old, the difference was only three days. 'Manchurian' crabapple trees had more bloom and more bees foraging than 'Delicious' trees (Table 2). The peak number of bee foragers coincided with full (90%) bloom.

Differences in bee behavior and bloom dates between 'Manchurian' crabapple and 'Delicious' were observed. None of these events appeared detrimental to the use of 'Manchurian' crabapple as a pollinizer for 'Delicious'.

Table 2. Comparison of blooming dates of 'Manchurian' crabapple and 'Delicious' apple.

	20% bloom open				90% bloom open				80% petal fall			
Year	Manchurian		Red Delicious		Manchurian		Red Delicious		Manchurian		Red Delicious	
1982	5/1	(0)*	5/11	(0.3)	5/11	(31)	5/14	(2)	5/16	(6)	5/17	(5)
1983	4/27	(18)	4/30	(3)	5/3	(27)	5/3	(10)	5/7	(11)	5/7	(7)
1984	5/7	(5)	5/10	(6)	5/12	(28)	5/14	(9)	5/15	(23)	5/8	(4)

*Numbers in brackets are number of honey bees per tree per minute.

Table 1. Foraging behavior of honeybees on 'Manchurian' crabapple and 'Delicious' apple.

	Activity (%)				Time (seconds)			
	Nectar collectors		Total foragers		Nectar collectors			1 bee to
Year	top working	side working	Nectar collectors	Pollen collectors	top working	side working	Pollen collectors	visit 5 flowers
'Manchurian' crabapple								
1982	99	1	66	34	8.1	7.0	9.8	---
1983	98	2	86	14	9.1	6.3	14.8	58
1984	96	4	83	17	7.9	7.3	8.4	54
Mean	98a	2a	78a	22a	8.4a	6.9a	11a	56a
'Delicious'								
1982	46	54	60	40	12.1	6.5	9.9	---
1983	38	62	85	15	11.2	6.4	12.0	55
1984	49	51	69	31	13.0	6.9	10.3	46
Mean	44b	56b	71a	29a	12.1b	6.6a	10.7a	51a

Means within a column followed by the same letter are not significantly different ($P \geq 0.05$); Duncan's [1951] multiple range test.

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LIFE HISTORY AND COLD STORAGE OF *AMBLYSEIUS CUCUMERIS* (ACARINA:PHYTOSEIIDAE)

DAVID R. GILLESPIE
AGRICULTURE CANADA, RESEARCH STATION
AGASSIZ, B.C. V0M 1A0
AND
CAROL A. RAMEY
DEPARTMENT OF BIOLOGY
UNIVERSITY OF VICTORIA
VICTORIA, B.C.

Contribution No. 366, Agriculture Canada, Research Station, P.O. Box 1000, Agassiz, British Columbia, Canada V0M 1A0

Abstract

Details were determined for the life history of the phytoseiid mite, *Amblyseius cucumeris*, with first-instar western flower thrips, *Frankliniella occidentalis*, as prey. *A. cucumeris* completed development in 11.09, 8.74 and 6.25 days at 20, 25 and 30°C respectively. This is slightly longer than reported for *A. cucumeris* by other authors using eggs of *Tetranychus* mites as prey. The mean egg production was 1.5 ± 0.99 eggs per day. In cold storage tests, after 10 weeks, 63% of *A. cucumeris* survived at 9°C, 1.2% survived at 2°C and 0% survived at -8°C.

INTRODUCTION

The predatory mite, *Amblyseius cucumeris* Oudemans (Acarina:Phytoseiidae), is a potential biological agent for various species of thrips (Thysanoptera) on greenhouse cucumbers and peppers (Ramakers 1983; De Klerk & Ramakers 1986). Previous work on the biology and life history of *A. cucumeris* was done using eggs of various tetranychid mite species (eg. El-Badry & Zaher, 1961, Kolodochka 1985). This did not allow for possibly different effects