Journal of the Arkansas Academy of Science

Volume 9 Article 5

1956

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SPINACH APHID CONTROL BY LADYBIRD BEETLES

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Some species of aphids have long been recognized as a favorite food of Ladybird beetle adults and larvae. In spite of the tremendous reproductive capacity of aphids, the Ladybird beetle is capable of holding aphid populations well in check under certain natural conditions.

This paper presents results of studies of the spinach aphid and the interrelationship of mixed populations of the Ladybird beetle and spinach aphid under controlled conditions.

MATERIALS AND METHODS

Large Cage for Population Studies

Figure 1 presents a picture of a cage constructed in one corner of a green house for the large cage experiment. The cage was three feet high supported by legs three feet in length. The sides of the cage were covered with muslin and the top with "sunray wire," a transparent glass substitute.

Figure 2 shows a sketch of the floor plan of the cage. A six-feet-square wooden floor was covered with approximately six inches of soil. A sleeve-covered manhole was left in the center of the wooden floor for entry into the cage. A one-foot-square duct provided an opening between the cage and an outside window. The duct was covered at the outer end with a fine mesh screen to exclude the passage of insects. An 8-inch fan installed in the duct was used to regulate temperature. A thermostat inside the cage was set to start the fan at 80° F. On days when cage temperature was above 80° F., the fan pulled cooler air in from outside. Recordings of a thermostat

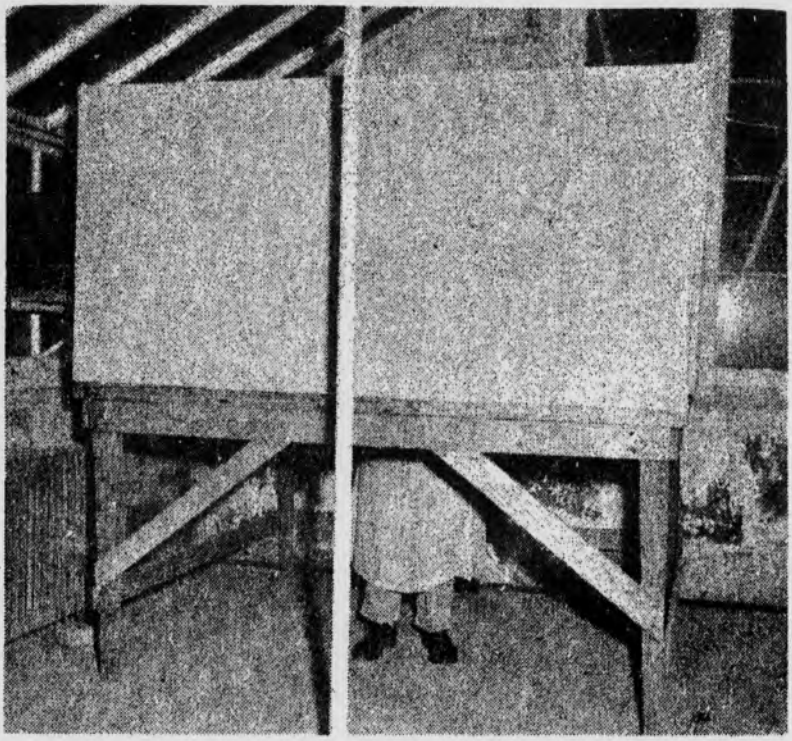

Figure 1 Population Study Cage

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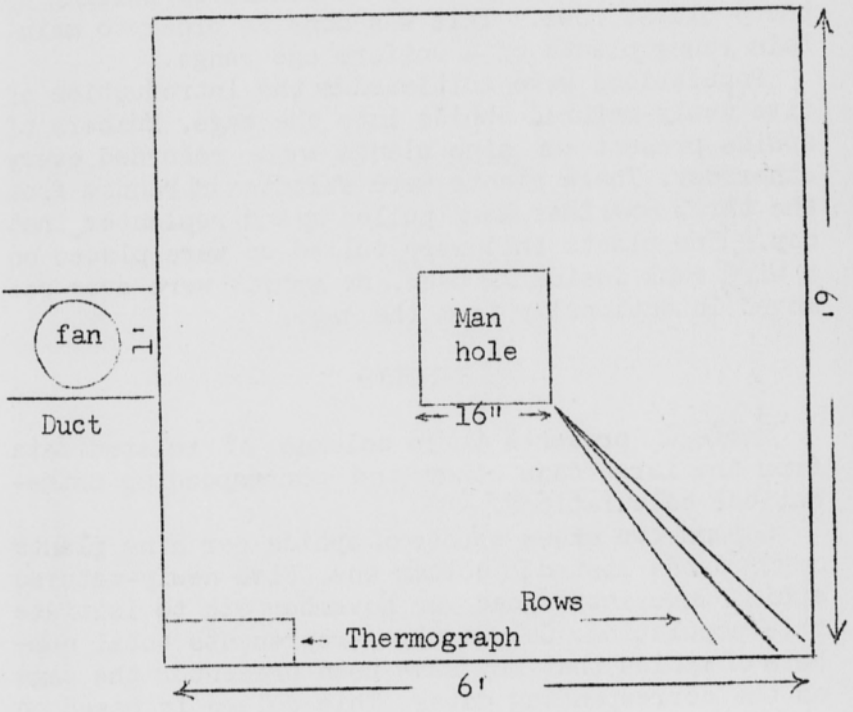

Figure 2 Floor Plan of Cage

revealed an average temperature inside of the cage of 74.17° F. for the entire experimental record.

Radishes were used as food plants for the aphids because they germinate and grow faster than spinach. Three rows were planted every other day with a total of 9 plantings or 27 rows. When the total space was planted, new plantings were continued by pulling up the 3 oldest rows. This was done in order to maintain young plants of a uniform age range.

Populations were initiated by the introduction of five newly-matured aphids into the cage. Numbers of aphids present on nine plants were recorded every other day. These plants were selected at random from the three rows that were pulled up and replanted that day. The plants that were pulled up were placed on a wire rack inside the cage. No aphids were ever removed intentionally from the cage.

RESULTS

Table 1 presents three columns of related data from the large cage study and corresponding mathematical calculations.

Column two shows counts of aphids per nine plants on the dates listed in column one. Five newly-matured aphids were introduced on November 9th to initiate this population. Column three represents total numbers of aphids that may have been present in the cage on the corresponding dates. This column is based on counts of aphids per nine plants and a close approximation of total plants. Assumption is made that aphids were equally distributed and that plants were uniform in size. Since aphid counts were made from the oldest plants, numbers in column three are somewhat exaggerated, even though they are based on actual counts. Column four represents a theoretical calculation of the potential population which five newly-matured spinach aphids could give rise to in thirty-one days. The above calculation is based on

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Table 1. The trend of a spinach aphid population in the absence of natural enemies under large cage conditions.

Date	Number aphids per 9 plants	Total aphids Actual[1]	Total aphids Theoretical[2]
November			
9	0	0	0
21	2	511	949
22			1,317
23	34	8,511	1,760
24			2,276
25	21	5,340	2,866
26			3,814
27	40	10,217	5,401
28			7,910
29	482	124,227	11,459
30			16,354
December			
1	34	8,591	29,878
2			31,290
3	456	117,725	41,899
4			56,081
5			76,276
6	854	220,358	106,034
7			149,347
8	946	243,810	210,802
9			295,788
10	1,347	347,603	398,897
11			
12	607	156,503	
13			
14	303	78,251	
15			
16	475	122,602	
17			
18	80	20,666	
19			
20	176	45,395	

[1] Total population present in cage based on counts in column 2.

[2] Calculations of the possible potential population.

records of individual rearing of spinach aphids on radishes. This theoretical calculation was increasing at the rate of 103,109 aphids per day by the thirty-first day, which would indicate a fairly close correlation between the calculated total population actually present and the theoretical totals on that date.

Columns two and three indicate an apparent decline of this population after December 10th, even though natural enemies were completely excluded. Since there was no obvious reduction in number of aphids present on the basis of total plant surface area, an explanation of probable causes of this decline is presented herewith.

Probably the most important factor contributing to the decline in numbers of aphids per plant was much smaller plants, hence smaller surface area. The smaller plants were apparently caused by both the heavy aphid population and weather conditions unfavorable for plant growth; e.g., short, cloudy days. The appearance of large numbers of winged aphids along with the population peak could well have been a partial cause of the declining numbers of aphids per plant. The appearance of winged aphids is nearly always accompanied by crowded conditions and/or shortage of food. Many of the winged aphids left the plants, and apparently spent the remainder of their lives on the cage walls. Presumably they were trying to escape from the cage. Many of the non-winged aphids also exhibited a general discontent by continuously crawling about the cage during the population peak.

Table 2 presents records from the spinach aphid population subjected to lady bettles under large cage conditions. Five newly-matured aphids were introduced into the cage on January 11, 1955.

Column two presents number of aphids per nine plants on the dates listed in column one. Fluctuations within this column are closely correlated with

absence or presence of lady beetle larva or adults.

A mixture of four different species of lady beetle adults were introduced into the cage. As shown in column three, these were introduced into the cage at intervals. Many of the first adult beetles introduced failed to reproduce. Additional introductions were made at intervals, attempting to provide for the initiation of a lady beetle population that would eliminate the aphids present in the cage.

Column four presents the number of larvae which hatched in the cage. Lady beetle eggs were deposited in clusters on the sides and top of the cage. Counts of larvae were made on the date hatching occurred. Newly-hatched larvae remained in a cluster around the egg shells for a few hours.

The most obvious result shown in Table 2 is the rapid reduction in number of aphids per nine plants between March 10 and March 20. However, the plants appeared to be very unhealthy, and the aphids seemed discontented even before March 10, 1955. Hence the aphid population would have probably taken a downward trend at this point without the effect of natural enemies, as shown in Table 1.

Hippodomia convergens (Guer) was the most prevalent species of lady beetle introduced into the cage. According to observations by Clausen (1) an individual of this species consumed an average of 349 aphids during the larval period and 863 during total adult life. Females lived considerably longer than males and consumed approximately three times as many aphids. He reports an average of 163 days for the larval period of this species. On the basis of Clausen's findings the aphid population could not have been eradicated by the lady beetles alone if conditions favorable for maximum aphid reproduction had existed. Hence the effect of limited plant surface area due to sickened and smaller plants surely favored the eradication of aphids by the lady beetles present.

Nevertheless, the presence of lady beetles, es-

Table 2. The effect of lady beetle adults and larva upon a spinach aphid population under large cage conditions.

Date	Number aphids per 9 plants	Number adult L. B. introduced	Number newly hatched L.B. larvae
January			
11	0		
22	15		
24	17		
26	79		
28	109	10	
30	109	4	
February			
1	306	6	
3	396	29	
5	352		
7	528		
9	770	2	27
11	871	4	15
13	1,001		43
15	489		
17	573	5	First adults emerge from pupae
19	357		
21	281		
23	579		
25	345	6	
27	501	5	
March			
1	289	5	
2			34 adults present in cage
4	439	4	25
6	919		30
8	2,010		29
10	2,538		8
12	1,620		60
14	76		28
			15
16	28		32
18	9		24
20	0		
22	0		

pecially the larval stage, seemed to be very effective in holding the aphid population in check. On the basis of a 16-day larval feeding period, the 85 larvae which hatched between February 9 and February 13 may have consumed an average of 1,483 aphids per day or a total of 29,665 aphids. This potential consumption of aphids by lady beetle larvae plus help from lady beetle adults present would account for the progressively lower counts of aphids per nine plants between February 13 and March 1. The 214 lady beetle larvae which hatched between March 4 and March 18 may have consumed an average of 2,919 per day or a total of 87,599 aphids.

SUMMARY

The spinach aphid has a tremendous reproductive capacity. As the population increases, plants become progressively unhealthy and stunted under large cage conditions. Potential increase of aphids is then checked by lack of sufficient plant surface area.

Lady beetle adults and larvae can rapidly reduce a population of spinach aphids when present in sufficient numbers. Plants recover amazingly fast when freed of aphids.

LITERATURE CITED

1. Clausen, C. P. 1916. Life History and Feeding Records of a Series of California Coccinellidae. Univ. of Calif. Pub. Tech. Buls. Vol. 1 No. 6: 251-299.