

The Effect of Japanese Beetle Feeding on the Yield of Soybeans¹

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The Japanese beetle was first found in Indiana in 1934 and now occurs in over 50 localized areas in the state. Most of these infestations are confined to urban areas where the feeding habits of larvae and adults are similar to those in the eastern states. However, some infestations do occur in rural areas where the normal food of the adult, the foliage of trees and shrubs, is scarce. This is especially true in Newton County where the original infested area of 1,000 acres found in 1953 had increased to over 100,000 acres by 1959. In such rural areas the principal food of the adult has been the foliage of smartweeds and soybeans. Larvae are more abundant in the weedy and grassy areas, although many are able to complete development in corn and soybean fields. Because of the economic importance of the soybean crop to Indiana farmers, reduction in yields from either beetle feeding on the foliage or larval feeding on the roots would be of special concern.

Field observations and trapping records in the Newton County area indicate that the first beetles appeared between June 20 and 27. Populations increased gradually and usually reached a peak around July 20. However, the finding of newly emerged beetles as late as August 10 indicated either a long emergence period or perhaps individuals with a life cycle differing from the normal. The preferred food of beetles in this region has always been smartweeds, but as the numbers of individuals and mating activity increased, beetles scattered throughout soybean fields. Regardless of the food plant, beetles tended to congregate in groups of two to six or eight and to feed on the sunny upper leaves. On soybeans feeding continued for a few hours up to a day before the beetles scattered to new locations.

Observations in the Newton County area indicated that the beetle population was highest in 1957 and dropped in 1958 and again in 1959. Beetle counts were made in the same two fields in all three years and showed a high peak in 1957 of 42 beetles per 100 feet of soybean row. Beetle numbers, of course, varied in the surveyed sections of rows with the presence or absence of smartweed and with the temperature, as more flights and other activity occurred when temperatures were between 80 and 90° F. The number of leaflets damaged ranged from three to six per infested plant or perhaps 5 to 10 per cent of the total foliage. Even in this field only about one plant in 20 suffered damage at some time during July and August. Thus the loss from beetle feeding was less than one per cent of the total foliage.

An exceptionally heavy population of beetles was found in 1957 on 12 rows of soybeans used as a border around a corn field. They were first observed on July 29 and averaged 500 per 100 feet on the outside row and totalled some 36,000 beetles per acre. This concentration was perhaps

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caused by a forced migration from an adjacent weedy, low area following heavy rains and flooding. On August 2 the farmer sprayed with DDT and killed all beetles present. During the five or six days that the insects were feeding they destroyed about 10 per cent of the foliage. The possible loss to this field, if untreated, was estimated at about 30 per cent of the foliage. This entire field was planted to soybeans in 1958 and the border area had less than two beetles per 100 feet of row, while counts in 300 feet (in corn the previous year) were around 30.

In addition to the amount of feeding a second factor influencing the extent of loss to soybean yields was the stage of plant growth at the time of beetle feeding. This started in early July and reached a peak in late July and early August. Numbers of individuals on foliage dropped rapidly after the middle of August. In 1957 and 1959 beetles were scarce after September 1, although in 1958 some were present to around October 1. In a study of losses to soybeans from simulated hail damage Kalton et al. (1) in Iowa described 10 stages of plant growth and found reduction in yields only when foliage was removed as seeds were beginning to develop in the lower pods. This period in general was from July 27 to August 5. Young plants 6 to 12 inches tall and with two to five trifoliolate leaves unfolded were injured less, while foliage damaged after the "green bean" stage hastened maturity. They found that the removal of 10 to 75 per cent of the leaves before blooming reduced yields only slightly, while 10, 25, 50, 75 and 100 per cent defoliation during the critical period reduced yields 8, 13, 18, 36 and 83 per cent respectively.

To simulate feeding injury and to determine subsequent losses in yield, soybeans were planted on the Purdue Agronomy farm in 1958 and 1959. Varying amounts of foliage were removed by hand from plots on one up to six dates. The soybeans used in 1958 was Clark, a late maturing variety. Foliage was removed on an eight day schedule and the amount removed was a percentage of the total foliage present on that day. The timing and amounts removed and the subsequent yields are given in Table 1. Maximum feeding activity of the beetle occurred around August 4 in that year, but the plots with 25 per cent of the foliage removed on that date had the highest yields of the experiment. The removal of 50 and 75 per cent of the foliage on this one date caused no significant reduction over the undamaged and the 25 per cent plots. Plots with multiple defoliations, especially when these occurred late into August, had significant reductions in yield as did those plots with 75 per cent defoliation on August 20 and the two plots with 100 per cent on August 4 and 20.

In 1959 the effect of foliage removal was compared with normal and with sprayed plants of Lindarn soybeans. While insects are of little importance on soybeans, leafhoppers and the spotted cucumber beetle were rather abundant this season. The plots sprayed three times with DDT at a rate of one pound actual per acre produced the highest yield of the experiment, but were not significantly better than the normal plants. Plots sprayed with a new phosphate insecticide, Dimethoate, at a rate of one pound actual per acre produced a good yield, but was significantly lower than the DDT plots.

The effect on yield of removing various amounts of foliage is given in Table 2. The amounts of foliage removed were reduced from the

TABLE 1. Yield of Clark soybeans when certain percentages of the total foliage present were removed by hand picking at various stages of growth. Agronomy Farm, 1958

Treatment No.	Dates and Amount of Foliage Removed						Yield per acre bushels
	July 17	July 25	Aug. 4	Aug. 12	Aug. 20	Aug. 27	
	%	%	%	%	%	%	
7.	—	—	25	—	—	—	47.9
20.	—	—	—	—	—	—	46.7
4.	25	—	25	—	—	—	46.6
14.	—	—	—	—	25	—	45.5
1.	25	—	—	—	—	—	44.5
11.	—	—	25	—	25	—	43.7
9.	—	—	75	—	—	—	43.5
2.	50	—	—	—	—	—	43.5
8.	—	—	50	—	—	—	43.2
5.	25	25	25	25	—	—	42.8
6.	—	25	25	25	25	—	40.8
19.	—	—	—	25	25	25	40.7
12.	—	—	25	—	50	—	40.4
13.	—	—	50	—	25	—	40.0
3.	75	—	—	—	—	—	39.7
18.	—	—	25	25	25	25	39.7
15.	—	—	—	—	50	—	37.6
16.	—	—	—	—	75	—	34.8
10.	—	—	100	—	—	—	29.6
17.	—	—	—	—	100	—	23.4
L. S. D.	19:1						4.2
	99:1						5.5

TABLE 2. Yield of Lindarn soybeans when some plots were sprayed and others had certain percentages of the foliage present removed by hand picking at various stages of growth. Agronomy Farm, 1959.

Treatment No.	Dates and Amount of Foliage Removed							Yield per acre bushels
	July 9	July 16	July 23	July 30	Aug. 6	Aug. 13	Aug. 20	
	%	%	%	%	%	%	%	
8. DDT Spray ¹	x	—	x	—	—	x	—	49.1
9. Untreated	—	—	—	—	—	—	—	46.7
10. Dimethoate Spray ²	x	—	x	—	—	x	—	45.5
2.	—	10	—	10	—	10	—	45.6
6.	—	—	—	50	—	—	—	45.1
4.	—	25	—	25	—	25	—	43.9
5.	—	—	25	—	25	—	25	43.2
3.	—	—	25	—	25	—	—	42.7
1.	10	10	10	10	10	10	10	42.5
7.	—	—	50	—	50	—	—	38.8
L. S. D.	19:1							2.8
	99:1							3.9

¹ DDT at 1 pound actual per acre was applied July 9, 23 and August 10.

² Dimethoate applied at 1 pound actual on the same three dates

previous year and consequently few yields were significantly lower than the untreated plots. A 10 per cent removal on three dates caused no appreciable reduction, while 10 per cent removal on seven consecutive weeks did reduce yield. A 50 per cent removal on July 30 caused no reduction, while 50 per cent removal on July 23 and August 6 resulted in a big reduction. In general the removal of foliage on August 6 or later had more influence on yield than did the earlier removal.

The effect of feeding by beetles caged on soybean plants was observed in Newton County in 1958 and 1959. Three cages, 3 feet high, 2½ feet wide and 10 feet long, were placed over soybeans in a commercial field. Beetles were introduced into two cages at various dates starting in late July. One cage was considered "heavy," one "medium" and one "none." In the first year 48 females and 21 males were introduced into the first cage over a period of 18 days. About half this number were placed in the second cage. In the "none" cage at least five were observed, apparently emerging from the soil after the cage was set. Feeding was not extensive in any of the cages, although beetles were seen through September and one was found alive on October 1. Plant growth in the cages was more or less normal, although plants were 10 to 12 inches taller than those outside. Beans harvested from the caged areas were about the same, ranging from 448 to 468 grams.

In 1959 the cages were again placed in a commercial field. In the "heavy" cage 83 females and 86 males were placed and in the "medium" 36 females and 41 males. Little feeding or beetle activity was observed in any of the cages. Yields of beans from caged areas were 515, 517 and 415 grams and from a comparable area outside the cage an average of 669 grams. Although a quarter inch mesh hardware cloth was used on the cage, it was possible that some beetles escaped.

Summary. The Japanese beetle in Newton County showed a definite host preference for the foliage of smartweed, but did become scattered over soybean fields in late July and early August. Beetle populations in the years 1957 and 1959 were low and even in the heaviest infested fields less than one per cent of the foliage showed feeding injury. One exception was an area of 1¼ acres where 12 rows of soybeans were planted as a border along the end of a corn field. Here the beetle count on the outside row was 5 per foot and 2 per foot on the inner row or a total of approximately 36,000 per acre. Damage in the five days before the farmer killed all beetles with a DDT spray was estimated at 10 per cent of the foliage.

Losses caused by beetle feeding were simulated in tests at Lafayette by the hand removal of foliage from soybeans. Plots had 10, 25, 50, 75 and 100 per cent of the foliage removed on one or up to seven different dates. In general 10 and 25 per cent of the foliage could be removed on several dates without reducing the yields. The critical period of growth was from July 28 to about August 8 when the beans were starting to fill the pods. The removal of 10 per cent of the foliage at seven weekly intervals did cause some reduction.

Literature Cited

1. KALTON, R. R., C. R. WEBER and J. C. ELDRIDGE. 1949. The effect of injury simulating hail damage to soybeans. Iowa A. E. S. Res. Bul. 359.